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Chemical composition and *in situ* degradability of silages from dual-purpose sorghum hybrids

Composição química e degradabilidade *in situ* de silagens de híbridos de sorgo duplo propósito

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Abstract

The objective was to determine chemical composition and *in situ* degradability for silages of dual-purpose sorghum hybrids. Twenty-five hybrids of double-purpose sorghum were investigated in a randomized block design with three replicates. Ammoniacal nitrogen (NH_3-N), pH, chemical composition of the silage and *in situ* degradability were determined. Silage of the hybrids 9929012, 947216, 947030, 947254, 947072, 947252, 12F042066, 1141570 and 1141562 presented greater dry matter content, ranging from 402.9 to 470.7 g kg^{-1}. The greatest crude protein content was presented by silages from the hybrids 9929036, 9929030, 12F042224, FEPAGRO19, FEPAGRO11, 9929026, 947030, 947072, 947252, 12F042226 and BRS Ponta Negra. The silage of hybrid 1141562 exhibited the lowest neutral detergent fiber content (588 g kg^{-1}). The highest values of dry matter and crude protein degradability were observed in the silages of the hybrids 9929030, 947252, 947072, 12F042066 and 12F042226. The use of ensilage of the 9929030 and 12F042226 hybrids is recommended because these silages present a better chemical composition of dry matter, crude protein and neutral detergent fiber and better dry matter and crude protein degradability.
Key words: Crude protein. Forage conservation. Nutritive value. *Sorghum bicolor.*

Resumo

Objetivou-se determinar composição química e degradabilidade *in situ* das silagens de híbridos de sorgo duplo propósito. Foram estudados vinte e cinco híbridos de sorgo duplo propósito em delineamento

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de blocos casualizados com três repetições. Foram determinados nitrogênio amoniacal (NH_3-N), pH, composição química e degradabilidade *in situ* da silagem. As silagens dos híbridos 9929012, 947216, 947030, 947254, 947072, 947252, 12F042066, 1141570 e 1141562 apresentaram maior teor de matéria seca, variando de 402,9 a 470,7 g kg^{-1}. O maior teor de proteína bruta foi apresentado pelas silagens dos híbridos 9929036, 9929030, 12F042224, FEPAGRO19, FEPAGRO11, 9929026, 947030, 947072, 947252, 12F042226 e BRS Ponta Negra. A silagem do híbrido 1141562 apresentou o menor teor de fibra em detergente neutro (588 g kg^{-1}). Os maiores valores de degradabilidade da matéria seca e proteína bruta foram observados nas silagens dos híbridos 9929030, 947252, 947072, 12F042066 e 12F042226. Recomenda-se o uso da ensilagem dos híbridos 9929030 e 12F042226, pois estas silagens apresentam melhor composição química de matéria seca, proteína bruta e fibra em detergente neutro e melhor degradabilidade da matéria seca e proteína bruta.

Palavras-chave: Conservação de forragem. Proteína bruta. *Sorghum bicolor*. Valor nutritivo.

Introduction

The use of sorghum silage in animal feed in the dry seasons of the year is a way of sustaining herds of ruminants raised on pasture. The use of sorghum silage has been increased because the corn crop presents a lower water shortage tolerance than the sorghum crop. The tolerance of sorghum to water restriction is probably related to water uptake and transport (ARGENTA et al., 2014; LIU et al., 2014).

Silage production from double-purpose sorghum is an interesting option because in addition to increasing productivity, sorghum can provide better silages due to a greater quantity of grains, chemical composition and degradability values. The nutritional value and productivity provided are crucial forage characteristics for animals (SUZUKI et al., 2010). In animal production, nutrition is an essential point and depends on four factors: nutritional requirements, composition of the feed, digestibility of the feed and the amount of nutrients that the animal ingests (THOMAS et al., 2013).

Values observed by Pires et al. (2009) for the degradation potential ranged from 592.0 g kg^{-1} for the CMSXS165 silage to 309.0 g kg^{-1} for the BR700 silage. At 24 hours, Cavalcante et al. (2012) observed similarity between maize and sorghum in the *in natura* form. In the composition of hybrid-type sorghum silages, Avelino et al. (2011) found values of 304 and 16.1 g kg^{-1} for the DM and EE, respectively, for the Volumax silage and 365 and 20.5 g kg^{-1} for the DM and EE, respectively, in the AG-2005. In the case of double-purpose sorghum hybrids, variations may exist in both the degradation and composition, and selecting among the hybrids studied is necessary to achieve better results. Chemical composition varies among the hybrids, and ruminal degradation can be used to identify the best silages. Thus, this research was developed with the objective of determining the chemical composition and the *in situ* degradability among silages of double-purpose sorghum hybrids.

Material and Methods

The experiment was conducted at the Federal University of Piauí, *Campus* Professora Cinobelina Elvas, Bom Jesus City, Piauí State, Brazil (09º04’28”S, 44º21’31”W, 277 m altitude) from January to August 2014 and under strict accordance with the National Council Guide to Animal Experimentation Control (CONCEA). The ethics committee of the Federal University of Piauí approved the experimental protocol (protocol number: 016/14). The climate is characterized as hot and semi-humid, with a minimum temperature of 18 ºC and maximum of 36 ºC and an average annual precipitation of 900 mm (ANDRADE JUNIOR et al., 2004).

Twenty-five double sorghum hybrids (grain and silage production) supplied by Embrapa Maize and Sorghum (Sete Lagoas, Minas Gerais, Brazil) were used: 9929036, 9929030, 12F042224, 12F042150, FEPAGRO18, FEPAGRO19, FEPAGRO11, 9929012, 9929026, 947216, 947030, 947254, 947072, 947252, SF15, SF11, SF25, PROG134IPA, 12F042140, 12F042066, 12F042226, 12F042422, 12F042226, BRS 506 and BRS Ponta Negra.

The total area of 620 m² was divided into 75 plots of 4.00 m² each (2.00 × 2.00 m), with 0.50 m spacing between rows, totaling five rows per parcel and 2.00 m between blocks. Seeds of all hybrids were distributed in grooves with depths of approximately 3.00 cm, with 20 seeds per meter, with a population in the harvest of 140,000 to 170,000 plants ha^{-1} according to the recommendations proposed by Ribas (2007).

The fertilization was carried out according to the soil analysis performed. The following fertilizers were applied at planting: 40.0 kg P ha^{-1} (single superphosphate) and 60.0 kg K ha^{-1} (Potassium chloride). Forty days after planting, 70.0 kg N ha^{-1} (urea) was applied according to the recommendations of Sousa and Lobato (2004). All plants were cut manually from the plots, then processed in a stationary forage, it was considered the moment of harvest the farinaceous grain, which ranged from 106 to 134 days after planting (Table 1).

Table 1. Characterization of double purpose sorghum hybrids.

Hybrids	Harvest age (days)	Height of plant (cm)	Amount of Grain (%)	Forage dry matter (t ha^{-1})
9929030, 12F042226	106	88-121	14-24	14-16
12F042150, 9929012, 947216, 947072, 947252	118	128-191	14-36	16-27
947254, 12F042066, BRS Ponta Negra	124	146-165	17-30	11-16

The material was processed using a stationary shredder forage machine set to 2-2.5 cm cuts and ensiled with compaction and approximate density of 550 kg of green mass m^{-3}. Experimental cylindrical silos with 10 cm in diameter and 30 cm in length were used, which were sealed after filling. The silo opening occurred after 28 days, when a 20 g silage sample was collected for pH measurement and ammoniacal nitrogen (NH_3-N) in relation to total nitrogen (dry matter basis) analysis. A composite sample of approximately 400 g was collected and subjected to pre-drying in an air drying oven at 55°C for 72 h, followed by milling in a Wiley mill with a 1 mm sieve.

The pre-dried material was ground into 2 mm particles in a Wiley knife mill and packaged in plastic bottles for further analysis. A portion of the samples (triplicate) was ground to 1 mm for the following content analysis according to AOAC (1990): dry matter (DM: method n°. 934.01), ether extract (EE: method n°. 920.39) and crude protein (CP) according to the Kjeldahl method (method n°. 981.10). The neutral detergent fiber (NDF) content was determined as described by Van Soest et al. (1991). Acid detergent fiber (ADF) contents were determined as described by Robertson and Van Soest (1981).

A portion of the silage (triplicate) was used while fresh for the pH evaluation (MIZUBUTI et al., 2009), performed with a pH meter (MA522 model, Marconi Laboratory Equipment, Piracicaba, Brazil). The ammonia nitrogen (mg g^{-1} total N) content was determined as described by Bolsen et al. (1992).

For the *in situ* incubation of the silage of 10 double-purpose sorghum hybrids, a randomized block design with three replicates was used, with each animal representing a block: 9929030, 12F042150, 9929012, 947216, 947254, 947072, 947252, 12F042066, 12F042226 and BRS Ponta Negra. The following criteria were used: precocity, productivity, morphological characteristics and presence of grain, according to Table 1. The pre-dried samples of the silages of these hybrids were ground in a Wiley mill (knife mill) using a 5 mm sieve, according to recommendations of incubations for silages proposed by Nocek (1988).

For the determination of the *in situ* degradability, three Santa Ines sheep (approximately 14 months of age, 35 kg of body weight) were used. The sheep were provided with permanent fistulated rumen cannulas and kept in individual pens. The animals were submitted to a period of adaptation for 14 days, during which concentrated feed and corn silage (40:60) were provided twice each morning. Water was available to the animals *ad libitum*. Ten double-purpose sorghum hybrids were placed into TNT-type bags (8 × 5 cm) in a quantity of approximately 20 mg of DM cm^{-2} of surface area in the bag (NOCEK, 1988). Incubation periods of 0, 6, 12, 24, 48, 72 and 96 h were used. The bags were placed in reverse order and in triplicate in each of the animals to ensure repetition for all animals and to promote uniformity. After each incubation period, the bags were removed from the rumen, washed thoroughly under running distilled water, and dried.

The *in situ* degradability of the DM and CP was determined using the weight difference for each component between the weighing carried out before and after ruminal incubation and was expressed as a percentage. After coefficients a, b, and c were obtained, these values were inserted into the equation proposed by Ørskov and McDonald (1979) to calculate the degradability:

$$Dt = a + b \times (1 - e^{-ct})$$

in which Dt = the fraction potentially degraded at time t (g 100^{-1} g), a = the soluble fraction (g 100^{-1} g), b = the potentially degradable insoluble fraction (g 100^{-1} g), c = the rate of degradation of fraction b (g 100^{-1} g h^{-1}), and t = the time (h^{-1}). The nonlinear coefficients a, b and c were estimated using Gauss-Newton iterative procedures. The undegradable fraction (U) was calculated according to U (g 100^{-1} g) = 100 – (a + b).

To evaluate the effective degradability (ED), it was calculated with the mathematical model:

$$ED = a + [(b \times c) / (c+K)]$$

where K = rate of passage of solids through the rumen, defined here as 2%/h, 5%/h and 8%/h, and related to the level of low, medium and high food intake, respectively.

The values of pH, ammoniacal nitrogen and chemical composition were submitted to analysis of variance and analyzed by the Scott-Knot procedure at 5% significance using SISVAR software version 5.6. The degradability data were analyzed by Tukey's test at 5% significance, with the aid of SAS (Statistical Analysis System, version 9.2).

Results and Discussion

Dry matter (DM) content presented greater means in hybrids 9929012, 947216, 947030, 947254, 947072, 947252, 12F042066, 1141570 and 1141562, with values varying between 402.9 and 470.7 g kg^{-1} (Table 2). Of these hybrids, only the hybrid 1141570 was not ensiled with a DM above 350 g kg^{-1}. The variation in the DM contents of the *in natura* material did not affect the pH values of the hybrid silages. According to Goeser et al. (2015), the DM losses in the fodder occur in the fermentation processes and even at silo opening; therefore, as the pH and DM content are strongly related, fodder with low DM contents (between 300 and 350 g kg^{-1}) should be avoided for ensilage. In addition, plant silage with optimal DM content contributes to reduced concentrations of mycotoxins (LOUČKA et al., 2014; SCHMIDT et al., 2015).

Hybrids 947030, 947254 and 947072 presented greater pH ($P < 0.001$), with means of 4.49, 4.46 and 4.52, respectively, compared to the other hybrids (Table 2). Hybrids 947030, 947254 and 947072 presented a pH above the ideal range for silage to be characterized as good quality. According to França et al. (2011), the silages characterized by good quality must have a pH of approximately 4.2, which avoids proteolysis and the consequent production of butyric acid. This range can vary from 3.8 to 4.2 in ideal silage. Hybrids 9929036, 12F042150, FEPAGRO18, FEPAGRO11, 9929012, 9929026, 947216, 947252, SF15, SF25, PROG134IPA, 1141572, 12F042066, 12F042226, 1141570, BRS506, and BRS Ponta Negra had values within the optimal pH range.

Table 2. Chemical composition, ammoniacal nitrogen ($N–NH_3$) and pH values of silage of dual-purpose sorghum hybrids(1).

Sorghum Hybrids	pH	NH_3-N(2)	Chemical composition (g kg^{-1} DM)				
			DM(3)	CP(4)	EE(5)	NDF(6)	ADF(7)
9929036	3.9c	0.1b	326b	54.7a	19.4c	710b	541b
9929030	4.2b	0.1b	373b	59.7a	20.4c	678c	493b
12F042224	3.5d	0.1b	354b	54.5a	18.8c	728b	471c
12F042150	4.0c	0.1b	328b	47.3b	16.1c	711b	505b
FEPAGRO18	3.8d	0.2a	339b	49.7b	15.5c	672c	464c
FEPAGRO19	3.7d	0.1b	357b	63.0a	22.9c	672c	498b
FEPAGRO11	4.0c	0.1b	330b	61.5a	32.7a	737b	462c
9929012	4.2b	0.1b	429a	52.1b	22.7c	677c	541b
9929026	4.2b	0.1b	300b	56.2a	16.7c	685c	527b
947216	3.9c	0.1b	404a	41.9b	14.7c	644d	514b
947030	4.5a	0.1b	403a	60.7a	26.9b	683c	508b
947254	4.5a	0.1b	425a	45.1b	19.4c	744b	528b
947072	4.5a	0.1b	465a	63.0a	18.1c	717b	549b
947252	4.2b	0.1b	416a	60.9a	17.2c	674c	437c
SF15	3.8c	0.2a	354b	50.6b	32.7a	655d	474c
SF11	3.7d	0.1b	334b	40.9b	17.0c	721b	522b
SF25	3.9c	0.2a	349b	40.8b	19.5c	693c	530b
PROG134IPA	3.9c	0.1b	355b	51.2b	23.1c	726b	555b
1141572	4.2b	0.1b	354b	44.2b	23.6c	823a	672a
12F042066	4.2b	0.1b	472a	47.5b	15.5c	723b	497b
12F042226	4.1b	0.2a	292b	59.9a	28.6b	512f	340d
1141570	3.9c	0.1b	432a	40.6b	25.4b	761b	489b
1141562	4.3b	0.1b	450a	40.8b	33.9a	588e	504b
BRS506	4.0c	0.2a	348b	41.8b	10.9c	623d	373d
BRS Ponta negra	3.9c	0.1b	326b	65.9a	17.3c	726b	573b
CV(8)(%)	4.0	18.6	8.9	15.6	19.2	4.1	10.1
P-value	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001

(1)Means followed by different letters in the same column differ by Scott-Knot test at 5% probability. (2) Relation to total nitrogen (DM basis), (3)DM: Dry matter, (4)CP: Crude protein, (5)EE: Ether extract, (6)NDF: neutral detergent fiber, (7)ADF: acid detergent fiber, (8)CV: Coefficient of variation.

For the ammoniacal nitrogen (NH_3-N) contents, the sorghum silage of the hybrids FEPAGRO18, SF15, SF25, 12F042226 and BRS506 showed the greatest mean values. The values of ammoniacal nitrogen are within the range recommended by Neumann et al. (2009) ammoniacal nitrogen values lower than 10% relative to total nitrogen indicate that the fermentation process did not result in excessive protein breakdown in ammonia and that the amino acids constitute the major part of the non-protein nitrogen (NPN). Therefore, all hybrids presented values of ammoniacal nitrogen considered ideal for good-quality silage.

In relation to the CP contents, greater concentrations were observed for hybrids 9929036, 9929030, 12F042224, FEPAGRO19, FEPAGRO11, 9929026, 947030, 947072, 947252, 12F042226 and BRS Ponta Negra, with averages ranging from 54.5 to 65.9 g kg^{-1}. The CP contents for hybrids 9929036, 9929030, 12F042224, FEPAGRO19, FEPAGRO11, 9929026, 947030, 947072, 947252, 12F042226 and BRS Ponta Negra exhibited values close to those found by França et al. (2011), who obtained an average value of sorghum silage of 68 g kg^{-1}. During the ensiling process, nutrient losses occur due to aerobic respiration and as effluents. In this sense, hybrids with higher nutritional value should be tested positively, since even when losses occur, silages tend to have higher nutritional values, and the morphological characteristics among the hybrids may have influenced these results (Tabela 1).

Differences existed among the sorghum hybrid on EE, NDF and ADF ($P < 0.001$). Sorghum hybrid 1141572 silage presented a greater NDF mean content (823.3 g kg^{-1}). The greatest value of ADF in the sorghum silage was obtained from the 1141572 hybrid, which presented the lowest NDF content. In contrast, the lowest mean content was observed in the sorghum hybrid 12F042226 silage, with 512 g kg^{-1} NDF. The lowest levels of ADF were found in the silages of the 12F042226 and BRS506 hybrids, with 340 and 373 g kg^{-1}, respectively.

The EE values obtained in the hybrids, with an average content of 52 g kg^{-1}, were lower than those found in the silage from sorghum studied by Oliveira et al. (2010). The authors affirm that high EE in forage is a positive factor, since this extract can be an energy source for the animals.

In silage production, the whole plant is used, and sorghum tends to have a higher proportion of stem, which is reflected in the fiber content. Because sorghum plants present more lignified tissues than other morphological parts of the plant, the variations in fiber content among the hybrids can be explained (FUSTINI et al., 2017). The botanical diversity of the plant, as well as the state of maturity, influences these values (BELANCHE et al., 2014).

Sorghum silage of the hybrids 9929030, 947216, 947072, 947252, 12F042066 and 12F04222 presented greater DM disappearance ($P < 0.001$) at 96 hours. The DM disappearance of the hybrid 9929012 silage was greater at time 0 however, it changed in the 6-hour incubation, with the silage of the hybrid 9929030 obtaining a greater average disappearance of 28.8 g 100^{-1} g in the 12-hour incubation period. The sorghum silages of the hybrids 9929030 and 9929012 showed greater DM disappearance, with averages of 32.8 and 32.1 g 100^{-1} g, respectively (Table 3).

In the 24-hour incubation period, for determination of the DM disappearance, the sorghum silages of the hybrids 9929030, 9929012, 947072 and 947252 presented similar means, thus, these hybrids produced more rapidly disappearance silages. In the incubation period of 72 and 96 hours, besides the sorghum silages of the hybrids 947072 and 947252, the silages of the hybrids 9929030, 947216 and 12F042066 showed greater DM disappearance. Changes and differences in the degradation rate of the DM can be caused by differences in the cell wall structure of the evaluated sorghums, mainly in the cellulose content (GUIMARÃES JÚNIOR et al., 2010). Sorghum silages of the 12F042150, 947254 and BRS Ponta

Negra hybrids presented slow disappearance rates of DM during the whole incubation period.

The sorghum silage of hybrids 9929030, 12F042150, 947072, 947252, 12F042066, 12F042226 and BRS Ponta Negra presented greater CP disappearance ($P < 0.05$), ranging from 67.8 to 74.9 g 100^{-1} g at 96 hours (Table 3). The best CP disappearance means were observed in the sorghum hybrid 947252 silage over the incubation time and in the hybrid 9929030 silage in the 6-hour incubation period, indicating that these hybrids undergo faster disappearance. According to Guimarães Júnior et al. (2010), the differences observed among silages can be attributed to several factors such as the crop, the evaluated varieties, the management used in the cutting and silage, and the environmental conditions such as climate and soil where the plants are grown.

Table 3. Mean disappearance of dry matter (DM) and Crude Protein (CP) from dual purpose sorghum hybrids silage, as a function of ruminal incubation time [(1)].

Sorghum hybrids	Disappearance as a function of time (h) g 100^{-1} g						
	0	6	12	24	48	72	96
				Dry Matter			
9929030	20.6ab	28.8a	32.8a	39.2a	45.8ab	54.9a	61.1a
12F042150	18.4b	25.3ab	28.3ab	34.8ab	39.4ab	46.0b	53.5ab
9929012	23.1a	26.3ab	32.0a	36.6a	41.3ab	49.4ab	53.2ab
947216	20.6ab	23.9ab	28.2ab	32.5ab	45.0ab	51.7a	56.0a
947254	16.0b	18.4b	23.0b	28.1b	34.7b	45.8b	49.6b
947072	17.0b	21.5ab	26.8ab	37.1a	48.5a	53.6a	65.9a
947252	17.7b	21.1ab	27.3ab	38.0a	49.3a	55.6a	61.5a
12F042066	17.1b	20.3ab	27.8ab	33.4ab	40.9ab	51.0a	59.3a
12F042226	17.2b	21.4ab	27.1ab	32.5ab	42.1ab	49.1ab	58.7a
BRS Ponta Negra	13.2b	17.6b	23.8b	28.6b	35.4b	49.2ab	51.8b
CV[(2)] (%)	7.3	10.0	9.4	8.9	8.6	9.1	8.7
P-value	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
				Crude Protein			
9929030	25.7b	41.5a	51.4a	53.2a	58.8a	66.8a	71.2a
12F042150	22.0b	37.9ab	43.6b	49.3a	56.6ab	64.4a	71.4a
9929012	25.4b	26.1b	29.2c	32.4c	35.3c	37.6b	42.5b
947216	24.8b	29.2b	34.4c	40.3b	52.8b	59.7a	63.9ab
947254	19.4ab	24.0b	31.9c	39.3bc	47.4b	58.6a	61.9ab
947072	16.9c	28.9b	34.3c	41.7b	58.3a	66.8a	74.9a
947252	32.9a	45.3a	49.7a	54.0a	59.1a	63.4a	70.4a
12F042066	24.4b	30.6b	40.0b	46.8ab	53.2ab	63.3a	69.8a
12F042226	23.0b	29.6b	35.7c	43.0b	51.7b	59.2a	68.1a
BRS Ponta Negra	25.7b	34.1ab	42.3b	46.7ab	53.7ab	64.4a	67.8a
CV (%)	8.6	9.1	9.1	8.4	9.1	10.0	9.1
P-value	0.027	< 0.001	< 0.001	0.005	0.009	< 0.001	< 0.001

[(1)]Means followed by different letters in the same column differ by Tukey's test at 5% probability. [(2)]CV: Coefficient of variation.

The sorghum silage of the hybrid 947072 was highlighted, which retained greater CP disappearance values throughout the incubation period. In contrast, the sorghum silage of the BRS Ponta Negra hybrid presented the lowest performance for disappearance among the silages tested for the entire incubation period. According to Goes et al. (2012), this variation can be attributed to the specific characteristics of the protein, accessibility to the digestible enzymes or presence of antinutritional substances.

For the DM fractions, the sorghum silages of the hybrids 9929030 and 9929012 presented greater ($P = 0.003$) soluble fraction “a” concentrations of 22.5 and 23.0 g 100^{-1} g, respectively. An effect was observed on fraction “b” ($P = 0.013$) for DM degradability, with mean values ranging from 42.0 to 80.4 g 100^{-1} g. The sorghum silages of the hybrids 9929012, 947216 and 947252 were greater ($P < 0.001$) for the undegradable fraction “U” of the DM, with average values 35.0, 31.3 and 34.3 g 100^{-1} g, respectively. No effect ($P = 0.152$) was observed for the “c” fraction or for the rate of degradation of fraction “b” (Table 4).

Table 4. Soluble fraction (a), potentially degradable (b), rate of degradation of fraction “b” (c) (expressed in g 100^{-1} g h^{-1}) and non-degradable fraction (U) of dual purpose sorghum hybrids silages [(1)].

Sorghum hybrids	Fraction of degradation (g 100^{-1} g)			
	“a”	“b”	“c”	“U”
		Dry Matter		
9929030	22.5a	67.8b	0.008	9.63c
12F042150	18.4b	78.8a	0.005	2.75d
9929012	23.0a	42.0c	0.013	35.0a
947216	20.6ab	48.1c	0.014	31.3a
947254	16.0b	60.0bc	0.009	24.0b
947072	17.0b	65.6b	0.013	17.4bc
947252	17.7b	47.9c	0.024	34.3a
12F042066	17.1b	80.4a	0.007	2.41d
12F042226	17.2b	80.1a	0.007	2.70d
BRS Ponta Negra	13.2c	65.5b	0.009	12.1c
CV[(2)] (%)	8.8	9.5	9.0	9.0
P-value	0.003	0.013	0.152	< 0.001
		Crude Protein		
9929030	27.3ab	54.6b	0.014ab	18.1c
12F042150	23.1b	68.8ab	0.010b	8.14d
9929012	25.4b	26.2d	0.010b	48.4a
947216	24.8b	47.9c	0.018a	27.2b
947254	19.4bc	51.4bc	0.018a	29.2b
947072	16.9c	77.2a	0.014ab	5.93d
947252	32.9a	59.2b	0.008b	7.87d
12F042066	24.4b	57.9b	0.015a	17.7c
12F042226	23.0b	66.0ab	0.011b	10.9cd
BRS Ponta Negra	25.72b	54.77b	0.014a	19.5c
CV (%)	9.1	8.1	8.9	9.5
P-value	0.005	< 0.001	0.041	0.008

[(1)]Means followed by different letters in the same column differ by Tukey’s test at 5% probability. [(2)]CV: Coefficient of variation.

The sorghum silages of the hybrids 9929030 and 9929012 had greater soluble fraction “a” concentrations. As the greatest DM soluble fraction, “a” can provide the nutrients present in the silage to the rumen microorganisms faster consequently, this fraction tends to be degraded in less time. For example, the larger the value is for fraction “a”, the greater the feed degradation (GUIMARÃES JÚNIOR et al., 2010; CARDOSO et al., 2012).

The greatest concentrations of the potentially degradable fraction “b” of the DM were obtained in the silages of the 12F042150, 12F042066 and 12F042226 hybrids thus, these hybrids have greater DM degradation. According to Cardoso et al. (2012), in research on silages with three genotypes of sorghum, average values of the potentially degraded fraction varied from 43.4 to 53.8 g 100^{-1} g, which were lower than those from the study on the hybrids compared herein.

Sorghum hybrid 9929012 silage had the greatest fraction “U”, which resulted from lower average degradation of fractions “a” and “b”, proving that the CP degradation of silage requires a longer period for degradation. The greater the fraction “U” is, the longer the silage needs to pass in the rumen for the DM to be degraded. The silages of the 12F042150, 12F042066 and 12F042226 showed faster degradation because of the values of fraction “U”.

Variations obtained in the CP degradation fraction show the superiority of the soluble fraction “a” for the hybrid 947072, which allowed acquisition of a considerable value for fraction “b”. The silage of the hybrid 9929012 showed lower CP degradation and did not stand out during the incubation period. The undegradable fraction values were obtained at lower values only for the 12F042150, 947072 and 947252 hybrids, thus indicating that these hybrids were more degradable however, the degradation rate was still slow. However, the effect on the “c” degradation rate ($P = 0.041$) of the crude protein was higher in the silages of the hybrids 947216, 947254, 12F042066 e BRS Ponta Negra with variations of 0,014 a 0,018 g 100^{-1} g h^{-1}.

The effective degradability presented reduction in the times (2, 5 and 8 hours) for all hybrids in the dry matter and crude protein contents (Table 5). Pires et al. (2010) observed a similar effect, in corn, sorghum and *Brachiaria* silages for effective degradability of dry matter and crude protein.

Table 5. Effective degradability in silage of dual-purpose sorghum hybrids.

Sorghum hybrids	Effective Degradability (g 100^{-1} g h^{-1})		
	2	5	8
	Dry Matter		
9929030	45.2	36.3	34.0
12F042150	40.0	33.5	33.3
9929012	40.5	33.2	30.7
947216	40.2	30.7	27.2
947254	34.3	25.0	22.0
947072	43.2	31.0	26.7
947252	42.6	31.4	26.7
12F042066	40.3	29.4	26.1
12F042226	40.0	29.5	26.4
BRS Ponta Negra	35.6	25.6	22.4

continue

continuation

	Crude Protein		
9929030	61.7	62.7	54.3
12F042150	58.2	56.2	54.8
9929012	34.3	30.0	28.5
947216	47.3	37.1	33.2
947254	44.4	33.9	29.7
947072	52.3	39.5	35.5
947252	62.0	65.5	62.9
12F042066	51.6	41.6	38.3
12F042226	49.2	39.0	35.9
BRS Ponta Negra	52.8	44.6	42.5

Descriptive data analysis.

Conclusions

The silages of the hybrids 9929036, 12F042224, FEPAGRO11, 9929026 and BRS Ponta Negra obtained better results only for the chemical composition, and hybrids 947072, 947252 and 12F042066, only for degradability.

The use of hybrids 9929030 and 12F042226 is recommended because they present silage with a better chemical composition of DM, CP and NDF and better degradability of DM and CP.

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