IJAS Iranian Journal of Applied Animal Science

Ingestive Behavior of Heifers Feeding with Marandu Grass Silage

Research Article

G.A. Mendes[1], V. Rocha Júnior[1*], J.R.M. Ruas[1], F. Vieira e Silva[1], F.P. Monção[1], D.A. Silva[1], P.F. Santana[1] and G.S.S. David[1]

[1] Department of Animal Science, Faculty of Agricultural Science, State University of Montes Claros (Unimontes), Av. Reinaldo Viana, 2630, Janaúba, Minas Gerais, Brazil

Received on: 7 Jul 2017
Revised on: 6 Aug 2017
Accepted on: 31 Aug 2017
Online Published on: Mar 2019

*Correspondence E-mail: vicente.rocha@unimontes.br

Online version is available on: www.ijas.ir

ABSTRACT

The present study was aimed at assessing the ingestive behavior of ¾ Zebu × Holstein heifers confined to different levels of substitution of sorghum silage by marandu grass silage. Twenty heifers were used with initial average weight of 346.25 kg, divided into completely randomized experimental design with 5 repetitions and the following treatments: treatment 1) roughage fraction of the diet composed of 100% of sorghum silage; treatment 2) roughage fraction of the diet composed of 70% of sorghum silage and 30% of marandu grass silage; treatment 3) roughage fraction of the diet composed of 30% of sorghum silage and 70% of marandu grass silage and treatment 4) roughage fraction of the diet composed of 100% of marandu grass silage. Concentrate was provided (25.25% soybean meal, 73.44% ground corn and 1.31% mineral mixture, based on natural matter), made calculations for ingestion of 1.2% of the live weight. Visual observations were accomplished for determination of ingestive behavior, every 21 days. The substitution of sorghum silage by marandu grass silage increased time with feeding, it did not affect time with rumination, time of chew, number of chews a day nor number of meals a day, but it resulted in lower feed efficiency, without interfering in the rumination efficiency of dry matter (DM) and neutral detergent insoluble fiber (NDF).

KEY WORDS chew, feeding, idle, rumination, sorghum silage.

INTRODUCTION

The sorghum crop occupies space that was of corn in the manufacture of silage, especially in regions with irregular rains (Costa *et al.* 2016), and the use of conserved forage represents a significant plot of the cost of feedlot. However, considering that feedlot is a high risk activity and with low profitability, it is still necessary to search for food alternatives. In this scenario, grass silage of the *Brachiaria* genus, with lower cost in relation to sorghum silage, is an option for the producers, since the forage is already established in many properties, making the silage cost lower (Rigueira *et al.* 2013). However, it is important to evaluate these forage grass silages in animal tests, so that more information on ingestive behavior can be obtained when grass silages are used to feed confined cattle. Among the main factors that influence the ingestive behavior of animals, it can be highlighted the quantity and quality of the fiber present in diets, particle size of the food, hydration of the food, exposure of the soluble nutrients for fermentation and microbial colonization, and factors inherent to animals and the environment (Riaz *et al.* 2014). The feeds containing high neutral detergent fiber (NDF) promote a reduction in the total dry matter intake, due to the limitation caused by rumen-reticulum

repletion (Riaz *et al.* 2014; Ma *et al.* 2015). According to various authors (Antunes *et al.* 2014; Pimentel *et al.* 2015; Pimentel *et al.* 2016), the rumination time may increase due to a higher intake of foods containing a high proportion of fibrous constituents.

In feedlot systems in tropical climates, the use of zebu-crossed animals may favor a desirable ingestive behavior, with a longer period of feeding of animals and a shorter period of the animals in idleness, due to their higher adaptability to elevated temperatures (Mizubuti *et al.* 2013). In addition to these factors, the composition of diets, especially in relation to the quality of the voluminous fraction, has a direct influence on the ingestive behavior of the animals and it is a determining factor for the success of the feedlot activity.

The present study aimed at assessing the ingestive behavior of crossbred heifers ¾ Zebu × Holstein, fed in feedlot with different levels of replacement of sorghum silage by marandu grass silage.

MATERIALS AND METHODS

The experiment was conducted at the Experimental Farm at Agricultural Research Company of Minas Gerais (EPAMIG), in the municipality of Felixlândia located in the western center of Minas Gerais state, from May to September of 2015. It was used a completely randomized experimental design with 20 crossbred heifers ¾ Zebu × Holstein, with initial mean body weight (BW) of 346.25 ± 12 kg (standard error mean), distributed in four treatments, as it follows: treatment 1) the forage fraction of the diet was composed of 100% sorghum silage; treatment 2) the forage fraction of the diet was composed of 70% sorghum silage and 30% of marandu grass (*Brachiaria brizantha* cv. Marandu) silage; treatment 3) the forage fraction of the diet was composed of 30% sorghum silage and 70% of marandu grass silage and treatment 4) the forage fraction of the diet was composed of 100% marandu grass silage. Five replicates were used for each treatment, being each heifer considered an experimental unit.

Before the experimental period, which lasted 84 days, the heifers went through an adaptation period of experimental diets and facilities of 15 days, being confined in individual pen, with covered trough and drinking fountain. The experimental diets were formulated to allow a weight gain of 1 kg of BW/day, according to recommendations of the national research council (NRC, 2001), and they were supplied daily with an excess of 5% of dry matter, to allow leftovers, depending on weight and voluntary intake. The quantities of food were adjusted to the needs. The roughage was supplied *ad libitum* and the concentrate, which was the same for all animals, was supplied in a fixed ratio of 1.2% of body weight (BW), in the natural matter of the concentrate. The forage fraction of the diet was given once a day, always in the morning, while the concentrate was supplied in the morning and afternoon in equal proportion.

The concentrate composition used in all treatments consisted of 25.25% soybean meal, 73.44% ground corn and 1.31% mineral mixture, based on natural matter. To adjust the protein content of the diets so that they were isoproteic, urea was added to the fractions of the different treatments in the following proportions: treatment 1) 0.00%; treatment 2) 0.23%; treatment 3) 0.53% and treatment 4) 0.76% of urea in natural matter.

The sorghum used for silage production was from the Volumax variety, harvested at 90 days of age. For the elaboration of the marandu grass silage, the surplus of this forage was used (90 days of regrowth), which was already established in the pastures of the EPAMIG farm, being ensiled in the rainy season. The silos were opened after 60 days of silage.

The chemical composition of the ingredients and diets were determined (Table 1 and Table 2, respectively). Dry matter (DM), crude protein (CP), lignin, ethereal extract (EE), ash, neutral detergent fiber (NDF), acid detergent fiber (ADF), neutral detergent insoluble nitrogen compounds (NDIN) and acid detergent (ADIN), total carbohydrates (TC) and non-fibrous carbohydrates (NFC) were determined or calculated according to the description of Detmann *et al.* (2012).

The animals were individually identified with earrings and dewormed with 1% Ivermectin (7 mL/animal; Ivomec, Merial, Paulinia, SP, Brazil).

The total experimental period was 84 days, divided into four periods of 21 days to evaluate the ingestive behavior. The twenty heifers were submitted to visual observation to evaluate the ingestive behavior every 21 days of the experimental period, during two consecutive days. On the first day, heifers were observed for three periods of two hours (9 am to 11 am, 1 pm to 3 pm, and 5 pm to 7 pm), to verify the average time spent with meristic chewing, measured by digital timer and the mean of the number of chewing for rumen bolus, measured by manual counting. On the second day, visual observation was performed every 5 minutes for 24 hours (Mezzalira *et al.* 2011) to determine the ingestive behavior related to feeding, rumination and idle.

The average number of meristic chewing per day was obtained by multiplying the mean time (in minutes) of rumination for 24 hours by the number of meristic chewing (per minute). The average number of bolus per day was obtained by dividing the mean time of rumination (in minutes), at 24 hours per day, by the mean time of chewing per bolus (in minutes). The total chewing time was calculated by adding the feeding and rumination times for 24 hours.

Table 1 Chemical composition of ingredients

Item, g/kg dry matter	Sorghum silage	Marandu grass silage[2]	Corn	Soybean meal
Dry matter	243.0	462.5	893.1	897.3
Crude protein	64.2	45.0	87.3	461.7
Neutral detergent fiber	730.6	720.4	139.8	146.2
Neutral detergent fiber[1]	692.8	663.3	100.4	73.0
Acid detergent fiber	312.5	399.1	40.8	68.6
Non-fibroso carbohydrate	164.9	189.6	756.1	385.0
Ethereal extract	21.6	16.0	40.7	17.1
Asches	56.5	86.1	15.5	63.2
Lignin	66.3	81.1	11.6	13.3

[1] Corrected for ash and crude protein.
[2] *Urochloa brizantha*.

Table 2 Chemical composition (g/kg of dry matter) of experimental diets

Item	Levels of substitution of sorghum silage by marandu grass silage (%)			
	0	30	70	100
Dry matter	351.8	385.8	468.6	558.9
Crude protein	113.5	110.8	111.1	108.7
Neutral detergent fiber	480.2	498.5	503.2	514.7
Acid detergent fiber	203.3	227.8	253.1	277.0
Non-fibrous carbohydrates	335.3	314.9	303.7	288.8
Ether extract	26.9	25.4	23.7	22.6
Asches	44.1	50.4	58.3	65.2
Lignin	43.2	47.8	52.2	56.6

The feed efficiency of DM and NDF was calculated by dividing the daily intake of DM and NDF (in kg) by the daily feeding time (in hours), as well as the DM rumination efficiency and NDF was determined by dividing the intake of DM and NDF (in kg) by the rumination time in hours. The intake index of DM and NDF, in minutes per kg, was calculated by dividing the feeding time (in minutes) by dry matter intake and NDF (in kg). Likewise, rumination and mastication of DM and NDF were estimated in minutes per kg. The methodology used to obtain the results of ingestive behavior variables is in accordance with the technique described by Burger *et al.* (2000).

Data were evaluated by analysis of variance and regression analysis. The statistical models were selected according to the significance of the regression coefficients using the F-test at 5% probability and coefficient of determination (R^2) (Ferreira, 2014).

RESULTS AND DISCUSSION

Feeding time, in minutes and percentage of the day, were the only variables that presented differences ($P<0.05$) with the increase of sorghum silage replacement levels by marandu grass silage (Table 3). It was verified that the animals spent more time feeding diets with lower proportions of sorghum silage and higher proportions of marandu grass silage, probably due to a greater food selection activity. These results differ from those found by Souza *et al.* (2015) that, when evaluating the behavior of lactating cows fed with different levels of castor meal in the diet, observed no differences for the mean time spent in feeding and rumination. For the other variables related to rumination and idle times, there were no differences ($P>0.05$), as well as the results found by Souza *et al.* (2015).

Pereira *et al.* (2007) working with dairy heifers of different genetic groups submitted to diets with different levels of fiber, did not find interaction of the genetic group with fiber level in the diet for the variables of ingestive behavior: times spent in feeding, rumination and idle. However, they registered difference between low and high fiber diets, since heifers that consumed 60% of NDF spent 28.0; 15.8 and 20.2% more time with feeding, rumination and total chewing activities, respectively, than those fed diets containing only 30% NDF.

Silva *et al.* (2005) evaluating increases of cassava bagasse (*Manihot esculenta*, Crantz) at different levels (5, 10, 15 and 20%) in diets based on elephant grass silage, verified a linear reduction in feeding and rumination times and an increase in the idle time of heifers in feedlot as a function of the increase levels of cassava bagasse, as it increased levels of cassava bagasse in the diets reduced the levels of NDF.

Burger *et al.* (2000) observed a linear increase in mean feeding time and rumination of Holstein calves as dietary NDF levels were increased.

Pereira *et al.* (2007) evaluated the ingestive behavior of dairy heifers receiving diets with different fiber levels and detected a longer time of total chewing when the animals were submitted to the diet with a higher NDF content (60%).

Table 3 Feeding times, rumination and idling, in minutes and percentage, (24 hours period), of crossbred heifers ¾ Zebu × Holstein fed diets with increasing levels of sorghum silage replacement by marandu grass silage

Item	Replacement levels sorghum silage (%)				CV[1] (%)	RE[2]
	0	30	70	100		
Feeding (min.)	258.75	248.75	293.75	327.50	16.04	1
Rumination (min.)	490.00	483.75	487.50	467.50	10.86	$\hat{Y}$= 482.18
Idling (min.)	691.25	707.50	658.75	645.00	8.80	$\hat{Y}$= 675.62
Feeding (%)	17.98	17.27	20.38	22.73	15.98	2
Rumination (%)	34.02	33.58	33.86	32.46	10.85	$\hat{Y}$= 33.48
Idling (%)	48.01	49.13	45.75	44.78	8.79	$\hat{Y}$= 46.92

[1] CV: coefficient of variation, in percentage.
[2] RE: regression equation; 1. $\hat{Y}$= 244.8 + 0.75X; R^2= 0.84 (P<0.05) and 2. $\hat{Y}$= 17.01 + 0.05X; R^2= 0.83 (P<0.05).

Non-significant results for the rumination time variable may be explained by the relatively close contents of NDF present in both sorghum silage and marandu grass silage. In Table 4, it is observed that the chewing time per bolus, in seconds, the number of meritics chews per bolus and the number of meristics chews per minute presented significant values (P<0.05) with linear reduction, as the proportions of sorghum silage in the diet decreased.

Possibly the greater selectivity of the food in the diets with higher proportions of marandu grass silage favored the ingestion of the diet by the animals, thus reducing the chewing time and the number of chews. However, the number of crabs per day increased with the growth of the level of substitution of sorghum silage by marandu grass silage.

These results demonstrate that although the diets with the highest proportions of marandu grass silage presented lower time and number of chews, the increase in the number of rumined bolus per day and the longer feeding time spent by the animals in these diets may have interfered in a harmful way in feed conversion (8.30 kg/kg of dietary weight gain with 100% sorghum silage *vs.* 12.79 kg/kg of dietary weight gain with 100% marandu grass silage), and also in the performance (1.26 kg/day in the diet with 100% sorghum silage *vs.* 0.96 kg/day in the diet with 100% marandu grass silage) of heifers fed with a higher proportion of marandu grass silage (Mendes *et al.* 2014). These results are related to the best digestibility of sorghum silage compared to the marandu grass silage verified in this experiment (70.82% DM digestibility of the diet with 100% sorghum silage *vs.* 61.97% DM digestibility of diet with 100% marandu grass silage) (Mendes *et al.* 2014).

For the total chewing time, in minutes, and the number of meristic chewing per day, there was no statistical differences, certainly because in the treatments with higher levels of marandu grass silage, the animals were able to select better the diet provided, because of the larger size of the particles, thus observing a shorter time and a lower number of chews for ruminal bolus, however, a greater number of ruminated bolus were observed per day.

The other variables, number of meals per day, number of rumination cycles per day and number of periods of idle per day, did not present significant values (P>0.05), and these results could be directly related to the similar amounts of fiber (NDF) present in the two rows studied, although there is differentiation regarding the quality of these fibers in these rows (Table 1).

The values presented for the feed efficiency, given by the ingestion in kg of DM/hour, were lower (P<0.05) when the sorghum silage substitution levels were increased by marandu grass silage (Table 5). This characterizes a negative linear regression that can be explained by the physical and chemical properties of the food, with sorghum silage presenting a greater degradability of the fiber due to the better quality of the fiber and the lower proportion of ADF present in this bulk (Table 1). Although the intakes of DM (10.69 kg/day) and NDF (5.39 kg/day) were not different between diets (Mendes *et al.* 2014), it can be verified that the chemical and/or physical characteristics of the bulks influenced the efficiency of feed per unit of time. The lowest digestibility of NDF in the diet with 100% marandu grass silage (53.11%) was observed in relation to the diet with 100% sorghum silage (63.82%), (Mendes *et al.* 2014).

Mendes Neto *et al.* (2007), in experiment with crossbred heifers, verified an increase in feed efficiency in grams of MS/hour, when the Tifton 85 hay was replaced by citrus pulp, due to the decrease of NDF contents in the diets. The data found in their study are in agreement with those found in this experiment, which showed that the quantity, quality and proportion of the fiber of the marandu grass silage resulted in a worse feeding efficiency.

As shown in Table 5, for the variables rumination efficiency of DM and NDF in kg/hour, no differences were observed (P>0.05). The explanation of these results could be based on the similar amounts of fiber present in sorghum silage and marandu grass silage, so that the quality of this fiber did not significantly influenced rumination efficiency, both DM and NDF. It should be noted that the daily intake of DM and NDF, in kg/day, was not different between diets (Mendes *et al.* 2014).

Table 4 Time, number of periods and duration of behavioral activities of crossbred heifers ¾ Zebu x Holstein fed diets with increasing levels of sorghum silage substitution by marandu grass silage

Item	Replacement levels sorghum silage (%)				CV[1] (%)	ER[2]
	0	30	70	100		
TMB (seconds)	55.63	53.19	44.54	45.42	17.35	1
NMB (seconds)	58.07	54.90	45.02	45.38	13.38	2
NMM(minutes)	62.81	62.43	61.96	59.68	3.92	3
Number Bolus (day)	513.16	557.71	659.62	636.00	14.25	4
TTM (minutes)	748.75	732.50	781.25	795.00	7.78	$\hat{Y}$= 764.37
NMM (day)	30.757	30.255	30.221	27.843	12	$\hat{Y}$= 29.769
Number of meals (day)	11.00	11.00	12.00	11.25	14.81	$\hat{Y}$= 11.31
NRC (day)	16.87	15.02	20.37	15.83	3.79	$\hat{Y}$= 17.02
NPI (day)	23.75	21.87	24.37	23.00	8.24	$\hat{Y}$= 23.25

[1] CV: coefficient of variation, in percentage.
[2] RE: regression equation; 1. $\hat{Y}$= 55.58 – 0.11X; R^2= 0.87 (P< 0.05); 2. $\hat{Y}$= 58.01 – 0.14X; R^2= 0.90 (P< 0.05); 3. $\hat{Y}$= 63.15 – 0.02X; R^2= 0.80 (P<0.05) and 4. $\hat{Y}$= 521.10 + 1.41X; R^2= 0.83 (P<0.05).
TMB: chews time for ruminal bolus; NMB: number of chews per ruminal bolus; NMM: number of meristics chews; TTM: total chewing time; NCR: number of rumination cycles and NPI: number of idle period.

Table 5 Feeding efficiency of crossbred heifers ¾ Zebu x Holstein fed diets with increasing levels of sorghum silage replacement by marand grass silage

Item (kg/h)	Replacement levels sorghum silage (%)				CV[1] (%)	RE[2]
	0	30	70	100		
ECDM	2.58	2.73	2.27	1.98	22.07	1
ECNDF	1.32	1.40	1.17	0.97	23.44	2
ERDM	1.35	1.32	1.37	1.33	13.59	$\hat{Y}$= 1.34
ERNDF	0.68	0.68	0.71	0.67	17.24	$\hat{Y}$= 0.69

[1] CV: coefficient of variation, in percentage.
[2] RE: regression equation; 1. $\hat{Y}$= 2.73 – 0.01X; R^2= 0.79 (P<0.05); 2. $\hat{Y}$= 1.40 – 0.0037X; R^2= 0.79 (P<0.05).
ECDM: efficiency of intake of dry matter; ECNDF: efficiency of intake of neutral detergent fiber; ERDM: efficiency of rumination of pasture dry matter and ERNDF: efficiency of rumination of neutral detergent fiber.

Table 6 Nutrients intake and ingestive behavior (min/kg of dry matter) of crossbred heifers ¾ Zebu × Holstein fed diets with increasing levels of sorghum silage replacement by marand grass silage

Item	Replacement levels sorghum silage (%)				CV[1] (%)	RE[2]
	0	30	70	100		
Dry matter	24.28	23.58	27.30	31.93	16.93	1
Neutral detergent fiber (NDF)	48.33	47.07	53.75	64.63	17.98	2
Rumination dry matter	46.00	45.76	45.53	45.52	14.17	$\hat{Y}$= 45.70
Rumination NDF	92.01	91.41	89.67	92.25	17.81	$\hat{Y}$= 91.33
Chew dry matter	70.30	69.36	72.85	77.47	10.97	$\hat{Y}$= 72.49
Chew NDF	140.35	138.47	143.40	156.85	14.36	Y= 144.76

[1] CV: coefficient of variation, in percentage.
[2] RE: regression equation; 1. $\hat{Y}$= 22.84 + 0.07X; R^2= 0.83 (P< 0.05); 2. $\hat{Y}$= 45.27 + 0.16X; R^2= 0.80 (P<0.05).

Souza *et al.* (2015) analyzing the feed and rumination efficiencies of DM and NDF in grams/hour, did not verify differences between levels of 0, 3.333, 6.66 and 10% of the castor meal added to the marandu grass. Carvalho *et al.* (2004) evaluated levels of 0, 15 and 30% of cocoa meal or palm kernel cake in diets for dairy goats and also did not notice a significant difference for feed efficiency; however, they observed a lower rumination efficiency for the diet with higher level of cocoa meal, due to the lower intake of DM and NDF.

Regarding the DM and NDF intakes in minutes per kg (Table 6), there was a positive linear effect with the increase of marandu grass silage levels, due to the fact that in these diets the animals spent more time in the food selection.

These results are in agreement with the ones registered for food efficiency, in which diets with greater proportions of marandu grass silage were ingested in less quantity in the same time interval. The best digestibility of sorghum silage probably also led to an optimization of the intake in a certain period of time. However, for the rumination time of DM and NDF, in minutes per kg, there was no significance (P>0.05) for values between different diets, a result that may find support in the proximal amounts of fibers in both roughages.

The DM and NDF chewing times, in minutes per kg, were not different (P>0.05) with the replacement of sorghum silage by the marandu grass silage, despite the lower digestibility of the grass silage fiber, in relation to sorghum silage.

An explanation for these results would be the differences in the DM contents of the two roughage, in which there would be a longer chewing time of the natural matter of the marandu grass silage, but this time would be equivalent to that of the sorghum silage, in the measurement of the mastication of DM, since the marandu grass silage presented higher levels of DM (46.25%) in relation to sorghum silage (24.30%), thus balancing the masticatory deficit of the natural matter of the silage of sorghum.

CONCLUSION

The replacement of sorghum silage for silage marandu grass implies greater feeding time for heifers and lower feeding efficiency, without changing the total chewing time.

ACKNOWLEDGEMENT

To Minas Gerais State Foundation for Research Support (FAPEMIG) for financial support; to EPAMIG- Experimental farm, Felixlândia city; to CNPq; to INCT-Animal Science; this study was financed in part by the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior - Brasil (CAPES) - Finance Code 001.

REFERENCES

Antunes A.P.S., Rocha Junior V.R., Ruas J.R.M., Caldeira L.A., Oliveira L.M., Souza V.M., Souza C.F. and Silva D.A. (2014). Characteristics of the ingestive behavior and milk production of F1 Holstein x Zebu cows fed with diets containing increasing levels of urea. *Rev. Bras. Ciênc. Vet.* **21,** 192-198.

Burger P.J, Queiroz C.A, Silca C.F.J., Valadares Filho C.S., Cecon R.P. and Casali P.D.A. (2000). Ingestive behavior in holstein calves fed diets with different concentrate levels. *Rev. Bras. Zootec*. **29,** 236-242.

Carvalho G.G.P., Silva F.F., Veloso M.C., Silva R.R., Silva O.G., Bonomo P. and Mendonça S.S. (2004). Ingestive behavior of dairy goats fed on cocoa meal or palm cake. *Pesq Agropec. Bras*. **39,** 919-925.

Costa R.F., Pires D.A.A., Moura M.M.A., Rodrigues J.A.S., Rocha Júnior V.R. and Tolentino D.C. (2016). *In situ* degradability of dry matter and fibrous fraction of sorghum silage. *Acta Sci. Anim. Sci*. **38,** 171-176.

Detmann E., Souza M.A., Valadares Filho S.C., Queiroz A.C., Berchielli T.T., Saliba E.O.S., Cabral L.S., Pina D.S., Ladeira M.M. and Azevedo J.A.G. (2012). Métodos para Análise de Alimentos. Instituto Nacional de Ciência e Tecnologia de Ciência Animal, Suprema, South Korea.

Ferreira D.F. (2014). Sisvar: A guide for its bootstrap procedures in multiple comparisons. *Ciênc. Agrotec*. **38,** 109-112.

Ma T., Tu Y., Zhang N.F., Deng K.D. and Diao Q.Y. (2015). Effect of the ratio of non-fibrous carbohydrates to neutral detergent fiber and protein structure on intake, digestibility, rumen fermentation, and nitrogen metabolism in lambs. *Asian Australasian J. Anim. Sci*. **28,** 1419-1426.

Mizubuti I.Y., Sestari B.B., Ribeiro E.L.A., Pereira E.S., Barbosa M.A.A.F., Prado O.P.P., Cunha G.E., Gomes R.C. and Costa C.B. (2013). Ingestive behavior of Nellore steers in feedlot fed with diets containing different corn hybrids. *Semina. Ciênc. Agr*. **34,** 4203-4212.

Mendes G.A., Rocha Júnior V.R., Ruas J.R.M., Pereira M.E.G., Silva F.V., Caldeira L.A., Costa M.D., Alves D.D. and Aguiar A.C.R. (2014). Substitution of sorghum silage by marandu grass silage: intake, digestibility and weight gain. *Rev. Bras. Ciênc. Vet.* **21,** 44-52.

Mendes Neto J., Campos J.M.S., Valadares Filho S.C., Lana P.R., Queiroz C.A. and Euclydes F.R. (2007). Chewing activity of dairy heifers fed diets with partial replacement of Tifton 85 hay with citrus pulp. *Rev. Bras. Zootec*. **36,** 618-625.

Mezzalira J.C., Carvalho P.C.F., Fonseca L., Bremm C., Reffatti M.V., Poli C.H.E.C. and Trindade J.K. (2011). Methodological aspects of ingestive behavior of grazing cattle. *Rev. Bras. Zootec*. **40,** 1114-1120.

NRC. (2001). Nutrient Requirements of Dairy Cattle. 7th Ed. National Academy Press, Washington, DC, USA.

Pereira J.C., Figueiredo N.D., Cunha V.P.R., Cecon P.R. and Faria S.E. (2007). Ingestive behavior and particles passage rate in dairy heifers from different genetic groups fed diets with different levels of fiber. *Rev. Bras. Zootec*. **36,** 2134-2142.

Pimentel L.R., Silva F.F., Silva R.R., Schio A.R., Rodrigues E.S.O. and Oliveira P.A. (2015). Feeding behavior of lactating cows fed palm kernel cake in the diet. *Acta Sci. Anim. Sci*. **37,** 83-89.

Pimentel P.R.S., Rocha Júnior V.R., Melo M.T.P., Ramos J.C.P., Cardoso L.G. and Silva J.J.P. (2016). Feeding behavior of F1 Holstein × Zebu lactating cows fed increasing levels of banana peel. *Acta Sci. Anim. Sci*. **38,** 431-437.

Riaz M.Q., Südekum K.H., Clauss M. and Jayanegara A. (2014). Voluntary feed intake and digestibility of four domestic ruminant species as influenced by dietary constituents: A meta-analysis. *Livest. Sci*. **162,** 76-85.

Rigueira J.P.S., Pereira O.G., Ribeiro K.G., Mantovan H.C. and Agarussi M.C.N. (2013). The chemical composition, fermentation profile, and microbial populations in tropical grass silages. *Rev. Bras. Zootec.* **42,** 612-621.

Silva R.R., Silva F.F., Carvalho G.G.P., Franco I.L., Veloso C.M., Chaves M.A., Bonomo P., Prado I.N. and Almeida V.S. (2005). Comportamento ingestivo de novilhas mestiças de holandês x zebu confinadas. *Arch. Zootec*. **54,** 75-85.

Souza D.D., Silva F.F., Schio A.R., Porto Junior A.F., Silva R.R., Santiago B.M., Rodrigues E.S.O., Abreu A.C., Pacheco C.C. and Muricy J.F. (2015). Feeding behavior of dairy cows fed different levels of castor meal in the diet. *Semina. Ciênc. Agr*. **37,** 2355-2364.