Semina: Ciências Agrárias
ISSN: 1676-546X
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Universidade Estadual de Londrina
Brasil

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Semina: Ciências Agrárias, vol. 37, núm. 6, noviembre-diciembre, 2016, pp. 4255-4264
Universidade Estadual de Londrina
Londrina, Brasil

DOI: 10.5433/1679-0359.2016v37n6p4255

Feeding behavior of dairy cows on pasture fed detoxicated castor meal in the diet

Comportamento ingestivo de vacas leiteiras em pastejo recebendo níveis de inclusão de farelo de mamona detoxicado na dieta

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Abstract

This study evaluated the feeding behavior of lactating cows on pasture of *Brachiaria (Urochloa) decumbens* fed with concentrate supplementation containing different levels of castor meal inclusion treated with calcium hydroxide Ca (OH) 2, in the proportions of 0; 3.3; 6.6 to 10% of the total diet. Eight cows (degree of blood ½ to ¾ Holstein x Zebu), with previous average production of 3000-4000 kg adjusted to 300 days of lactation and average body weight of 465.16 kg ± 65.45 kg were distributed in two 4 x 4 Latin squares. The behavior was assessed every five minutes for 24 hours on the 21st day of each period. The results were tested by analysis of variance and regression at $p < 0.05$ probability. The time spent in grazing, rumination, idle and in the trough; total chewing time, number of cuds per day, chewing per day; chewing per cud; the number of periods of grazing, rumination, idle and in the trough; time spent by period of grazing, rumination, idle and in the trough were not different between treatments. The feed efficiency (g DM h^{-1}; g NDFa h^{-1} and g TDN h^{-1}) and time spent per cud ruminated TSR sec cud^{-1}) were linearly reduced. It is recommended to include up to 10% castor meal treated with $Ca(OH)_2$ in the total diet.

Key words: Bite. Co-product. Pasture. Ruminant.

Resumo

Objetivou-se avaliar o comportamento ingestivo de vacas leiteiras em pastagem de *Brachiaria (Urochloa) decumbens* submetidas a suplementação concentrada com diferentes níveis de inclusão de farelo de mamona tratada com hidróxido de cálcio $Ca(OH)_2$, nas proporções de 0; 3,3; 6,6 e 10% na dieta total. Utilizaram-se oito vacas (grau de sangue ½ a ¾ Holandês x Zebu), com produção média anterior entre 3.000 a 4.000 kg, ajustada para 300 dias de lactação e peso corporal médio 465,16 kg ± 65,45 kg. Os animais foram distribuídos em dois Quadrados Latinos 4 x 4. O comportamento foi avaliado a cada

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Received: Mar. 10, 2016 – Approved: Sept. 05, 2016

cinco minutos, durante 24 horas no 21º dia de cada período. Os resultados foram submetidos a análises de variância e regressão a 0,05 de probabilidade. Os tempos despendidos nas atividades de pastejo, ruminação, ócio e cocho; tempo de mastigação total, número de bolos ruminados por dia, mastigação por dia; mastigação por bolo; o número de período de pastejo, ruminação, ócio e cocho; tempo gasto por período de pastejo, ruminação, ócio e cocho não houve diferença entre os tratamentos. A eficiência de alimentação (em g MS h^{-1}; g FDNc h^{-1} e g NDT h^{-1}) e tempo gasto por bolo ruminado TRB seg $bolo^{-1}$ reduziram linearmente. Recomenda-se a inclusão de até 10% de farelo de mamona tratada com $Ca(OH)_2$ na dieta total.

Palavras-chave: Bocado. Coproduto. Pastagem. Ruminante.

Introduction

Brazil is a country of continental dimensions, with huge potential for production of various foods, generating various types of agro-industrial waste and co-products. However, biodiesel production, focus of great interest and expansion worldwide, may significantly increase the availability of co-products, resulting from the extraction of oil plants of the biodiesel production chain oil, producing cakes or meal with potential for use in animal feed.

Nevertheless, concern for environmental issues and large great fluctuation in prices of traditional food; including soybeans, cotton and sunflower, have guided the interest in introducing these co-products in ruminant diets and, therefore, which has grown considerably, representing a viable alternative, from both a nutritional and economic point of view, since the Northeast region is the largest producer of castor plant in Brazil.

The ingredients used in animal diet originated from the processing of oilseeds, including cotton, peanut, sunflower, palm oil, castor oil, etc., generate cakes and meals with potential for use, especially for ruminants, becoming an alternative source to animal production.

In the 2013/14 season, there were planted 106,300 hectares (ha), 96.98% total produced in the Northeast. The state of Bahia produced 81.48% national supply, reaching 52,800 tons, while the Central South region, which ranks second, with 3.2 thousand ha area cultivated (CONAB, 2014). The use of co-products make the concentrate supplementation more attractive to milk producers, since the protein value of these foods is almost equivalent to those used in ruminant diets. Thus, the search for alternative foods that provide the same nutritional effect to animals with a better economic return, is of fundamental importance for the dairy activity.

Production systems that use only the pasture as exclusive food to dairy cows do not meet the nutritional requirements due to the quantity and quality of nutrients available by the forage (PITTA et al., 2013). This could compromise the body reserves to ensure milk production, and cause the emergence of reproductive problems in the animal.

The study of feeding behavior in animals fed diets containing co-products can guide the feeding system, and clarify possible problems related to the intake and productive performance. In this sense, the use of castor meal in diets for ruminants would represent an integration of both production chains, both of biodiesel and livestock, providing a better quality of life to the farmer, through the generation of jobs and income, reducing environmental damage and offering an array of options to dairy or milk cattle producers (COSTA, 2010).

Castor meal is the main product after oil extraction, but its use in animal feed is limited because of anti-nutritional factors, ricin and ricinine. Ricin is a lethal toxin of major proportions, which must be subjected to a detoxification process, so that its inclusion in the diets produces a safe food free from toxicity.

In this context, this study aimed to evaluate the behavior of lactating cows on pasture of *Brachiaria (Urochloa) decumbens* fed concentrate supplementation with different levels of castor meal inclusion treated with calcium hydroxide in the diet.

Material and Methods

The experiment was conducted at Paulistinha Farm in the municipality of Macarani, state of Bahia, from July 1st to September 22nd, 2014. Analyses of the samples were carried out at the Laboratory of Forage and Pasture, Campus Itapetinga, state of Bahia. In the field phase, data on temperature (maximum, minimum and average) and rainfall were collected during the experimental period through pluviometer and thermometer (Table 1), installed on the farm.

Table 1. Average temperature, average maximum (TMAX) and minimum (TMAX) temperature and total rainfall, per month, observed during the experimental period.

Variables	Month		
	July	**August**	**September**
TMAX (C°)	31	32	37
TMIN (C°)	17	15	16
Mean (C°)	23.79	24.105	25.815
Rainfall (mm)	39	0.0	0.0

Eight crossbred Holstein x Zebu cows (degree of blood ranging from ½ to ¾), at the third or fourth lactation, with previous average production between 3000 and 4000 kg, adjusted to 300 days, with an average body weight of 465.16 kg ± 65.45 kg, were managed in area of five hectares formed by *Brachiaria* (*Urochloa*) *decumbens*. The cows were also selected for days in milk between 80 and 120 days at the beginning of the experiment, distributed in two 4 x 4 Latin squares. The animals were supplemented with concentrate to meet the maintenance requirements, body weight gain of 0.15 kg day $^{-1}$ and producing 15 kg milk day^{-1} adjusted to 3.5% fat, according to the table of requirements (NRC, 2001). The forage: concentrate ratio of diets on a dry matter basis is listed in Table 2.

Table 2. Proportion of ingredients of concentrates on a dry matter basis for lactating cows.

Ingredients	Levels of inclusion of castor meal (% DM)			
	0.00	**3.33**	**6.66**	**10.00**
Ground corn	55.52	53.80	52.11	50.46
Whole cottonseed	23.67	23.37	23.09	22.81
Soybean meal	16.34	10.91	5.62	0.44
Detoxicated castor meal	-	7.60	15.01	22.27
Minerals[1]	1.87	1.85	1.82	1.80
Urea + ammonium sulfate	1.34	1.32	1.31	1.29
Limestone	1.26	1.15	1.03	0.93
Total	100	100	100	100
		Ratio %		
Forage	54.19	57.16	56.99	54.86
Concentrate	45.81	42.84	43.01	45.14

[1]Composition: Calcium 200 g; Cobalt 200 mg; Copper 1,650 mg; Sulfur 12 g; Iron 560 mg; Fluorine (max) 1,000g; 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.

The castor bean meal used was purchased from an agroindustry located in the metropolitan region of Salvador, state of Bahia. As for antinutritional factors, inactivation of ricin from castor bean meal was made by alkaline treatment using a solution of $Ca(OH)_2$ in the ratio of 1 kg in 10 L water and applied in amount of 60 g lime per kg of castor meal, on a natural matter basis, as recommended by (OLIVEIRA, 2008). After mixing the meal with lime solution, the material was allowed to stand for 12 hours, and immediately after dried in the sun.

The four diets consisted of inclusion levels of castor meal (*Ricinus communis* L.) in the total diet. The experiment lasted 84 days divided into four experimental periods of 21 days each, with the first 20 days for adaptation of animals to diets and the last for collection of behavioral data. In each experimental period, forage and supplements were sampled to evaluate their chemical composition (Table 3).

Table 3. Chemical composition of simulated grazing, castor meal, concentrate, availability and supply of forage referring to the experimental periods.

Item	Levels of inclusion of castor meal (% DM)					
	Simulated grazing	**FMT[2]**	**0.00**	**3.33**	**6.66**	**10.00**
DM (%)[3]	43.72	90.00	88.47	87.35	87.59	89.14
CP (%)[4]	7.66	32.56	26.93	26.38	27.48	26.00
EE (%)[5]	3.45	1.13	10.54	10.56	9.62	11.28
NFC (%)[6]	15.31	4.12	56.04	60.00	54.22	45.83
NDF_{cp} (%)[7]	66.15	44.35	6.70	6.74	6.78	8.58
ADF (%)[8]	36.78	40.57	6.05	7.90	12.10	16.24
MM (%)[9]	7.43	17.84	5.45	5.94	7.10	7.17

Item 1st	Experimental Period				
	2nd	**3rd**	**4th**	**Mean**	
PDMA kg (ha)[10]	2221.03	2244.87	2048.41	2397.35	2227.85
FS kg DM/100 kg BW[11]	14.28	14.27	13.05	15.39	14.25

[2]FMT – Detoxicated castor meal; [3]DM – Dry matter; [4]CP – Crude protein; [5]EE – Ether extract; [6]NFC –Non-fiber carbohydrate; [7]NDFcp – Neutral detergent fiber corrected for ash and protein; [8]ADF – Acid detergent fiber; [9]MM – Mineral matter; [10]Pasture dry matter availability and [11]Forage supply.

Forage samples of simulated grazing were obtained from the intake observed in cows, collecting forage in the stratum cows visited. Pasture was evaluated every 21 days during the study period, being taken only 12 samples in the paddock, cut at 5 cm from the ground and placed in plastic bags, weighed and taken a composite sample, and after fractionation, the structural components were separated: leaf blade, green sheath+stem and senescent material (Table 4), which were weighed, in grams, on a natural matter basis, and calculated the percentage of each, according to methodology described by (McMENIMAN, 1997). Through the equation proposed by Gardner (1986), it was possible to calculate the amount of forage biomass available in the paddock, expressed in kg DM ha^{-1}.

Table 4. Proportion of components of *Brachiaria* (*Urochloa*) *decumbens* and leaf: stem ratio.

Item	Paddock mean
Leaf blade (%)	36.36
Green sheath+stem (%)	36.36
Senescent material (%)	27.28
Leaf: stem ratio	1.00

Samples of food and feces were placed in plastic bags and freezer-stored at –20°C for further analysis, carried out in the laboratories of UESB. Samples of forage, concentrate and feces of each animal were pre-dried in a forced ventilation oven at 55°C and ground in a knife mill (1 mm sieve) for chemical analysis. Analyses of dry matter (DM), crude protein (CP), ether extract (EE), acid detergent fiber (ADF) and mineral matter (MM) of diets were performed as proposed by (DETMANN et al., 2012). The neutral detergent fiber, free of ash and protein (NDFap), was calculated according to (MERTENS, 2002; LICITRA et al., 1996). The non-fiber carbohydrates (NFC) of samples that did not contain urea were calculated by the equation proposed by Detmann and Valadares Filho (2010), using the following formula:

$$NFC = 100 - (\%CP + \%EE + \%Ash + \%NDFap)$$

NFC of samples containing urea was calculated with the equation of Hall (2000), using the following formula:

$$NFC = 100 - ((\%CP - \% CPU + \%U) + \%MM + \%EE + \%NDFap).$$

Where, %CPU = crude protein content from urea and %U = urea content.

Total digestible nutrient (TDN) content was calculated according to NRC (2001), TDN = DCP + DEE x 2.25 + DNDF + DNFa.

In which: DCP = digestible crude protein; DEE = digestible ether extract; DNDF = digestible neutral detergent fiber; DNFC = digestible non-fiber carbohydrates.

All animals were subjected to visual observation to evaluate the feeding behavior for 24 h. Data collection on the time spent on activities of grazing, rumination and in the trough was performed on the 21st day of each experimental period, with the use of digital stopwatch handled by eight trained observers, using, during the night observation, flashlight for data collection. To facilitate the visualization, animals were marked with colored ribbons tied around the neck, and ear tags. The observations of the activities were recorded at five-minute intervals, as recommended by Gary et al. (1970).

The number of cud chews and time spent in ruminating each cud were determined using a digital stopwatch. For this evaluation, observations were made for four cuds, in three different periods of the day (10-12, 14-16 and 19-21 h), in all experimental animals. Feed efficiency (FE), rumination efficiency (RE), the number of cuds per day (NC), the total chewing time per day (TCT) and the number of cud chews per day (NCCd) were obtained according to the methodology described by (BÜRGER et al., 2000).

It was considered the voluntary intake of DM and NDFap to evaluate feed and rumination efficiencies relative to the amount in grams of DM and NDF per unit time and per feeding period. The number of cuds ruminated daily was obtained by dividing the total rumination time (minutes) by the average time spent in ruminating a cud.

Feed and rumination efficiencies were obtained as follows:

$$FE = DMI\ FT^{-1}$$

$$FENDFa = CFDNc\ TAL^{-1}$$

$$RT = DMI\ RT^{-1}$$

$$RENDFa = CNDFa\ RT^{-1}$$

Where: FE = feed efficiency; DMI = daily dry matter intake (g day^{-1}); FT = feeding time (hours); FENDFa= feed efficiency of NDFa; DNDFa = daily NDFa intake (g day^{-1}); RT = rumination time (hours); RENDFa = rumination efficiency (g day^{-1}).

Data were tested by means of analysis of variance and regression analysis, using the System for Statistical and Genetic Analysis (SAEG, 2007). The statistical models were chosen according to the significance of the regression coefficients, using the test F-test at 5% probability and coefficient of determination (R^2).

Results and Discussion

Dry matter intake (DMI), expressed in kilograms per day (kg day^{-1}) and in percentage of body weight (% BW) showed a decreasing linear effect ($P < 0.05$) with increasing levels of inclusion of castor meal in the diet (Table 5). This result was probably caused by high dry matter content of pasture and low leaf: stem ratio (Table 4), besides the content of neutral detergent fiber in concentrate (Table 3). The reduction in the leaf: stem ratio and increased levels of inclusion of castor meal in the concentrate had a direct influence on the DMI.

Table 5. Intake parameters, feed efficiency and ruminating chews of dairy cows fed different levels of castor meal in the diet.

Variables	Levels of inclusion of castor meal (% DM)				Eq.[1]	CV%[2]	P[3]
	0.00	3.33	6.66	10.00			
IDM (kg day^{-1})[11]	13.92	13.03	11.97	11.76	[4]	6.85	0.001
IDM (%BW)[12]	2.96	2.79	2.59	2.54	[5]	7.96	0.003
INDFap (kg day^{-1})[13]	5.48	5.01	4.58	5.06	[6]	10.01	0.019
FE (g DM h^{-1})[14]	1525.87	1407.33	1253.54	1007.51	[7]	17.20	0.001
FENDFc (g NDFa h^{-1})[15]	600.63	543.71	498.04	405.23	[8]	19.92	0.009
TDNFE (g TDN h^{-1})[16]	974.11	943.56	812.51	682.21	[9]	15.57	0.001
RE (g DM h^{-1})[17]	2413.69	2025.57	2149.45	1762.96	2087.92	23.03	0.090
RENDF (g NDFa h^{-1})[18]	995.70	1044.54	1062.41	1000.95	1025.90	26.42	0.949
TDNRE (g TDN h^{-1})[19]	1535.09	1352.65	1401.59	1193.15	1370.62	29.03	0.412
TCT (h day^{-1})[20]	930.63	987.50	973.75	986.88	969.69	6.47	0.259
NCR (number day^{-1})[21]	422.30	453.77	418.55	450.91	436.38	14.36	0.564
NC (number day^{-1})[22]	20475.90	22538.67	21466.05	20595.72	21269.09	17.53	0.671
NC (number cud^{-1})[23]	52.97	53.40	53.69	49.13	52.30	6.98	0.074
TSC (seg cud^{-1})[24]	57.42	57.42	55.96	52.77	[10]	6.01	0.040

[1]Regression equations; [2]Coefficient of variation in percentage and [3]Probability of error. [4]$Y = -0.226x + 13.794$, $R^2 = 0.94$; [5]$Y = -0.0438x + 2.9389$, R2 = 0.95; [6]$Y = 0.0214x^2 - 0.2646x + 5.5235$, $R^2 = 0.91$, Point of minimum = 6.18; [7]$Y = -51.277x + 1554.8$, $R^2 = 0.97$; [8]$Y = -18.96x + 606.66$, $R^2 = 0.98$; [9]$Y = -30.209x + 1004.1$, $R^2 = 0.94$ and [10]$Y = -0.4625x + 58.204$, $R^2 = 0.82$. [11]IDM – intake dry matter; [12]IDM – intake dry matter in function body weight; [13]INDFap – intake of neutral detergent fiber corrected for ash and crude protein; [14]FE – dry matter feeding efficiency; [15]FENDFAa – feeding efficiency of neutral detergent fiber corrected for ash; [16]TDNFE – total digestible nutrients feeding efficiency; [17]RE – dry matter rumination efficiency; [18]RENDF – rumination efficiency of neutral detergent fiber corrected for ash; [19]TDNRE – total digestible nutrients rumination efficiency; [20]TCT – total chewing time; [21]NCRd – number of cuds ruminated per day; [22]NCd – number of chews per day; [23]NCc – number of chews per cud and [24]TSC – time spent per cud.

Mendes et al. (2013) evaluated the feeding behavior of dairy cows on *Brachiaria brizantha* pasture receiving different concentrate levels in the diet and observed average consumption of 2.89% BW. However, the results found in this study were lower for the average consumption of DM due to the BW, with an average of 2.75% for the treatments; this difference is probably related to the period of the year, in which studies took place in different hydrological periods.

For the intake of (NDFap), expressed in kilogram per day (kg day^{-1}) and percentage of body weight (% BW), there was a quadratic effect (P <0.05) on the treatments with the point of minimum at the level of 6.18% (kg day^{-1}) inclusion of castor meal. The observed effect certainly occurred due to the reduction in dry matter intake and increased NDF levels of diets (Table 3). Cobianchi et al. (2012) worked with confined dairy cows fed castor bean meal treated with calcium oxide and identified significant differences in NDFap intake from 33.3% inclusion.

The effects observed for dry matter feed efficiency (FE g DM h^{-1}), feed efficiency of neutral detergent fiber corrected for ash and protein (FENDFa g NDFa h^{-1}), and feed efficiency of total digestible nutrients (FETDN g TDN h^{-1}) and time spent per cud (TSRB sec cud^{-1}) decreased linearly (P <0.05), following the same trend of DMI. However, the variables assessed in this study demonstrate the influence of the inclusion of castor meal, as they were reduced with the inclusion of castor meal in the diets. Probably, this feed efficiency decreased due to the neutral detergent fiber content in the diet (Table 3).

Conversely, Silva et al. (2005) evaluated the feeding behavior of grazing heifers and stated that the feed efficiency depends on the variation and content of fiber components in the diet. According to Van Soest (1994), the efficiency with which the animal chooses the food is related to the time spent in consumption and specific weight of the food consumed.

It was also observed the effect of inclusion of the treated castor meal (P <0.05) on the time spent per cud, a result attributed to the chemical characteristics of the diet. This result is consistent to that reported by Missio et al. (2010), where the number of chews per cud showed a linear reduction.

The rumination efficiencies of dry matter (g DM h^{-1}), neutral detergent fiber (g NDFa h^{-1}) and total digestible nutrients (g TDN h^{-1}) were not affected (P> 0.05), as well as the total chewing time (TCT) and number of ruminated cuds per day (NRC). The same effect was found for the number of chews per day (NCd) and number of chews per cud (NCb); despite the increase in the NDF level in the diet (Table 3), this did not affect (NCd) and (NCb).

These results are consistent with those reported by Costa et al. (2011), for the total chewing time, number of cuds and number of chews per day (SILVA et al., 2005), and total chewing time, as well as Pereira et al. (2007) and Mendonça et al. (2004), for the number of chews per cud and rumination efficiency, which also found no significant effect of treatment on these variables.

Pereira et al. (2007) tested diets with different levels of fiber for confined dairy heifers and verified that the increase in NDF content in the diet increases total chewing time, number of chews per cud and per day and number of cuds. Levels of castor meal in the diet did not affect any of these parameters, probably by low intake of NDF.

Considering the total time spent in activities of grazing, rumination and in the trough, no differences were detected (P> 0.05) with the inclusion of castor meal in the diet. The numerical trend of longer time spent in grazing observed in (Table 6) was probably due to the content of neutral detergent fiber (NDF) of the diets, as previously discussed, which may have led the animals to spend more time selecting the most nutritious parts of the pasture, with an increase of 57.5 (min day^{-1}) between the lowest and the highest level of inclusion of castor meal. Pereira et al. (2007) investigated the feeding behavior of heifers fed diets with different levels of fiber and found that the time spent in feeding and rumination increased with the NDF increase in diet and noticed a reduction in the time spent in idle, different from the results found in this study.

The inclusion of castor meal in the diet (Table 7) did not affect (P> 0.05) the number of periods of grazing (NPG), rumination (NPR), idle (NPI) and in the trough (NPT). In the same way, the time spent per period of grazing (TPG), rumination (TPR), idle (TPI) and in the trough (TPT) were also not influenced by the addition of castor meal in the diet. This can be explained by the habit of the animals that search for food at specific times of the day, regardless of the treatment.

Table 6. Total time spent in activities of grazing, rumination, idle and in the trough of dairy cows fed different levels of castor meal in the diet.

Activity (min day^{-1})	Levels of inclusion of castor meal (% DM)				Eq.[1]	CV%[2]	P[3]
	0.00	3.33	6.66	10.00			
Grazing	561.88	585.63	601.88	619.38	592.19	9.76	0.266
Rumination	368.75	401.88	371.88	367.50	377.50	16.30	0.645
Idle	477.50	424.38	431.25	429.38	440.63	13.58	0.284
Trough	31.88	28.75	36.25	25.00	30.47	38.98	0.308

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

Table 7. Números de períodos e tempo de duração das atividades comportamentais de vacas leiteiras alimentadas com dietas recebendo diferentes níveis de farelo de mamona.

Behavioral activities	Levels of inclusion of castor meal (% DM)				Eq.[1]	CV%[2]	P[3]
	0.00	3.33	6.66	10.00			
NGP (number day^{-1})[4]	6.38	6.75	6.25	6.50	6.47	21.88	0.907
NRP (number day^{-1})[5]	11.75	11.00	10.38	9.75	10.72	14.88	0.111
NIP (number day^{-1})[6]	13.63	13.50	13.13	13.88	13.53	19.23	0.950
NPT (number day^{-1})[7]	2.13	1.75	1.75	1.75	1.85	24.96	0.296
TGP (h)[8]	1.55	1.51	1.67	1.66	1.60	20.84	0.708
TRP (h)[9]	0.53	0.62	0.63	0.64	0.61	21.10	0.345
TIP (h)[10]	0.63	0.52	0.55	0.52	0.56	26.91	0.431
TPT (h)[11]	0.24	0.25	0.34	0.22	0.26	36.87	0.124

[1]Regression equations; [2]Coefficient of variation in percentage and [3]Probability of error. [4]NGP – number of grazing periods; [5]NRP – number of rumination periods; [6]NIP – number of idle periods; [7]NPT – number of periods in the trough; [8]TGP – time per grazing period; [9]TRP – time per rumination period; [10]TIP – time per idle period and [11]TPT – time per period in the trough.

Mezzalira et al. (2011) argued that animals managed on pastures with high forage supply achieve a high intake rate and reach satiety and as a consequence there is a reduction in meal duration, an increase in satiety time and longer intervals. The same authors point out that the number and duration of meals are directly related. Santana Júnior et al. (2013) reported that the increase in the periods of activities promotes shorter times per periods.

Conclusions

It is recommended to include up to 10% castor meal treated with calcium hydroxide in the total diet for dairy cows, with no significant influence on activities of grazing, idle, rumination and in the trough.

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