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Effects of Feeding Licury (*Syagrus coronate*) Cake to Growing Goats*

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ABSTRACT : The objectives of this study were to determine the highest inclusion of licury (*Syagrus coronate*) cake in the diet of growing Boer goats without adverse effects on intake and digestibility and to determine its effects on ingestive behavior and physiological responses. Twenty entire, one year old 3/4 Boer goats, 18.1 kg (DS = 2.2) average body weight (BW), were allocated to dietary treatments in a completely randomized design. Each animal was confined in a 1.0 m^2 pen with a suspended floor and given *ad libitum* access to clean, fresh water. Diets were formulated to meet NRC (2007) requirements and the ingredients were: 50% of Tifton-85 (*Cynodon* sp.) hay, corn meal, soybean meal, mineral and vitamin premix, and licury cake. The treatments were: i) no addition of licury cake to the diet, ii) 15% (DM basis) addition of licury cake, iii) 30% licury cake and, iv) 45% licury cake. The experiment lasted for 17 days; the first 10 days were used to adapt the animals to the diets and facilities. The inclusion of licury cake increased the fiber concentration of the diets; however, there was no effect on either dry matter (DM) or organic matter (OM) intake. There was a linear increase ($p<0.05$) in the EE content of the diet as the addition of licury cake increased; however, EE intake did not differ ($p>0.05$) between treatments. The digestibility of non-fibrous carbohydrates (NFC) decreased with increasing inclusion of licury cake, as did NFC intake. The efficiency of ingestion of DM and NDF presented a negative quadratic effect with the inclusion of licury cake. Results from this study indicate that licury cake can be fed to goats at up to 45% of the diet without adverse effects on either intake or digestibility.
(**Key Words :** Intake, Digestibility, Behavior, Efficiency of Ingestion, Efficiency of Rumination, Fatty Acid)

INTRODUCTION

Goat breeding is important for meat and milk production, especially in the Northeast of Brazil, where production is the largest in the country. However, herd productivity index is low because of the low technical investment and feed availability. The use of regional by-products for animal feeding is a viable alternative to improve productivity, especially those with similar nutritional value to conventional feeds but with a lower cost (Costa et al., 2009).

Licury cake is obtained by pressing the seeds of *Syagrus coronate* (Mattius) Beccari, a palm tree well adapted to semi-arid regions in Brazil. Its oil is extracted for supply to the cosmetics and soap industries and, occasionally, for human and animal feeding (Borja et al., 2008; Queiroga et al., 2010). The residual cake following the oil extraction has potential for use as an alternative to traditional protein sources in animal feeds and to decrease feeding costs.

There is little published data on the use of licury cake as an animal feed and the results from this study may give support for nutritionists to recommend it as an alternative protein source, especially for animals raised in semi-arid regions. Therefore, the objectives of this study were to determine the highest inclusion of licury cake in the diet of growing Boer goats without adverse effects on intake and digestibility and to determine its effects on ingestive behavior and physiological responses.

MATERIAL AND METHODS

The experiment was conducted from May to June, 2008, in the Veterinary School facilities at the Federal University of Bahia, located in Salvador, Bahia, Brazil. The local environment is characterized by its humid climate, annual average precipitation of 1.900 mm, average relative humidity of 81%, and an average temperature of 25.3°C, with a maximum of 28.1°C and a minimum of 22.5°C (CEI, 1994).

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Twenty entire 3/4 Boer goats, one year old and 18 kg (SD = 2.2) average body weight (BW), were allocated to dietary treatments in a completely randomized design. Vermifugation and vaccine application were performed according to the local sanitary schedule. Each animal was confined in a 1.0 m^2 pen with a suspended floor and given *ad libitum* access to fresh, clean water daily.

Diets were formulated to meet NRC (2007) recommendations and the ingredients were: Tifton-85 (*Cynodon* sp.) hay, corn meal, soybean meal, mineral and vitamin premix, and licury cake. The treatments were: i) no addition of licury cake on the diet; ii) 15% (DM basis) addition of licury cake; iii) 30% licury cake; and iv) 45% licury cake. Diets were formulated to have 50:50 forage to concentrate ratio. The animals were fed twice daily, at 9:00 h and 16:00 h, with the appropriate total mixed ration (TMR). Orts were set to remain between 10 to 20% of feed offered and were weighed daily.

The experiment lasted for 17 days, the first 10 days being for adaptation of the animals to the diets and facilities. Data on ingestive behavior were collected on the 11th day and physiological parameters on the 12th day. After that, there were two days for adaptation to the feces collection bags unit, consisting of an apron of vinyl-coated nylon attached to the rump of the animal, and the last three days were used for the collection of feces and orts.

Orts and feces were sampled at 8:00 h and 15:00 h. After collection, feces were weighed and placed in previously identified plastic bags, and then stored at -10°C. These were then thawed, weighed, and dried in a fan forced oven at 55°C for 72 h. Orts and dried feces samples were ground through a 1-mm screen and homogenized.

The samples were analyzed for dry matter (DM), crude protein (CP), ether extract (EE), and ash according to the methods described by the Association of Official Analytical Chemists (1990). Concentration of neutral detergent fiber (NDF), acid detergent fiber (ADF), non-fiber carbohydrates (NFC), cellulose and hemicellulose were determined using the method described by Van Soest et al. (1991). Hemicellulose was estimated by subtraction of ADF from NDF and cellulose was estimated by subtraction of lignin from ADF. NDF was determined by the addition of a heat stable amylase, but without sodium sulphite. NDF insoluble nitrogen (NDIN) and ADF insoluble nitrogen (ADIN) were measured by analyzing nitrogen in the residue of the NDF and ADF procedure, respectively (Licitra et al., 1996).

On the 11th day, each goat was observed every five minutes over 24 h in order to determine the time spent on ingestion, rumination, and resting according to Johnson and Combs (1991), totaling 288 reports. The observations started at 6:00 and, at night artificial illumination was used. These measurements were performed by observers positioned with minimum interference on the animal's behavior.

The evaluation of ingestive behavior was performed as described by Burger et al. (2000). Briefly, the efficiency of NDF and DM intake (ENDFI and EDMI, respectively) were calculated by dividing the daily intake by the daily time of ingestion. The rumination efficiency of NDF and DM (RENDF and REDM, respectively) were calculated by dividing the intake of each fraction by the time of daily rumination.

A thermo-hygrometer and a black globe thermometer were installed in the experimental environment with the objective of determining the index of temperature and humidity (ITH), according to Buffington et al. (1981). Recording of environmental and physiological variables was undertaken twice weekly during the entire experiment.

Table 1. Chemical composition of the dietary ingredients

Nutrients	Ingredients				
	Corn	Soybean meal	Licury cake	Premix	Hay
Dry matter (%)	88.4	90.5	95.7		
Mineral matter[1]	1.42	5.73	7.39	100	6.23
Organic matter	86.9	84.8	88.3	0.00	89.4
Crude protein[1]	6.88	42.6	23.6	0.00	7.40
Ether extract[1]	3.01	2.61	10.1	0.00	0.62
Neutral detergent fiber[1]	11.3	10.9	51.5	0.00	80.8
Acid detergent fiber[1]	4.67	10.8	34.9	0.00	45.1
Cellulose[1]	3.59	6.88	17.6	35.8	3.59
Hemicellulose[1]	6.66	3.53	16.7	35.7	6.66
Lignin[1]	1.08	0.85	17.3	0.00	9.20
NID[2] neutral	7.00	1.00	35.0	0.00	63.0
NID acid	3.00	2.00	9.00	0.00	9.00
Non-fibrous carbohydrates[1]	70.8	36.4	7.37	0.00	2.19

[1] % of DM. [2] Nitrogen insoluble in detergent (% of total N).

The physiological responses of the animals were evaluated through the following measurements: respiratory frequency (RF), cardiac frequency (CF), and rectal temperature (RT). These parameters were determined twice daily, at 9:00 h and 15:00 h.

The licury oil was analyzed for fatty acids by extraction based on the technique described by Rodrigues-Ruiz et al. (1999): a 2 ml sample of the oil (in duplicate) was transferred to a separation funnel, to which was added 30 ml of isopropanol, and, after agitation, 22.5 ml of hexane was added and the mixture agitated again for 3 minutes. The solution was then centrifuged at 2,520 g for 5 minutes at 5°C, and the superior layer was transferred to another separation funnel. The inferior layer was again extracted twice with 22.5 ml of hexane, and these extracts were then added to the first. The water was removed from the extracts by adding 15 ml of 0.47 M Na_2SO_4. The hexane layer was collected in a bottle and evaporated at 50°C in a rotating evaporator with continuous nitrogen flow.

The trans-esterification of free fatty acids was performed as described by Eifert at al. (2006), using sodium methoxide as methylation agent. The profile of free fatty acids was determined by gas chromatography, with a 100 m capillary column (SP-2560) and flame ionization detector (FID). Nitrogen was used as carrier gas. A standard (CRM 164; Commission of the European Communities, Community Bureau of Reference, Brussels, Belgium) was used for determining the recovery levels of free fatty acids. Fatty acid concentrations were expressed in g/100 of total fatty acids.

Data were submitted to regression by the software SPSS 16.0. The level of significance used was $p<0.05$.

RESULTS AND DISCUSSION

The inclusion of licury cake increased the fiber concentration of the diets (Table 2); however, there was no effect ($p<0.05$) on the DM and OM intake (Table 3). In contrast, Cardoso et al. (2006b) found that increasing NDF levels from sorghum silage in lamb diets reduced DM consumption. Probably, the size of the fibrous fraction of the licury cake, which was finely ground to be mixed into the rations, did not cause rumino-reticular filling. Therefore, we speculated that there was no significant reduction of the passage rate of solids among the experimental diets.

High levels of EE in diets may have a negative effect on DM intake (Relling and Reynolds, 2007), although this was not the case in this study where DM intake did not differ among treatments. Therefore, there was a linear increase on the percentage of EE as the addition of licury cake increased in the diet and no treatment effect on the EE intake (Table 3). Silva et al. (2005), feeding goats with

Table 2. Ingredient and chemical composition of experimental diets

Item	Inclusion of licury cake (%)			
	0	15	30	45
Ingredients (% of dry matter)				
Corn meal	24.3	16.5	10.6	6.2
Soybean meal	24.2	16.1	8.1	0
Licury cake	0	15.8	29.9	42.2
Mineral and vitamin premix[1]	1.5	1.5	1.5	1.5
Tifton hay	50	50	50	50
Chemical composition (% of dry matter)				
Dry matter (%)	92.7	93.7	94.5	95.3
Organic matter	86.3	86.7	87.1	87.4
Mineral matter	6.35	6.94	7.43	7.82
Crude protein	15.7	15.4	14.9	14.1
NID[2] neutral	9.00	9.00	8.00	7.00
NID[2] acid	3.00	3.00	3.00	3.00
Ether extract	1.67	2.83	3.86	4.78
Neutral detergent fiber	45.9	52.2	57.9	62.9
Acid detergent fiber	25.5	30.1	34.1	37.5
Lignin	5.07	7.65	9.95	11.9
Non-fibrous carbohydrates	27.1	19.9	13.7	8.63
EL (Mcal/kg)	1.24	1.15	1.06	0.98

[1] Nitrogen insoluble in detergent.

[2] Levels of guarantee (by kg in actve elements): calcium 120.00 g; phosphorus 87.00 g; sodium 147.00 g; sulphur 18.00 g; copper 590.00 mg; cobalt 40.00 mg; cromus 20.00 mg; iron 1,800.00 mg; iodine 80.00 mg; manganese 1,300.00 mg; selenium,15.00 mg; zinc 3.800 mg; molibden 300.00 mg; maximum fluor 870.00 mg; Iron solublity (P) in citric acid at 2% minimum - 95%.

Table 3. Effect of licury cake addition on intake of dry matter (DM), crude protein (CP), ether extract (EE), neutral detergent fiber (NDF), non-fibrous carbohydrates (NFC) and total digestible nutrients (TDN)

Consumption	Inclusion of licury cake				SEM	p-value	
	0	15	30	45		Linear	Quadratic
DM, g/d	548	470	540	477	59.3	0.589	0.906
g/MW/d	61.2	57.2	59.2	54.7	6.36	0.528	0.981
% BW/d	2.95	2.82	2.84	2.66	0.31	0.508	0.941
OM, g/d	512	437	501	445	55.30	0.578	0.878
g/MW/d	57.1	53.0	54.8	50.9	5.93	0.518	0.99
% BW/d	2.76	2.63	2.63	2.47	0.28	0.498	0.97
CP, g/d	69.4	57.5	64.5	45.7	6.49	0.045	0.621
g/MW/d	7.77	6.97	7.07	5.22	0.70	0.025	0.066
% BW/d	0.38	0.34	0.34	0.25	0.03	0.023	0.432
EE, g/d	16.0	16.3	21.5	17.5	2.63	0.505	0.652
g/MW/d	1.79	1.98	2.37	2.00	0.29	0.412	0.508
%BW/d	0.09	0.10	0.11	0.10	0.01	0.387	0.475
NDF, g/d	332	305	367	354	40.6	0.479	0.883
g/MW/d	37.0	36.9	40.2	40.5	4.34	0.462	0.973
% BW/d	1.79	1.83	1.93	1.97	0.21	0.477	0.992
ADF, g/d	179	169	205	201	23.2	0.335	0.906
g/MW/d	19.9	20.4	22.4	23.0	2.47	0.306	0.997
% BW/d	0.96	1.01	1.08	1.12	0.12	0.315	0.969
Hemicellulose, g/d	149	134	161	153	17.3	0.635	0.859
g/MW/d	16.7	16.3	17.7	17.5	1.87	0.64	0.948
% BW/d	0.81	0.81	0.85	0.85	0.09	0.663	0.983
Cellulose, g/d	148	136	162	156	18.0	0.538	0.875
g/MW/d	16.5	16.5	17.8	17.9	1.91	0.522	0.968
% BW/d	0.80	0.82	0.85	0.87	0.09	0.538	0.996
TDN, g/d	263	243	252	238	14.5	0.236	0.695
g/MW/d	29.6	29.4	27.8	27.2	1.66	0.197	0.931
% BW/d	1.40	1.50	1.30	1.30	0.08	0.205	0.996

levels of cocoa meal, a by-product similar to licury cake due to the presence of similar values of EE and NDF, observed the same selection process by animals fed cocoa meal at 30% of the diet. The EE intake observed was 17.9 g/d (Table 3), a value lower than found by Silva et al. (2005) feeding dairy goats with levels of palm kernel cake, a regional byproduct derived from the production of palm kernel oil (chemical composition also similar to the licury cake). The high EE intake observed by those authors was explained by the high proportion of concentrate present on the diet.

The ingestion of NDF was not influenced by the level of inclusion of licury cake (Table 3). The animals consumed approximately 2.8% of their BW as NDF. This observation may represent the ability of the animal to select dietary ingredients, favoring the non-fibrous ingredients, thereby maintaining similar amounts of NDF ingested among treatment diets.

There was a linear decrease in the non-fibrous carbohydrate (NFC) intake with the addition of licury (Figure 1). The soybean meal used in our study had 36.4% NFC whereas licury cake had only 7.4%, thus decreasing NFC percentage with the progressive addition of licury cake (Table 2). This result was also found by Menezes et al. (2004), who fed goats with levels of substitution of corn by cassava peel, which has a lower percentage of NFC than corn.

Silva et al. (2005), feeding dairy goats with different levels of cocoa meal and palm kernel cake, observed high levels of consumption of NFC, averaging 825 g/d, whereas the observed consumption in this study was only 49.5 g/d. Such difference in NFC consumption is basically caused by the proportion of roughage to concentrate, which was different between the experiments: Silva et al. (2005) used only 36% of roughage, a lower value than used in this experiment (50%), therefore favoring the higher consumption of NFC reported by these authors.

Although the diets were designed to be isonitrogenous, there was a linear decrease in CP intake with addition of licury cake (Table 3). This could be explained by the

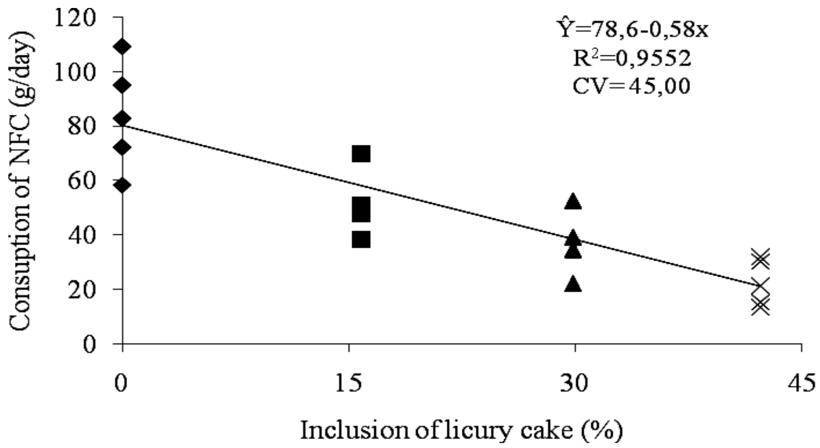

Figure 1. Intake of NFC of diets with levels of inclusion of licury cake.

selection performed by the animals during feed ingestion due to the high levels of EE and lignin present in the cake, which may have caused the animals to consume less licury. Therefore, the rations with higher quantities of this ingredient provided lower CP consumption. Barroso et al. (2006) also observed a similar behavior for the consumption of CP with isonitrogenous diets when they fed sheep with dried winery residues and energetic sources.

The decrease in digestibility of NFC with the inclusion of licury cake in the diets (Table 4) did not affect the intake of total digestible nutrients (TDN) (Table 3). The increase in EE digestibility may have compensated for the decrease in NFC digestibility.

The digestibility of EE increased linearly with licury cake inclusion (Table 4), probably due to the increase of EE percentage in the treatment diets and its higher digestibility. Yamamoto et al. (2005) also observed an increase in EE digestibility when they studied the inclusion of vegetable oils in rations of feedlot lambs. The EE of licury cake may have a higher digestibility than the EE from other dietary ingredients, mainly because of the higher percentage of medium chain fatty acids. Another factor that could have contributed to the higher apparent digestibility of EE is that the amount of dietary EE increased when licury was added, diluting the amount of endogenous EE and, thus, increasing its apparent digestibility (Palmquist, 1991).

Licury oil has a unique composition of fatty acids when compared to more commonly used fatty acid sources. The short and medium chain fatty acids represent about 80% of the total fatty acids of licury oil, where C12:0 fatty acid has the highest percentage, averaging 43% of the total fatty acids, followed by C14:0, averaging 15%.

The digestibility coefficients of NDF and hemicellulose (Table 4) exhibited a quadratic response. The NDF digestibility was lowest when licury cake addition was 17.3%, increasing until 45% inclusion. This reduction in the digestibility with the inclusion of licury cake may have been caused by the percentage of fatty acids. Because the licury oil has higher percentage of medium chain fatty acids, the microbial ecosystem may have shifted to the detriment of cellulolytic bacteria. These free fatty acids have amphipathic characteristic, being soluble in organic solvents and water, and are toxic to ruminal bacteria and protozoa (Jordan et al., 2006). However, the increase in

Table 4. Effect of licury cake addition on the coefficient of digestibility of dry matter (DM), crude protein (RP), ether extract (EE), neutral detergent fiber (NDF), acid detergent fiber (ADF), cellulose, hemicellulose and Non-fibrous carbohydrates (NFC)

Item (%)	Inclusion of licury cake (%)				SEM	p-value	
	0	15	30	45		Linear	Quadatic
DM	75.9	69.8	73.6	80.5	3.22	0.277	0.069
OM	77.1	71.5	74.9	81.7	3.06	0.268	0.065
CP	79.0	73.2	77.9	76.7	2.68	0.863	0.452
EE	90.6	91.1	94.0	95.3	0.76	0.000	0.673
NDF	76.9	71.1	75.4	84.1	2.85	0.097	0.026
ADF	72.1	64.1	67.9	78.4	3.92	0.262	0.033
Cellulose	78.7	75.0	78.0	85.8	2.61	0.083	0.051
Hemicellulose	82.1	79.4	84.6	91.5	1.83	0.004	0.033
NFC	71.0	61.8	50.1	37.6	8.19	0.006	0.864

fiber ingestion tends to promote a higher stimulus to rumination and, therefore, to salivation. This process maintains the rumen pH at adequate levels, favoring the development and the maintenance of cellulolytic flora and improving the degradation of NDF. This result was also found in confined goats receiving soybean hulls in substitution to corn; the dietary NDF digestibility increased with the addition of soybean hulls (Hashimoto et al., 2007). However, Silva et al. (2005), working with varying levels of cocoa meal and palm kernel cake, did not observe an increase in the digestibility of dietary NDF, averaging 47.3%. The digestibility of the fiber observed by the latter authors was below the values found in this work (84.15%; Table 4) when 45% of licury cake was used. On the other hand, the digestibility coefficient of ADF did not differ (p>0.05) among treatments, which was expected since the ADF fraction represents the least digestible fraction of the diet.

The digestibility of the DM and OM did not differ among treatments (p<0.05), demonstrating that licury cake could be used as an alternative to soybean meal for feeding goats, with no negative effects on the digestibility of the diet. The average values for DM and OM digestibility of the diets containing licury meal were 74.99% and 76.36%, respectively (Table 4). These values are higher than those obtained by Silva et al. (2005) when feeding goats with different levels of palm kernel cake and cocoa meal; the digestibility coefficients of DM and OM averaged 66.0% and 68.3%, respectively.

Crude protein digestibility was not affected by the inclusion of licury meal in the diet, demonstrating that the protein fraction of licury cake is as available as that of soybean meal, enabling its use as a protein source in ruminant diets. Similarly, Silva et al. (2005), using palm kernel cake in feeding of dairy goats, did not observe differences in digestibility of CP between treatments.

The digestibility of NFC decreased with inclusion of licury cake, a similar result to that found on the consumption of this dietary fraction. This behavior could be explained by the lower digestibility of the NDF from licury cake (Borja et al., 2009), indicating that the NFC of the cake is protected by less digestible components, such as the cellular wall components (Jung and Allen, 1995). Such a result was also found by Cunha et al. (2008) feeding sheep with levels of whole cottonseed, a source of protein that presents similar levels of NFC compared to licury cake.

Even with the increase in fiber percentage in the diet with addition of licury cake, the time spent on rumination was not influenced (p>0.05) by the treatment diets (Table 5). The fiber from licury cake may have a low capacity to stimulate rumination; this may be explained by the physical composition of the licury cake used in our experiment, since the cake was ground before being mixed with the concentrate and, by this process, the size of the fiber is compromised, decreasing its ability to stimulate rumination (Dado and Allen, 1994). Carvalho et al. (2008), feeding sheep with different levels of cocoa meal, did not observe any difference on the mean time of rumination (466 min), a value similar to that observed in our study.

The level of addition of licury cake that maximized the time of ingestion was 20.1%; above this percentage, the time dedicated to food ingestion by the animals was reduced. Changes to the time spent in feeding and rumination activities have been frequently observed in studies where the experimental diets presented variation in fiber levels (Beauchemin et al., 1989; Cardoso et al., 2006a). Assuming the animals increased forage selection as licury cake percentage increased in the diet, the difference observed only for ingestion time may have resulted from the animal's strategy in increasing initial chewing time and selection to compensate for the reduction in consumption of nutrients.

The efficiency of ingestion of DM and NDF exhibited a negative quadratic effect with the inclusion of licury cake (Figure 2b and 2c). For instance, the animals consuming 45% of licury cake spent less time during ingestion, but did not decrease DM or NDF intake. Therefore, the animals fed 45% licury cake were more efficient. Carvalho et al. (2008), feeding sheep with different levels of cocoa meal, did not observe differences in the efficiency of DM and NDF ingestion, which could be explained by the lower consumption of these fractions.

Total chewing time (TCT) showed the same quadratic behavior as ingestion time. The rumination time was lower for the animals fed 45% licury cake, even with the increase of fiber level in the diets (Figure 2d). The higher time of chewing was about 728 minutes daily, a value observed with the animals fed approximately 20% licury cake. A

Table 5. Effect of licury cake addition on the time spent in rumination, rest, dry matter rumination efficiency of (DMRE) and neutral detergent fiber rumination efficiency (NDFRE)

Parameters	Inclusion of licury cake (%)				SEM	p-value	
	0	15	30	45		Linear	Quadratic
Rumination	435	463	486	391	43.0	0.658	0.214
Rest	809	762	695	899	53.0	0.462	0.042
ERDM	75.6	60.9	66.7	73.1	8.04	0.973	0.202
ERFND	45.7	39.5	45.3	54.8	5.52	0.221	0.188

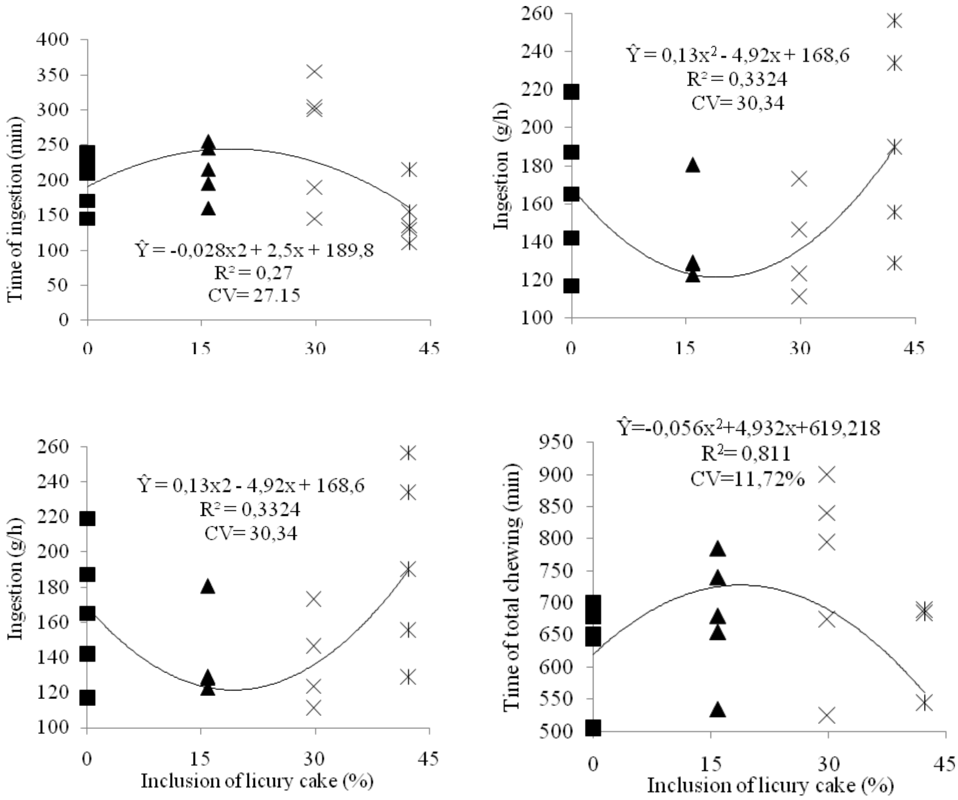

Figure 2. a) Time of ingestion, b) Efficiency of dry matter ingestion, c) Efficiency of fiber in neutral detergent ingestion, d) Time of total chewing in goats fed with rations containing levels of inclusion of licury cake.

similar value (658 min/d) was found by Morais et al. (2006) feeding confined male lambs.

Climatic factors have great influence on the feeding behavior of animals. Thermal comfort indices were developed so that only one variable would represent the influence of climate on the animals. The tropical climate of Salvador is very propitious to high temperatures and humidity (29.5°C and 78% RH); therefore, the temperature-humidity index (THI) presented a high value of 82 during this work. Brasil et al. (2000), studying the effects of thermal stress on the production of dairy goats, demonstrated that with a THI near 85, the animals are in caloric stress, a value near the one found during the afternoon in the present work.

The physiologic variables that indicate thermal stress were above normal values for respiratory and cardiac frequency (Table 6). However, there was a reduction in the respiratory frequency of the animals that received diets with higher levels of licury cake, but these values remained outside the interval considered normal for goats (Silva et al., 2006). The higher percentage of EE present in the diets with higher levels of licury cake may have provided a greater quantity of energy to the animal, without increasing the caloric increment produced by ruminal fermentation, with a lower production of heat (Lopez, 2007; Oliveira et al., 2009). The respiratory evaporation and sweating rate are the main mechanisms used by animals to lose heat, in attempting to keep body temperature within normal limits (Brasil et al., 2000). In our work, the control of body temperature of the animals may have been efficient, enabling the animals to maintain the temperature within the interval considered normal for goats. According to Souza et al. (2008), the temperature of goats can vary from 38.5°C to 40.5°C.

The cardiac frequency observed in the present study was slightly above the values considered normal for goats,

Table 6. Effect of licury cake addition on respiratory frequency, cardiac frequency and rectal temperature of the animals on each treatment

Item	Inclusion of licury cake (%)				SEM	p-value	
	0	15	30	45		Linear	Quadratic
Respiratory frequency (breath/min)	36	34	32	32	5.2	0.030	0.197
Cardiac frequency (beat/min)	92	92	88	94	2.7	0.933	0.477
Rectal temperature (°C)	38.4	38.3	38.2	38.4	2.0	0.924	0.356

between the ranges of 70 to 80 beats/min (Silva et al., 2006). Silva and Starling (2003) emphasized the importance of respiratory stabilization, as a high respiratory frequency for a long time can cause reduction in blood CO_2 pressure, besides increasing the heat accumulated in the tissues due to the accelerated work of respiratory muscles. The reduction in blood pressure is responsible for the increase in cardiac beating in the attempt to maintain blood pressure at its physiologic level.

CONCLUSION

Licury cake demonstrated potential for feeding to goats based on intake and digestibility, and could be included up to 45% of rations.

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