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Divergence of the fermentative and bromatological characteristics of 25 sorghum hybrid silages[1]

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ABSTRACT - The objective of this study was to evaluate the divergence of bromatological and fermentative characteristics of silages of 25 sorghum (*Sorghum bicolor* L. Moench) hybrids. The experimental design was completely randomized with 25 treatments and four replications. The mean values of pH differed with variation from 3.45 to 3.87 for hybrids 866005 and 870051, respectively, and the mean pH value was 3.66. The average percentage of lactic acid ranged from 2.90 to 7.43 dag/kg of dry matter (DM) in hybrids 870035 and 866005, respectively, with an average of 4.65 dag/kg DM. Through cluster analysis by the Tocher method and average Euclidean distance based on the fermentative characteristics, five groups were formed: one with 18 hybrids, another with four and three groups with one hybrid in each. In group three, there were the hybrids that showed the highest values of lactic acid. Hybrids 870025, 870035, 870081, 870095, 866034, and 870031 showed higher DM content and the hybrid BRS 610 had the lowest average compared with the others. Hybrids 1F305, BRS 610, Volumax, and XBS60329 had the lowest levels of non-fiber carbohydrates and higher neutral detergent fiber corrected for ash and protein. Despite the fermentative and bromatological divergences between hybrids, they are not a limiting factor to silage production.

Key Words: crude protein, forage conservation, non-fiber carbohydrates, semiarid

Introduction

The semiarid northeastern region of Brazil is characterized by having unevenly distributed rainfall, concentrated in a short rainy season, followed by a long dry season. This irregular pattern of rainfall is one of the biggest challenges in producing feed for livestock.

The forage conservation in the form of silage can be a viable alternative to reduce the problem of scarcity of forage in drier times of the year and enable the production systems in the semiarid region.

Among the various grass species that have characteristics for silage, corn (*Zea mays*) and sorghum (*Sorghum bicolor* L. Moench) are those with the most appropriate profile for this purpose due to the ease of cultivation, high forage yield, and especially, the characteristics that promote silage of adequate fermentation and satisfactory quality, as the high content of soluble carbohydrates. In the evaluation of sorghum hybrids, producers seek for the combination of production traits and high nutritional value, and to meet the nutritional requirements, reduce the cost with feeding and contribute to optimum bioeconomic performance.

Currently, there is the market availability of hybrids that have good balance of stalks, leaves and panicles, combining high dry matter (DM) productivity and high nutritional value (Molina et al., 2002). The sorghum forage is characterized by high natural matter (NM) production per hectare, with a lower number of panicles. The dual-purpose sorghum has high yields of NM and DM combined with greater participation of the panicle component, reaching 68% in DM (Silva et al., 2011).

Sorghum silages are characterized for presenting appropriate fermentation profile, given the amount of soluble carbohydrates mainly present in the stem, which ensure the preservation of the fermentation and nutritive value of the ensiled material. Ribeiro et al. (2007), evaluating sorghum hybrids, observed proper fermentation profile of the silage in terms of DM content, crude protein, ammonia nitrogen in relation to total nitrogen and pH, with values of 32.65, 6.82, 1.92 and 4.02, respectively. The nutritional

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value of sorghum silage depends on the characteristics of the hybrid used, such as height, percentage of panicles, stem and leaf, and the stage of maturity at harvest (Cândido et al., 2002).

Therefore, the objective was to evaluate the divergences of bromatological and fermentation characteristics of the silages of 25 sorghum hybrids.

Material and Methods

Twenty-five sorghum hybrids (*Sorghum bicolor* L. Moench) developed by the breeding program of Embrapa Milho e Sorgo designated by the following names or codes were evaluated: 866005, 866019, 866033, 866034, 866035, 866036, 866037, 866040, 866041, 866042 , 866043, 866044, 870025, 870031, 870035, 870041, 870051, 870067, 870081, 870085, 870095, 1F305, BRS 610, Volumax and XBS60329.

The hybrids were grown at the experimental station of the Instituto Nacional do Semi-Árido (INSA), in Campina Grande, Paraíba, Brazil.

Sowing took place on April 18, 2009, in plots of 4.9 m^2 (4.9 × 1.0 m), spaced 70 cm between rows and thirty days after planting, thinning was performed in order to keep the crop density of 12 plants per linear meter. Fertilization based on soil chemical properties of the experimental area was conducted, using 100 kg/ha of nitrogen in the form of ammonium sulfate and 60 kg/ha of P_2O_5 in the form of superphosphate. The application of nitrogen was split, with 50% applied in the thinning period and the remaining fifteen days after thinning, while the phosphorus was applied at planting.

The hybrids were harvested and ensiled at the dough stage. As experimental hybrids reached the point of harvest on different days, three harvests were conducted. At 98 days, hybrids 866042, 866043, 866044, 870025, 870035, 870041, 870051, 870067, and BRS 610 were harvested. Hybrids 866005, 866019, 866033, 866034, 866035, 866036, 866037, 866040, 866041, 870031, 870081, 870085, 870095, Volumax, and XBS60329 were harvested at 104 days, and hybrid 1F305, at 131 days.

The plants were cut with knives 10 cm away from the soil and then chopped in a stationary forage machine. The material was ensiled in PVC silos with 10 cm of diameter and 40 cm of height. The compaction of the material was performed with wooden sockets to reach a density of about 550 kg/m^3. The silos were opened 40 days after ensiling.

The experiment was conducted in February 2010, at the Laboratory of Animal Nutrition of the Center of Agrarian Sciences of Universidade Federal da Paraíba (UFPB), located in Areia, Paraíba, Brazil, and at the Laboratory of Animal Nutrition of Universidade Estadual de Santa Cruz, belonging to the municipality Ilheus, Bahia, Brazil.

The design was completely randomized with 25 treatments and four replications; the silages of 25 sorghum hybrids were the treatments evaluated.

For pH determination, samples of approximately 25 g of silage were collected, to which 100 mL of water were added, and, after resting for an hour, the reading of the pH was performed, using a potentiometer. In another sample of 25 g, 200 mL of a 0.2 N H_2SO_4 solution were added to remain at rest for 48 hours, for filtering on Whatman filter to be performed. This filtrated solution was stored in the refrigerator for further analysis of ammonia-N (Bolsen et al., 1992). For the analysis of organic acids, 10 g of sample were dissolved into 90 mL of distilled water and filtered through Whatman-type filter paper (Kung Jr. & Ranjit, 2001). 1 mL of 20% metaphosphoric acid solution was added to 2 mL of filtrate. The samples were centrifuged at 13,000 rpm for 15 minutes, and then submitted to analysis of organic acids (lactic, acetic, propionic and butyric acids) in SHIMADZU high performance liquid chromatography (HPLC) coupled to a UV detector (UV), model SPD-10A VP using 210 nm as wavelength.

Approximately 500 g of silage sample were collected from each silo. These samples were oven-dried (60±5 °C) for 72 h, and processed in a knife mill with 1 mm sieve. From these samples, the dry matter (DM), crude protein (CP), mineral matter (MM) and ether extract (EE) were determined, according to methods described by Silva & Queiroz (2002). The contents of neutral detergent fiber (NDF) and acid detergent fiber (ADF) were evaluated using the compositions of detergent recommended by Mertens (2002) and Goering & Van Soest (1975), respectively. The autoclave micro-extraction method was used (Pell & Schofield, 1993). In the NDF analysis, the samples were treated with thermo-stable alpha-amylase, without the use of sodium sulfite and corrected for residual ash. The correction for ash from NDF and estimation contents of neutral detergent insoluble nitrogen (NDIN) and acid detergent insoluble nitrogen (ADIN) were made according to Licitra et al. (1996). The content of hemicellulose (HEM) was calculated by subtracting the NDF corrected for ash and protein (NDFcp) by the ADF corrected for protein (ADFp).

The concentration of non-fibrous carbohydrates (NFC) was estimated through the following formula: %NFC = 100 - (%CP + NDFap% + %EE + %MM), in which NDFap ccorresponds to NDF corrected for ash and protein (Sniffen et al., 1992).

The results were subjected to analysis of variance and when necessary, the Scott-Knott test ($\alpha = 0.05$) was used to compare the means of each hybrid, using the software

SAEG (Sistema de Análises Estatísticas e Genéticas, version 8.0). The test proposed by Scott & Knott (1974) was used for being a clustering method that, unlike other univariate tests of multiple comparison of means, eliminates the ambiguity and separates the means of treatments into homogeneous groups, facilitating the interpretation, especially when working with a large number of treatments (Santos et al., 2001).

Multivariate analysis was performed using as an aid tool the software SAEG (Sistema de Análises Estatísticas e Genéticas, version 8.0). The fermentation characteristics were examined by hierarchical clustering analysis using the Tocher method (Johnson & Wichern, 1992), adopting the Euclidean mean distance as a basic measure of dissimilarity and standardized data. pH, $N\text{-}NH_3$, and organic acids (latic, acetic, propionic and butyric) were used as discriminatory features.

Results and Discussion

According to the statistical analysis, difference (P<0.05) between the ensiled hybrids was observed for all fermentation characteristics evaluated (Table 1).

The average pH values were higher (P<0.05) for the silage made with hybrids 870025, 870031, 870041, 870067, 870051 870085 and 870081, with values greater than 3.75, followed by hybrids 866037, 866040, 866042, XBS60329 , 870035, 866044, which had pH values of silages varying between 3.79 and 3.81. According to McDonald et al. (1991), the optimal pH for well preserved silage should be between 3.8 and 4.2.

The silage made of hybrids 866036, 866035, 870095, Volumax, 866034, 866043, 1F305 and 866041 presented average pH between 3.72 and 3.67. These values were higher (P<0.05) in comparison with hybrids 866005, 866033, 866019, and BRS 610, which showed values inferior to 3.56, with a minimum of 3.45 for hybrid 866005. The low pH of these silages may be due to the soluble carbohydrates content of plants at the time of ensiling, because these are the main substrate used by lactic acid bacteria, contributing to acidification, due to the increase in lactic acid production, with low negative correlation, which in this study was -0.57.

The production of $N\text{-}NH_3$ was higher (P<0.05) for hybrids 866033, BRS610, and 1F305, with values between 5.64 and 6.81 dag/kg of total nitrogen (Table 1). According to Molina et al. (2002), silages which have $N\text{-}NH_3$ values lower than 12 dag/kg total nitrogen are considered of good quality. Therefore, the results found in this study were

Table 1 - Mean values of the silage fermentation characteristics of 25 sorghum hybrids

Hybrid	pH	$N\text{-}NH_3$	LA	AA	PA	BA
		dag/kg TN	dag/kg DM			
866005	3.45d*	4.58b	7.43a	0.85b	0.29a	0.04a
866019	3.53d	4.69b	5.92c	1.04a	0.23b	0.04a
866033	3.49d	5.69a	4.45d	1.01a	0.22b	0.02b
866034	3.59c	4.85b	4.30d	0.90b	0.18b	0.02b
866035	3.56c	4.13c	4.65d	1.02a	0.22b	0.03b
866036	3.56c	2.86c	5.53c	1.03a	0.23b	0.02b
866037	3.67b	4.18c	5.17d	0.92b	0.21b	0.02b
866040	3.67b	2.90c	4.57d	0.94b	0.21b	0.02b
866041	3.65c	3.17c	4.84d	0.97a	0.24b	0.02b
866042	3.68b	3.54c	4.74d	0.65c	0.27a	0.04a
866043	3.60c	3.18c	5.47c	0.71c	0.29a	0.03b
866044	3.72b	4.09c	5.27c	0.61c	0.27a	0.04a
870025	3.76a	3.45c	4.04d	0.52d	0.21b	0.03b
870031	3.77a	3.57c	3.97e	0.47d	0.20b	0.03b
870035	3.71b	3.01c	2.90f	0.26e	0.23b	0.02b
870041	3.79a	3.70c	4.36d	0.58c	0.22b	0.03b
870051	3.87a	4.51b	3.78e	0.62c	0.24b	0.04a
870067	3.80a	3.84c	4.61d	0.70c	0.22b	0.04a
870081	3.83a	3.46c	3.34f	0.51d	0.20b	0.02b
870085	3.81a	2.98c	3.90e	0.54d	0.18b	0.02b
870095	3.57c	4.22c	4.29d	0.53d	0.17b	0.02b
1F305	3.63c	6.81a	4.49d	0.71c	0.29a	0.04a
BRS 610	3.54d	5.64a	6.43b	0.91b	0.34a	0.04a
Volumax	3.57c	5.05b	4.56d	0.84b	0.30a	0.03b
XBS60329	3.68d	4.20c	3.30f	0.64c	0.18b	0.02b
Mean	3.66	4.09	4.65	0.74	0.23	0.03
CV (%)	1.31	21.81	8.34	12.81	17.63	26.38

$N\text{-}NH_3$ - ammonia nitrogen; LA - lactic acid; AA - acetic acid; PA - propionic acid; BA - butyric acid; TN - total nitrogen; DM - dry matter; CV - coefficient of variation.
*Means followed by same letter in the column do not differ by the Scott-Knott test (α = 0.05).

lower than those in the literature (Araujo et al., 2007; Ribeiro et al., 2007), which may be associated with adequate fermentation of the ensiled hybrids. The N-NH_3, expressed in dag/kg of total-N is regarded as one of the main variables resulting from the fermentation quality because it is an indicator of proteolysis during the fermentation process, conducted mainly by bacteria called *Clostridium*. According to Woolford (1984) and McDonald et al. (1991), the proteolysis extends during fermentation when there is no acidic conditions sufficient for the undesirable microorganisms to be inhibited.

The average percentage of lactic acid ranged ($P<0.05$) from 2.90 to 7.43 dag/kg of dry matter (DM), with higher ($P<0.05$) value for the hybrid 866005. Development of lactic acid bacteria in the silo depends on the presence of soluble carbohydrates. With the proper production of lactic acid and the rapid decrease in pH, the conditions for inhibition of proteolytic activity of plant enzymes and proliferation of undesirable bacteria are established (Santos et al., 2008).

For acetic acid, variation was observed ($P<0.05$) between hybrids with average percentage from 0.47 dag/kg DM for the hybrid 870031 to 1.04 dag/kg DM, for hybrid 866019, with an average of 0.74 dag/kg DM. The propionic acid showed average percentage of 0.23 dag/kg DM, ranging from 0.17% for hybrid 870095 to 0.34 dag/kg DM, for hybrid BRS610.

The high soluble carbohydrate content of sorghum silage favors the process of aerobic deterioration by fungi and yeasts, resulting in losses after the opening of the silo. However, the organic acids produced by fermentation, especially acetic and propionic acids, have fungicidal action and can mitigate this deterioration, increasing the aerobic stability of the silage (Ranjit & Kung Jr. 2000; Kung Jr. & Ranjit, 2001; Kleinschimit & Kung Jr., 2006; Mendes et al., 2008). The averages of butyric acid presented difference ($P<0.05$), with values close to zero. These values confirm the absence of secondary fermentation, which could cause nutrient losses. Butyric acid production is associated with fermentations carried out by clostridial, resulting in consumption of sugars and protein, which reduces the nutritional value and also the consumption of the silage. Based on the concentrations of butyric acid, it can be inferred that the activity of proteolytic clostridia in silage of all hybrids was minimized during the fermentation process.

Based on the fermentation characteristics, it can be inferred that in all silages there was an adequate fermentation process. Even if there are significant differences between the hybrids, pH, ammonia nitrogen and acid organic values are within the standards that characterize a well-fermented silage (McDonald et al., 1991).

Using as discriminatory features the pH, N-NH_3, lactic, acetic, propionic and butyric acids, five groups were established, by the Tocher method: one group contained 18 hybrids, other group contained four and three groups with a hybrid each (Table 2).

Forming groups allowed the visualization of closer hybrids with one or more characteristics in common. Group 1 comprised 72% of hybrids, which had the highest average pH value (3.71), followed by hybrid 1F305 with 3.63. The silage hybrids with the highest concentration of lactic acid (Table 3) are found in group 2. These silages had the lowest average pH, probably due to the increased amount of organic acids.

The values of ammonia nitrogen from all groups were within the range recommended by Molina et al. (2002) to obtain good quality silage, which is less than 12 dag/kg total nitrogen. However, the hybrid 1F305 (group 5) had the highest average in relation to the other groups. Even with higher N-NH_3 production, this did not affect the crude protein content (CP) of its silage, which was 6.79 dag/kg DM (Table 4).

It is possible to infer that there was low divergence between the fermentation characteristics of the silages assessed, because the difference between the groups was low due to the similarity in the silage fermentation and these characteristics are not limiting factors to any of the hybrids tested. The values observed in this study corroborated with the literature data (Rocha Jr. et al., 2000; Cândido et al., 2002; Molina et al., 2002; Rodrigues et al., 2002; Neumann et al., 2005; Skonieski et al., 2010).

The process of silage fermentation influences directly the loss of nutrients and consequently the bromatological

Table 2 - Grouping of 25 sorghum hybrids silages, based on fermentation characteristics, using the Tocher method and the Euclidean distance

Groups	Hybrids
1	866034, 866035, 866037, 866040, 866041, 866042, 866043, 866044, 870025, 870031, 870035, 870041, 870051, 870067, 870081, 870085
2	866005, BRS 610, Volumax, 866019
3	866033
4	866036
5	1F305

composition of the silages. As the fermentation was adequate in the silages assessed, based on the fermentation profile, no significant variation that could compromise the chemical composition of the hybrids studied was observed (Tables 4 and 5).

The DM content of silage hybrids ranged between 23.43 and 42.15 dag/kg of natural matter (NM), with an average of 34.68 dag/kg NM. Hybrids 870025, 870035, 870081, 870095, 866034, and 870031 had higher (P<0.05) values of DM and the hybrid BRS 610 had the lowest (P<0.05) average in relation to the others. The low DM content of the hybrid BRS 610 can be explained by the higher percentage of total DM in the stem, as observed by Silva et al. (2011). The higher values of DM in the silages may be associated with a high percentage of panicle, as observed by Silva et al. (2011). Neumann et al. (2002a)

Table 3 - Descriptive statistics of the fermentation characteristics of the groups formed by 25 silage sorghum hybrids

Groups		pH	$N\text{-}NH_3$	LA	AA	PA	BA
			dag/kg TN	dag/kg DM			
1	Mean	3.71	3.72	4.31	0.67	0.22	0.03
	Minimum	3.56	2.90	2.90	0.26	0.17	0.02
	Maximum	3.87	4.85	5.47	1.02	0.29	0.04
	CV (%)	2.44	14.77	15.79	29.39	14.93	24.23
2	Mean	3.52	4.99	6.08	0.91	0.29	0.03
	Minimum	3.45	4.58	4.56	0.84	0.23	0.03
	Maximum	3.57	5.64	7.43	1.04	0.34	0.04
	CV (%)	1.19	8.30	16.99	8.66	13.39	14.62
3	Mean	3.49	5.69	4.45	1.01	0.22	0.02
4	Mean	3.56	2.86	5.53	1.03	0.23	0.02
5	Mean	3.63	6.81	4.49	0.71	0.29	0.04

$N\text{-}NH_3$ - ammonia nitrogen; LA - lactic acid; AA - acetic acid; PA - propionic acid; BA - butyric acid; TN - total nitrogen; DM - dry matter; CV - coefficient of variation.

Table 4 - Bromatological composition of the silages of 25 sorghum hybrids

Hybrid	DM	MM	CP	EE	NDIN	ADIN
	dag/kg NM	dag/kg DM			dag/kg TN	
866005	31.74c*	7.29a	5.85b	1.73c	14.43a	9.36c
866019	33.07c	6.29b	6.69a	1.88c	16.63a	11.13b
866033	33.36c	6.11b	6.98a	1.75c	13.22b	9.76c
866034	41.55a	5.68b	7.01a	2.65b	14.78a	11.75b
866035	36.60b	6.25b	6.92a	2.65b	15.16a	10.92b
866036	33.72c	6.86a	6.45a	2.88b	12.53b	10.48c
866037	33.75c	6.79a	6.00b	2.79b	13.41b	14.23a
866040	36.28b	6.04b	7.12a	2.16c	12.20b	11.08b
866041	35.01c	6.09b	6.56a	2.41c	13.99a	13.62a
866042	30.27c	7.09a	6.25b	2.07c	13.32b	8.34 d
866043	31.21c	7.22a	6.59a	2.31c	13.03b	12.18b
866044	31.55c	6.71a	6.78a	2.66b	13.35b	12.50a
870025	39.69a	6.71a	6.75a	2.65b	11.72c	10.10c
870031	42.15a	6.00b	7.24a	2.98b	14.90a	8.66c
870035	39.87a	6.29b	6.52a	2.77b	8.38 d	11.24b
870041	34.52c	7.01a	7.19a	3.52a	10.68c	9.06c
870051	36.70b	5.77b	5.85b	2.17c	15.52a	13.17a
870067	32.11c	7.10a	6.14b	2.58b	11.37c	9.16c
870081	40.45a	6.36b	6.03b	3.41a	13.34b	9.47c
870085	38.64b	6.03b	6.63a	3.32a	15.40a	9.71c
870095	40.90a	5.90b	5.92b	2.17c	13.50b	9.34c
1F305	28.62d	5.62b	6.79a	2.02c	11.55c	6.13d
BRS 610	23.43e	7.43a	5.47b	2.26c	12.22b	8.06d
Volumax	29.54d	6.49b	5.59b	2.67b	16.84a	9.06c
XBS60329	32.17c	6.84a	5.44b	2.42c	16.55a	7.29d
Mean	34.68	6.48	6.43	2.52	13.52	10.23
CV (%)	6.20	8.29	6.87	15.58	12.26	15.20

DM - dry matter; MM - mineral matter; CP - crude protein; EE - ether extract; NDIN - neutral detergent insoluble nitrogen; ADIN - acid detergent insoluble nitrogen; NM - natural matter; TN - total nitrogen; CV - coefficient of variation.
*Means followed by same letter in the column do not differ by the Scott-Knott test ($\alpha = 0.05$).

observed DM values of 29.30 and 26.79 dag/kg NM in the forage sorghum hybrids silage and 32.62 and 35.50 dag/kg NM in dual-purpose hybrid silage.

The concentration of MM was different (P<0.05) between silage hybrids, ranging from 5.62 to 7.43, with an average of 6.48 dag/kg DM. These results were higher than those observed by Pedreira et al. (2003), which was 3.4 dag/kg DM. The ether extract content showed variation from 1.73 to 3.52 with an average of 2.52 dag/kg DM.

The average concentration of CP was 6.47 dag/kg DM in the silage hybrids, higher than those observed by Skonieski et al. (2010) and Cabral et al. (2003), of 6.10 and 5.53 dag/kg DM, respectively. For Neumann et al. (2002b), variations in the proportion of stems, leaves, and panicles of sorghum plants are the main responsible for variations in the protein content between different hybrids, since the appropriate fermentation profile minimizes losses of nutrients during the fermentation process.

Reflecting the fermentation process (Table 1), the concentrations of NDIN and ADIN observed in this study indicated that there was no significant loss of nitrogen, because they are within the ideal range, which is less than 12 dag/kg of total N (Roth & Undersander, 1995). Cândido et al. (2002) found values of ADIN ranging from 6.32 and 12.66 dag/kg of total N.

The concentrations of NFC showed differences (P>0.05) between the silage hybrids evaluated, but they were sufficient to ensure proper fermentation, since the soluble carbohydrates are the main substrate of lactic acid bacteria (Table 5). Hybrids 1F305, BRS 610, Volumax, and XBS60329 and had the lowest (P<0.05) levels of NFC and higher (P<0.05) NDFap levels. The hybrid 1F305 is characterized as forage because of the small number of panicles which can probably explain the high content of fibrous carbohydrates. The likely explanation for the NFC values of the hybrids BRS 610, Volumax, and XBS60329 would be the absence of grains at harvest, due to bird attack.

For the ADFp concentration, no differences were found (P<0.05) with the lowest value observed in the hybrid 870031 and average of 34.11 dag/kg DM. Hemicellulose values ranged from 15.62 to 36.46 dag/kg DM. The results are similar to those observed by Skonieski et al. (2010). Neumann et al. (2002b), evaluating different sorghum hybrids, found an average of 32.69 dag/kg DM for ADF content.

Based on the data, it was found that the silages of sorghum hybrids evaluated in this study had sufficient levels of carbohydrates to ensure the lactic fermentation, which did not affect the bromatological characteristics as discussed.

Table 5 - Mean values of fibrous and non-fibrous carbohydrates of 25 sorghum hybrids silage

Hybrid	NFC	NDFap	ADFp	HEM
	dag/kg DM			
866005	24.86c*	60.28b	40.48a	19.79d
866019	36.38a	48.76e	33.14a	15.62d
866033	31.29b	53.87c	33.94a	19.93d
866034	28.72b	55.95c	34.53a	21.42c
866035	29.99b	54.18c	34.48a	19.70d
866036	31.87b	51.94d	31.80b	20.14d
866037	28.30b	56.12c	33.53a	22.59c
866040	33.41a	51.27d	33.27a	18.00d
866041	32.61a	52.33d	32.48a	19.85d
866042	29.63b	54.97c	36.32a	18.65d
866043	27.23c	56.65c	35.81a	20.85c
866044	22.50d	61.36b	32.98a	28.37b
870025	23.36d	60.54b	35.25a	25.29b
870031	35.30a	48.48e	26.32c	22.16c
870035	22.99d	61.42b	36.21a	25.22b
870041	20.93d	61.35b	37.11a	24.23c
870051	25.99c	60.23b	36.37a	23.86c
870067	27.26c	56.92c	35.54a	21.38c
870081	26.74c	57.46c	35.13a	22.33c
870085	24.39c	59.64b	30.43b	29.21b
870095	30.58b	55.43c	34.72a	20.71c
1F305	22.14d	63.43a	35.20a	28.24b
BRS 610	21.31d	63.53a	35.28a	28.25b
Volumax	19.64d	65.61a	29.15b	36.46a
XBS60329	23.02d	62.27b	33.32a	28.96b
Mean	27.22	57.36	34.11	23.25
CV (%)	10.05	4.20	7.34	11.48

NFC - non-fiber carbohydrates; NDFap - neutral detergent fiber free of ash and protein; ADFp - acid detergent fiber free of protein; HEM - hemicelluloses; DM - dry matter; CV - coefficient of variation.
* Means followed by same letter in the column do not differ by the Scott-Knott test (α = 0.05).

There are divergences of fermentation and bromatological characteristics of silages; however, they all have values within the standards which classify a quality silage.

Conclusions

All hybrids have the potential for silage, based on the fermentation and chemical composition. Through the divergence of the fermentative and bromatological characteristics, the silages made of hybrids 866019 and 870031 stand out, nutritionally, for presenting low content of fibrous carbohydrates, resulting in better fermented silage with greater nutritional value.

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