Acta Scientiarum

http://www.uem.br/acta
ISSN printed: 1806-2636
ISSN on-line: 1807-8672
Doi: 10.4025/actascianimsci.v37i1.23391

Feeding behavior of lactating cows fed palm kernel cake in the diet

Leidiane Reis Pimentel[1*], Fabiano Ferreira da Silva[2], Robério Rodrigues Silva[2], Alex Resende Schio[1], Eli Santana de Oliveira Rodrigues[1] and Paulo Andrade de Oliveira[1]

*[1]Programa de Pós-graduação em Zootecnia, Universidade Estadual do Sudoeste da Bahia, Praça Primavera, 40, 45700-000, Itapetinga, Bahia, Brazil. [2]Universidade Estadual do Sudoeste da Bahia, Itapetinga, Bahia, Brazil. *Author for correspondence. E-mail: leidyrp@yahoo.com.br*

ABSTRACT. This study aimed to evaluate the effect of including of palm kernel cake on feeding behavior of lactating crossbred cows. Twelve crossbred Holstein x Zebu cows were distributed in three 4 x 4 latin squares, with the following treatments: control; inclusion of 5%; inclusion of 10%; inclusion of 15% palm kernel cake in the diet dry matter. The animals were observed during four periods as to feeding behavior, 24 hours in each period. There was no effect of inclusion of palm kernel cake ($p > 0.05$) on time spent on eating, ruminating and idling. The feeding efficiencies of dry matter and corrected neutral detergent fiber, total digestible nutrients, and the rumination efficiency of corrected neutral detergent fiber were not influenced ($p > 0.05$). There was a linear increase with the inclusion of palm kernel cake ($p < 0.05$) for the efficiencies of rumination of dry matter and total digestible nutrients. The number of periods and duration of behavioral activities was not affected ($p > 0.05$). The inclusion of palm kernel cake in diets for dairy cows causes no change in behavior activities and efficiencies of feeding and rumination, until the 15% level of inclusion.

Keywords: behavioral activities, feeding, feed efficiency, dry matter, idle, rumination.

Comportamento ingestivo de vacas lactantes alimentadas com níveis de torta de dendê na dieta

RESUMO. Objetivou-se avaliar o efeito da inclusão da torta de dendê no comportamento ingestivo de vacas mestiças em lactação. Foram utilizadas 12 vacas mestiças Holandês x Zebu, distribuídas em três quadrados latinos 4 x 4, sendo os tratamentos: controle; inclusão de 5%; inclusão de 10%; inclusão de 15% de torta de dendê na matéria seca da dieta. Os animais foram submetidos a quatro períodos de observação visual do comportamento ingestivo, durante 24 horas, em cada período. Não houve efeito da inclusão da torta de dendê ($p > 0,05$) nos tempos despendidos com alimentação, ruminação e ócio. As eficiências de alimentação, da matéria seca e da fibra em detergente neutro corrigida, dos nutrientes digestíveis totais, e a eficiência de ruminação da fibra em detergente neutro corrigida, não tiveram influência ($p >0,05$). Houve efeito linear crescente com a inclusão de torta de dendê ($p < 0,05$) para as eficiências de ruminação da matéria seca e para os nutrientes digestíveis totais. O número de períodos e tempo de duração das atividades comportamentais não foi influenciado ($p > 0,05$). A inclusão da torta de dendê em dietas de vacas leiteiras não altera as atividades comportamentais e as eficiências de alimentação e de ruminação, até o nível de 15% de inclusão.

Palavras-chave: atividades comportamentais, alimentação, eficiência alimentar, matéria seca, ócio, ruminação.

Introduction

The study of feeding behavior may provide new perspective to the conventional model of zootechnical science approach, opening new horizons and bringing innovations to situations not considered or misunderstood, especially regarding management practices (R. R. Silva et al., 2005). Also, it can be used as a tool for assessing diets, allowing the adjustment of feed management to achieve the best performance (Mendonça et al., 2004).

Daily activities are represented by three basic behaviors: feeding, ruminating and idling: its duration and distribution may be influenced by characteristics of the diet, management, weather and activity of the animals (Fisher, 1997). The feeding behavior of cattle kept in the field is characterized by long feeding periods, from 4 to 12 hours per day, but for feedlot animals, the periods range from one hour, for energy-rich foods, to six hour for more, for low energy sources (Bürger et al., 2000).

Appropriate nutritional management of animals depends on numerous factors, including the knowledge of grazing behavior, associated with the characteristic of the food provided (Marques et al.,

2008).The behavior patterns of food intake are one of the most effective means of adaptation to environmental factors, therefore, may indicate potential methods for increasing animal productivity (Carvalho et al., 2007).

In the case of animals receiving co-products in the diet, knowledge of feeding behavior may contribute to the development of rations and clarify issues related to the decrease in consumption (Carvalho et al., 2004), frequent in diets composed of co-products.

The palm kernel cake results from the extraction of palm oil in the biodiesel production. The Bahia State produces considerable amounts of palm kernel cake, which can be used as an alternative animal feed, since it is permanently available throughout the year. According to. Carvalho et al. (2006), palm kernel cake can be used in ruminant feeding, but its use should be monitored given the high concentrations of NDF and possible low palatability.

The use of agroindustrial residues in feeding animals, especially in the feedlot system, is essential when the goal is to reduce the production cost, as an alternative to prevent uncontrolled release into the environment. However, these residues must be used judiciously, i.e., evaluating a maximum level of inclusion in the diet, without causing undesirable effects on the production system. The palm kernel cake can be used in ruminant feed, but its effect on animal feeding behavior is poorly known.

Given this context, the present study evaluated the effect of including palm kernel cake on the feeding behavior of crossbred lactating cows.

Material and methods

The experiment was conducted at the Farm Paulistinha, municipality of Macarani, Bahia State, with 12 crossbred Holstein x Zebu cows (blood level ranging from ½ to ¾ of Holstein blood), at the third or fourth lactation with previous production between 2,500 and 3,500 kg adjusted to 300 days, with average lactation of 64 ± 13.32 days in the beginning of the experiment. The animals were divided in three 4 x 4 Latin squares to obtain the best level of inclusion of palm kernel cake, with the treatments: 0% = control (without inclusion of palm kernel cake in the diet); 5% = 5% inclusion of palm kernel cake in the diet dry matter; 10% = 10% inclusion of palm kernel cake; and 15% = 15% inclusion of palm kernel cake.

Sugar cane (*Saccharum officinarum*), RB 72454 variety, was used as forage, treated with 1% of a mixture of urea and ammonium sulfate (9:1) in the experimental stage. During a 7 day-period before the start of the experiment, cows were given forage containing only 0.5% of the mixture of urea, in order to adapt to this added to the forage, preventing thereby a possible intoxication.

The level of concentrate supplementation was determined by adjusting diets to have sufficient nutrients for maintenance, body weight gain of 0.15 kg day^{-1} and producing 15 kg milk day^{-1}, according to NRC (2001), based on data from chemical composition of sugar cane, corn, soybean meal and palm kernel cake, made before the experiment. The proportions of ingredients in the concentrate are shown in Table 1, on a dry matter basis.

The experiment began on September 24th, 2012, and ended on December 9th, 2012, made up of four experimental periods, lasting 19 days each, in which the first 14 days were used for adaptation. In each experimental period, forage and supplements were sampled by homogeneous collection, followed by manual quartering, to evaluate their chemical composition and determine the composition of the diets (Table 2).

Table 1. Proportion of ingredients on a dry matter basis.

Ingredients (%)	Level of palm kernel cake (% DM)			
	0	5	10	15
Sugar cane	68.40	64.92	61.01	57.50
Corn meal	22.74	22.16	21.94	21.33
Soybean meal	7.08	6.59	6.20	5.69
Palm kernel cake	0.00	4.30	9.16	13.85
Mineral salt[1]	1.01	1.02	1.01	1.02
Dicalcium phosphate	0.50	0.42	0.31	0.21
Limestone	0.25	0.32	0.35	0.38

[1]Composition: Calcium 200 g; Cobalt 200 mg; Copper 1.650 mg; Sulfur 12 g; Iron 560 mg; Fluorine (max) 1,000 g; Phosphorus 100 g; Iodine 195 mg; Magnesium 15 g; Manganese 1,960 mg; Nickel 40 mg; Selenium 32 mg; Sodium 68 g; Zinc 6,285 mg.

Table 2. Chemical composition of sugar cane and diets.

Components	Sugar cane + urea	Level of palm kernel cake (% DM)			
		0	5	10	15
Brix[1]	18.51	-	-	-	-
Dry matter (% DM)	29.71	37. 72	38.86	40.29	41.74
Crude protein (%DM)	10.71	12.31	12.35	12.36	12.71
Ether extract (% DM)	1.38	1.62	1.79	2.00	2.25
Neutral detergent $fiber_{cp}$[2](%DM)	58.54	44.65	43.27	43.88	44.79
Acid detergent fiber(%DM)	48.58	38.29	38.46	39.42	37.70
Non-fiber carbohydrates(%DM)	34.37	44.59	45.51	44.45	42.65
Total carbohydrates (%DM)	86.75	85.12	84.89	84.70	84.05
Lignin (%DM)	9.85	4.92	7.00	8.29	9.99

[1]Concentration of soluble sugars in cane sugar. [2]Neutral detergent fiber corrected for ash and protein.

Chemical composition analysis was performed of the palm kernel cake (Table 3) purchased at the company Óleos de Palma S.A. AGRO INDUSTRIAL, located in the municipality of Taperoá, Bahia State.

Table 3. Chemical composition of the palm kernel cake.

Component	Palm kernel cake
Dry matter (%)	92.25
Crude protein (% DM)	14.34
Ether extract (% DM)	10.56
Neutral detergent fiber $_{cp}$[1] (% DM)	65.63
Acid detergent fiber (% DM)	46.42
Lignin (% DM)	18.31
Mineral matter (% DM)	3.13

[1]Neutral detergent fiber corrected for ash and protein.

Animals were housed in individual covered pens of 16 m^2, equipped with trough and drinking fountain, fueled by gravity, with a capacity of 200 liters, common to two pens. Food was provided ad libitum as a complete mixture twice a day at 7h00 am and 3h00 pm, to allow 10% leftovers.

Samples of sugar cane, concentrate and palm kernel cake were frozen at -20°C; subsequently thawed and pre-dried. At the end of the experimental period, samples were ground in a mill with a 1 mm sieve, packed in capped bottles and stored for later analysis. Analyses of dry matter (DM), crude protein (CP), ether extract (EE), acid detergent fiber (ADF), lignin (Lig) and mineral matter (MM) of the diets were performed according to Silva & Queiroz (2002). The ash and protein-free neutral detergent fiber (NDF) was calculated according to Detmann & Valadares Filho (2010).

The animals were observed to assess the feeding behavior, on the day 18 of each period, without adjustment period because the animals were already part of an experiment to gain weight. Animals were observed simultaneously for 24 hours at 5 min.-intervals, in the control scale, totaling 288 daily observations (Gary et al., 1970). For the time spent on each activity, digital timers were used by four trained observers, positioned so as not to disturb the animals, who observed the animals in predetermined periods. A behavioral ethogram was developed with the activities of feeding, idling and ruminating. The feeding activity was recorded when the animal was feeding in the trough, and the idling activity, when the animal was resting. On the next day, we determined the number of cud chews and the time spent ruminating each ruminal bolus, using a digital timer. For this evaluation, we considered all animals in the experiment, three ruminal boluses, in three distinct periods (10-12, 14-16 and 19-21 hours). During the night observation of animals, the environment was maintained with artificial lighting, with a previous adaptation period.

The feeding efficiency (FE), the rumination efficiency (RE), the number of ruminal bolus per day (NRB), the total chewing time per day (TCT) and the number of cud chews per day (NCC) were obtained according to Bürger et al. (2000).

The voluntary intake of dry matter (DM) and neutral detergent fiber corrected for ash and protein (NDFcp) were considered when evaluating the efficiencies of feeding and ruminating in relation to the amount in grams of DM and NDF per unit time and feeding period. The number of boluses ruminated daily was obtained by dividing the total rumination time (minutes) by the average time spent on ruminating one bolus.

The feeding efficiency and rumination was obtained as follows:

FE = DDMI/FT
FE = DDMI /FT
FENDFc = CENDFc /FT
RE = DDMI /RT
ERNDFc = CENDFc /FT
ERTDN = DCTDN /RT

where:

FE= feeding efficiency; DRMI = daily dry matter intake (grams of DM); FT = feeding time (hours); CENDFc = consumption efficiency of NDFc; DINDFc = daily NDFc intake (grams of NDFc); DCTDN = daily consumption of TDN (grams of TDN); RT = rumination time (hours); RENDFc = rumination efficiency (grams of NDFc); RETDN = rumination efficiency of total digestible nutrients (grams of RETDN).

The experimental variables were assessed by analysis of variance and regression, using the SAS (2004). Statistical models were chosen according to the significance of the regression coefficients, using the F-test at 5% probability, and the coefficient of determination (R^2), with the studied biological phenomenon.

Results and discussion

There was no effect of including palm kernel cake in the diets ($p > 0.05$) on the time spent on feeding, ruminating and idling, 5.22; 8.33 and 10.44 hours day^{-1}, respectively (Table 4). The expected effect would be the same trend of dry matter intake, which was also not influenced by the inclusion of palm kernel cake. It can also be associated with the little difference between the diets, especially as to

the neutral detergent fiber corrected (NDFcp) (Table 2). According to Pereira et al. (2007), time spent on feeding and ruminating increased with the increase of dietary NDF, thus reducing the time spent on idle.

The amount of indigestible or poorly digestible materials consumed and the resistance of this material to particle size reduction increases the need for chewing (Mertens, 1994), altering the time spent on feeding and ruminating. G. G. P. Carvalho et al. (2007) observed that the inclusion of co-products, such as cocoa cake and palm kernel cake in diets for lactating goats, significantly increased fiber content, but the feeding behavior had not changed.

Table 4. Time spent on feeding, ruminating and idling, in hours, of lactating cows receiving different levels of palm kernel cake in the diet.

Activity	Level of palm kernel cake (% DM)				Eq.[1]	CV%[2]	P[3]
	0	5	10	15			
Feeding (h)	5.13	5.38	5.33	5.03	5.22	13.57	0.590
Ruminating (h)	8.70	7.93	8.34	8.35	8.33	9.89	0.586
Idling (h)	10.16	10.67	10.33	10.62	10.45	10.43	0.214

[1]Regression equations.[2]Coefficient of variation in percentage.[3]Probability of error.

The pattern of food search by feedlot cattle is typical, with two key moments: early morning and late afternoon, and the time spent daily in this activity by feedlot dairy cows has been 4.5 hours (Damasceno et al., 1999), ranging from one hour, for energy-rich foods, up to six hours or more for low energy foods (Bürger et al., 2000). The value registered in the present study, 5.22 hours for feeding, is within the range of variation cited by this author.

Correia et al. (2012) evaluated the feeding behavior of steers fed cakes from biodiesel production, including 16% of palm kernel cake in the total diet, and verified times spent daily on feeding, ruminating and idling at 304.37 (min. day^{-1}), 541.25 (min. day^{-1}) and 594.37 (min. day^{-1}), respectively. These results are similar to those found herein where animals spent more time in idleness and rumination.

In the same way, Macome et al. (2012) studied the inclusion of palm kernel cake in the diet for lambs through the feeding behavior, using four treatments (0, 6.5, 13.0 and 19.5% palm kernel cake in the total diet), and observed that the addition of palm kernel cake had an increasing linear effect for time spent by ingestion period and quadratic behavior for the time spent in idleness. In accordance with the authors, this can be explained by the composition of the experimental diet that contained high content of NDF. The inclusion of palm kernel cake in up to 19.5% affects some parameters of feeding behavior, but does not alter significantly the feeding behavior. There was no effect of adding palm kernel cake to the diet on the number of periods of feeding, ruminating and idling.

There was no effect of using palm kernel cake ($p > 0.05$) on intake of dry matter and neutral detergent fiber corrected (NDFcp), demonstrating that the inclusion of palm kernel cake in the diet at levels of up to 15%, which has high content of fiber, lignin and EE, had no effect on consumption. Although palm kernel cakeis a co-product with high content of NDFcp (65.63%), fraction negatively correlated with energy, mediated by physical mechanisms of satiety (Maggioni et al., 2009; Mertens, 1994), it had not affected consumption, because as the levels of palm kernel cake in the diet increased, the levels of forage in the same decreased, in order to balance the energy, as can be seen with the NDFcp content of the diets in Table 2.

When assessing the feeding behavior of steers fed palm kernel cake, Correia et al. (2012) observed that the replacement of soybean meal with palm kernel cake affects feeding behavior of steers, with decreased dry matter intake.

The effects observed for feeding efficiencies dry matter (FE) (Table 5) of neutral detergent fiber corrected (FENDFc) and total digestible nutrients (FETDN), as well as rumination efficiency of neutral detergent fiber corrected (RENDFc) showed no influence of the inclusion of palm kernel cake in the diet ($p > 0.05$). The non-differentiation of consumption for DM and NDF and time spent on eating and ruminating led to the lack of difference in FE and RE, both in relation to DM and NDF.

The efficiencies of DM and NDF intake and rumination are influenced by forage type (Pinto et al., 2010). The diets in this experiment contained sugar cane as the sole source of forage, only varying levels of palm kernel cake added to the diet. Thus, there were no changes in feeding efficiencies of DM and NDFc, possibly due to the absence of difference in the intake of NDFc of the diets.

In the present work, using lower levels of inclusion of palm kernel cake, no changes in the DM and NDF were observed; further studies can be performed with higher inclusion levels for lactating cows.

Significant effect was found for the inclusion of palm kernel cake in the diet ($p < 0.05$) (Table 5) for rumination efficiency of dry matter (RE) and rumination efficiency for total digestible nutrients (RETDN), with an increase of 1745.86 and 35.61 units, respectively, for each 1% of palm kernel cake added to the diet.

Table 5. Parameters of feeding efficiency and cud-chewing of lactating cows receiving different levels of palm kernel cake.

Feeding efficiency	Level of palm kernel cake (% DM)				Eq.[1]	CV%[2]	P[3]
	0	5	10	15			
DMI[4] (kg day^{-1})	14.71	14.89	15.74	15.52	[18]	7.93	0.133
INDFcp[5] (kg day^{-1})	6.57	6.49	6.98	6.98	[19]	8.57	0.082
TDNI[6] (kg day^{-1})	9.56	9.87	10.23	10.31	[20]	7.87	0.096
FE[7] (g DM h^{-1})	2911.59	2825.44	3051.49	3360.32	[21]	21.95	0.238
FENDFc[8] (g NDFc h^{-1})	1297.80	1234.07	1351.96	1509.23	[22]	22.02	0.153
FETDN[9] (g TDN h^{-1})	1894.33	1871.55	1978.33	2231.28	[23]	22.77	0.214
RE[10] (g DM h^{-1})	1730.18	1914.05	1908.74	1882.69	[24]	9.40	0.047
RENDFc[11] (g NDFc h^{-1})	771.91	833.27	846.84	846.55	[25]	10.11	0.108
RETDN[12] (g TDN h^{-1})	1186.33	1372.62	1374.06	1480.76	[26]	10.95	0.028
TCT[13] (h day^{-1})	830.00	798.75	820.42	802.92	[27]	7.57	0.568
NRB[14] (number day^{-1})	546.85	488.30	529.47	512.10	[28]	11.19	0.106
NCd[15] (number day^{-1})	30706.60	27702.47	29381.29	29178.79	[29]	10.94	0.173
NCb[16] (number day^{-1})	56.24	56.64	55.39	56.93	[30]	23.85	0.781
TRB[17](sec bolus^{-1})	57.51	58.48	56.69	58.58	[31]	23.00	0.583

[1]Regression equations; [2]Coefficient of variation in percentage; [3]Probability of error; [4]DMI – dry matter intake; [5]INDFcp – intake of neutral detergent fiber corrected for ash and protein; [6]TDNI – total digestible nutrients intake; [7]FE –feeding efficiency of dry matter; [8]FENDFc – feeding efficiency of neutral detergent fiber corrected; [9]FETDN – feeding efficiency of total digestible nutrients; [10]RE – rumination efficiency of dry matter; [11]REUNDFc – rumination efficiency of neutral detergent fiber corrected; [12]RETDN – rumination efficiency of total digestible nutrients; [13]TCT – total chewing time; [14]NBR – number of boluses ruminated per day; [15]NCd – number of chews per day; [16]NCb – number of chews per bolus and [17]TRB – time spent per ruminated bolus gasto.[18]$\hat{Y}$= 15.21; [19]$\hat{Y}$= 6.75; [20]$\hat{Y}$= 9.99; [21]$\hat{Y}$= 3037.21; [22]$\hat{Y}$= 1348.26; [23]$\hat{Y}$= 1993.87; [24]$\hat{Y}$= 45.222 + 1745.86x, R^2 = 0.45; [25]$\hat{Y}$= 824.64; [26]$\hat{Y}$= 1132.14 + 88.47x, R^2 = 0.49; [27]$\hat{Y}$= 813.02; [28]$\hat{Y}$= 519.18; [29]$\hat{Y}$= 29242.29; [30]$\hat{Y}$= 56.30; [31]$\hat{Y}$= 57.80.

The increased content of non-fiber carbohydrates and consequent reduction of neutral detergent fiber in the diet can result in shorter periods of feeding and rumination and, therefore, increase the total time spent daily on idleness. When the variation of the content of the fibrous components is not pronounced, the feeding efficiency may be not affected. In turn, the rumination efficiency is positively affected according to increasing content of dry matter in the diet (Silva et al., 2005).

Maciel et al. (2012) investigated the use of palm kernel cake in the diet of dairy heifers at the inclusion levels of 0.0; 11.9; 22.9 and 34.2% in the total diet dry matter, and found that the intake of DM and NDF decreased linearly as the palm cake was included in the diet. The authors observed that the dry matter intake at the highest level of inclusion of palm kernel cake was 54.5% lower compared with the control diet, expressed in kg day^{-1}. Increased rumination efficiencies of dry matter and total digestible nutrients may be related to the higher fiber content in the palm kernel cake.

Mendonça et al. (2004) reported that FE of the diet with cane sugar, added with 1% urea/SA and 50% concentrate was higher ($p < 0.05$) than that of the diet with 40% of concentrate, with the same amount of urea/SA. This indicates that the level of concentrate in the diet alters the FE of animals (Bürger et al., 2000).

Bürger et al. (2000) observed that RE linearly increased with the inclusion of concentrate in the diets, while RENDF decreased linearly. According to the authors, this was probably due to the decline in the cellulolytic activity of rumen microorganisms, besides the regurgitation of one part of the concentrate in the bolus during rumination.

Correia et al. (2012) evaluated the feeding behavior of Holstein x Zebu steers fed 16% palm kernel cake in the total diet, and verified no effect of diet on DM feeding efficiency (2060.0 g of DM ingested h^{-1}), NDF feeding efficiency (1330.0 g of DM ingested h^{-1}), DM rumination efficiency (1090.0 g DM ruminated h^{-1}), NDF rumination efficiency (710.0 g DM ruminated h^{-1}).

No effect of inclusion was detected of palm kernel cake ($p > 0.05$) on total chewing time (TCT) (Table 5), number of boluses ruminated per day (NBR), number of chews per day (NCd), presenting mean values of 813.02; 519.18 and 29,242.29, respectively.

In relation to the number of chews per bolus (NCb) and time spent per ruminated bolus (TRB), there was no effect ($p > 0.05$) (Table 5), averaging 56.30 number day^{-1} and 57.80 s bolus^{-1}, respectively, following the same trend of the times spent on feeding and ruminating, which were not influenced by diet.

A study developed by Pereira et al. (2007) with heifers supplied with diets containing 60% NDF reported that these animals spent more time on feeding and ruminating, with a higher rumination rate per kg NDF, higher number of chews per bolus, higher number of cud-chews per day, greater number of boluses and longer time on chewing per day compared with heifers fed diets containing 30% NDF.

The inclusion of palm kernel cake in the diet (Table 6) did not affect ($p > 0.05$) the number of periods of feeding (NPF), rumination (NPR) and idleness (NPI), with averages of 11.58; 20.98 and 28.44, respectively. For the time spent per period of feeding (TPF), rumination (TPR) and idleness (TPI), there was no effect of the addition of palm kernel cake in the diet, with averages of 0.48; 0.41 and 0.38 hours, respectively.

Table 6. Number of periods and duration of behavioral activities of lactating cows fed diets containing different levels of palm kernel cake.

Behavioral Activities	Level of palm kernel cake (% DM)				EQ.[1]	CV%[2]	P[3]
	0	5	10	15			
NFP[4] (number)	11.42	11.83	11.92	11.17	11.58	19.63	0.832
NRP[5] (number)	21.75	20.42	21.50	20.25	20.98	14.25	0.521
NIP[6] (number)	28.17	29.08	27.33	29.17	28.44	14.57	0.670
TFP[7] (hour)	0.47	0.47	0.48	0.49	0.48	26.02	0.947
TPR[8] (hour)	0.41	0.39	0.40	0.44	0.41	14.89	0.294
TIP[9] (hour)	0.37	0.38	0.39	0.38	0.38	15.96	0.723

[1]Regression equations; [2]Coefficient of variation in percentage; [3]Probability of error; [4]NFP – number of feeding periods; [5]NRP – number of rumination periods; [6]NIP – number of idle periods; [7]TFP – time per feeding period; [8]TRP – time per rumination period and [9]TIP – time per idle period.

Mendes Neto et al. (2007) stated that the change in the time or frequency of diet supply to the animal can modify the percentage distribution of feeding schedules of confined animals. In the present study, the diets were provided strictly on the same schedule every day, at seven and fifteen hours, thus no difference was registered in the number of periods of feeding, rumination and idleness.

According to Pinto et al. (2010), the use of the times spent on feeding and ruminating are good indicators of actual consumption, since several factors are related to the actual dry matter and fiber intake and to the characteristics of feeding and rumination behavior, such as physical and chemical properties of the diet, digestibility and degradability of the diet and the individual characteristics of the animal.

Conclusion

The inclusion of palm kernel cake in diets for lactating cows causes no increase in the time spent on feeding and ruminating, and does not alter the efficiency of feeding and rumination, as well as numbers of periods and duration of behavioral activities, using up to 15% of inclusion.

References

Bürger, P. J., Pereira, J. C., Queiroz, A. C., Coelho, J. F., Agostini, P. S., Valadares Filho, S. C., Casali, A. D. P. (2000). Comportamento ingestivo em bezerros holandeses alimentados com dietas contendo diferentes níveis de concentrado. *Revista Brasileira de Zootecnia*, 29(1), 236-242.

Carvalho, G. G. P., Pires, A. J. V. & Silva, F. F. (2004). Comportamento ingestivo de cabras leiteiras alimentadas com farelo de cacau ou torta de dendê. *Revista Brasileira de Zootecnia*, 39(9), 919-925.

Carvalho, G. G. P., Pires, A. J. V., Silva, H. G. O., Veloso, C. M. & Silva, R. R. (2007). Aspectos metodológicos do comportamento ingestivo de cabras lactantes alimentadas com farelo de cacau e torta de dendê. *Revista Brasileira de Zootecnia*, 36(1), 103-110.

Carvalho, S., Rodrigues, M. T., Branco, R. H. & Rodrigues, C. A. F. (2006). Consumo de nutrientes, produção e composição do leite de cabras da raça Alpina alimentadas com dietas contendo diferentes teores de fibra. *Revista Brasileira de Zootecnia*, 35(3), 1154-1161.

Correia, B. R., Oliveira, R. L., Jaeger, S. M. P. L., Bagaldo, A. R., Carvalho, G. G. P., Oliveira, G. J. C., Oliveira, P. A. (2012). Comportamento ingestivo e parâmetros fisológicos de novilhos alimentados com tortas do biodiesel. *Archivos de Zootecnia*, 61(233), 79-89.

Damasceno, J. C., Baccari Júnior, F. & Targa, L. A. (1999). Respostas comportamentais de vacas holandesas, com acesso à sombra constante ou limitada. *Pesquisa Agropecuária Brasileira*, 34(4), 709-715.

Detmann, E. & Valadares Filho, S. C. (2010). On the estimation of non-fibrous carbohydrates in feeds and diets. *Arquivo Brasileiro de Medicina Veterinaria e Zootecnia*, 62(4), 980-984.

Fisher, A. V. (1997). A review of the technique of estimating the composition of livestock using the velocity of ultrasound. *Computers and Electronics in Agriculture*, 17(2), 217-231. doi: http://dx.doi.org/10.1016/S0168-1699(96)01306-3

Gary, L. A., Sherritt, G. W. & Hale, E. B. (1970). Behavior of Charolais cattle on pasture. *Journal of Animal Science*, 30(2), 203-206.

Maciel, R. P., Neiva, J. N. M., Araujo, V. L., Cunha, O. F. R., Paiva, J., Restle, J., Lôbo, R. N. B. (2012). Consumo, digestibilidade e desempenho de novilhas leiteiras alimentadas com dietas contendo torta de dendê. *Revista Brasileira de Zootecnia*, 41(3), 698-706. doi: 10.1590/S1516-35982012000300033

Macome, F. M., Oliveira, R. L., Araujo, G. G. L., Barbosa, L. P., Carvalho, G. G. P., Garcez Neto, A. F. & Silva, T. (2012). Respostas de ingestão e fisiologicas de cordeiros alimentados com torta de dendê (Elaeis guineensis). *Archivos de Zootecnia*, 61(235), 335-342.

Maggioni, D., Marques, J. A., Rotta, P. P., Zawadzki, F., Ito, R. H. & Prado, I. N. (2009). Ingestão de alimentos. *Semina: Ciências Agrárias*, 30(4), 963-974.

Marques, J. A., Pinto, A. P., ABRAHÃO, J. J. S. & Nascimento, W. G. (2008). Intervalo de tempo entre observações para avaliação do comportamento ingestivo de tourinhos em confinamento. *Semina: Ciências Agrárias*, 29(4), 955-960.

Mendes Neto, J., Campos, J. M. S., Valadares Filho, S. C., Lana, R. P., Queiroz, A. C. & Euclydes, R. F. (2007). Comportamento ingestivo de novilhas leiteiras alimentadas com polpa cítrica em substituição ao feno de capim-tifton 85. *Revista Brasileira de Zootecnia*, 36(3), 618-625.

Mendonça, S. S., Campos, J. M. S., Valadares Filho, S. C., Valadares, R. F. D., Soares, C. A., Lana, R. P., Pereira, M. L. A. (2004). Comportamento ingestivo de vacas leiteiras alimentadas com dietas à base de cana-de-açúcar ou silagem de milho. *Revista Brasileira de Zootecnia*, 33(3), 723-728.

Mertens, D. R. (1994). Regulation of Forage Intake. In J. R. Fahey (Ed.), *Forage Quality, Evaluation, and Utilization* (pp. 450-493). Madison, WI, USA: American Society of Agronomy.

NRC. (2001). *Nutrient Requirements of Dairy Cattle* (7th rev. ed.): Natl. Acad. Press, Washington, DC.

Pereira, J. C., Cunha, D. d. N. F. V. d., Cecon, P. R. & Faria, E. d. S. (2007). Comportamento ingestivo e taxa de passagem de partículas em novilhas leiteiras de diferentes grupos genéticos submetidas a dietas com diferentes níveis de fibra. *Revista Brasileira de Zootecnia*, 36(6), 2134-2142.

Pinto, A. P., Marques, J. A., Abrahão, J. J. S., Nascimento, W. G., Costa, M. A. T. & Lugão, S. M. B. (2010). Comportamento e eficiência ingestiva de tourinhos mestiços confinados com três dietas diferentes. *Archivos de Zootecnia*, 59(227), 427-434.

SAS. (2004). *SAS/STAT User guide, Version 9.1.2*. Cary, NC, USA: SAS Institute Inc.

Silva, D. J. & Queiroz, A. C. (2002). *Análise de alimentos: métodos químicos e biológicos* (3 ed.). Viçosa, Minas Gerais, Brasil: Universdiade Federal de Viçosa.

Silva, R. R., Silva, F. F., Carvalho, G. G. P., Franco, I. L., Veloso, C. M., Chaves, M. A., Almeida, V. S. (2005). Comportamento ingestivo de novilhas mestiças de Holandês x Zebu confinadas. *Archivos de Zootecnia*, 54(205), 75-85.

Received on March 26, 2014.

Accepted on July 10, 2014.