

**Ingestive behavior of calves fed diets based on corn grain and supplementary hay****Comportamento ingestivo de bezerros alimentados com dietas a base de milho grão inteiro e feno suplementar**

DOI:10.34117/bjdv6n6-412

Recebimento dos originais:08/05/2020

Aceitação para publicação:17/06/2020

**Marluci Olício Ortêncio**

Mestre em Zootecnia pela Universidade Federal dos Vales do Jequitinhonha e Mucuri - UFVJM

Instituição: Universidade Federal dos Vales do Jequitinhonha e Mucuri - Campus Unaí

Endereço: Avenida Universitária, nº 1.000, Universitários, Unaí - MG, Brasil.

E-mail: marllucy.olicio@zootecnista.com.br

**Saulo Alberto do Carmo Araújo**

Doutor em Ciência Animal pela Universidade Estadual do Norte Fluminense - UENF

Instituição: Universidade Federal dos Vales do Jequitinhonha e Mucuri - Campus Unaí

Endereço: Avenida Universitária, nº 1.000, Universitários, Unaí - MG, Brasil.

E-mail: saulo.araujo@ufvjm.edu.br

**Norberto Silva Rocha**

Doutor em Ciência Animal pela Universidade Estadual do Norte Fluminense - UENF

Instituição: Faculdade de Ciências da Saúde de Unaí

Endereço: Av. Gov. Valadares, 1441 - Centro, Unaí - MG, Brasil.

E-mail: nsrocha@gmail.com

**Diego Azevedo Mota**

Doutor em Zootecnia pela Universidade Estadual Paulista Ciência - Unesp

Instituição: Universidade Federal dos Vales do Jequitinhonha e Mucuri - Campus Unaí

Endereço: Avenida Universitária, nº 1.000, Universitários, Unaí - MG, Brasil.

Instituição: Faculdade de Ciências da Saúde de Unaí

E-mail: diego.mota@ufvjm.edu.br

**Severino Delmar Villela**

Doutor em Zootecnia pela Universidade Federal de Viçosa - UFV

Instituição: Universidade Federal dos Vales do Jequitinhonha e Mucuri - Campus Unaí

Endereço: Avenida Universitária, nº 1.000, Universitários, Unaí - MG, Brasil.

Instituição: Faculdade de Ciências da Saúde de Unaí

E-mail: severino.vilella@ufvjm.edu.br

**Cláudia Braga Pereira Bento**

Doutora em Microbiologia pela Universidade Federal de Viçosa - UFV

Instituição: Universidade Federal dos Vales do Jequitinhonha e Mucuri - Campus Unaí

Endereço: Avenida Universitária, nº 1.000, Universitários, Unaí - MG, Brasil.  
Instituição: Faculdade de Ciências da Saúde de Unaí  
E-mail: cbpbento@ufvjm.edu.br

**Amanda Melo Sant'Anna Araújo**

Mestre em Ciência Animal pela Universidade Estadual do Norte Fluminense – UENF  
Instituição: Universidade Federal dos Vales do Jequitinhonha e Mucuri - Campus Unaí  
Endereço: Avenida Universitária, nº 1.000, Universitários, Unaí - MG, Brasil.  
Instituição: Faculdade de Ciências da Saúde de Unaí  
E-mail: amanda.araujo@ufvjm.edu.br

**Felipe Nogueira Domingues**

Doutor em Zootecnia pela Universidade Estadual Paulista Ciência – Unesp  
Instituição: Universidade Federal dos Vales do Jequitinhonha e Mucuri - Campus Unaí  
Endereço: Avenida Universitária, nº 1.000, Universitários, Unaí - MG, Brasil.  
Instituição: Faculdade de Ciências da Saúde de Unaí  
E-mail: felipe.domingues@ufvjm.edu.br

**ABSTRACT**

In this work, the influence of the addition of Tifton-85 hay supplement to the corn grain mix and commercial pellet was assessed in terms of the digestive behavior exhibited by the dairy calves. The Latin square 4 x 4 duplicate and simultaneous design was adopted in this experiment, in which the treatments included four levels of the hay supplement Tifton-85 (0, 0.2, 0.4, and 0.8 %) with respect to body weight, in the corn grain mix and commercial pellet, over four experimental periods, with two repetitions (eight animals). The effect of the hay levels ( $P < 0.05$ ) was evident in the time taken by the animals for feeding (TFE), rumination (TRU), and total chewing time (TCT), however, the time spent in leisure (TO) remained unaffected ( $P > 0.05$ ). The variables, chew time per bolus (CT/bolus), and number of chews per bolus (NC/bolus) showed no differences among the treatments ( $P > 0.05$ ), however, the number of chews per day (NC/day), and number of ruminal boluses (NRB) revealed significant variations ( $P < 0.05$ ). Among the treatments, the effects on feed efficiency (EFDM) and rumination (ERUDM) of dry matter ( $P < 0.05$ ) were evident, but the rumination efficiency of the neutral detergent fiber (ERUNDF), and rumination rate (RR) were not affected ( $P > 0.05$ ). The supplementary levels of hay added to the diet increased the rumination and chewing times.

**Keywords:** chewing, feeding efficiency, rumination.

**RESUMO**

Avaliou-se os efeitos da suplementação de feno de tifton-85 na dieta de milho grão inteiro e pellet comercial no comportamento digestivo de bezerros leiteiros. O delineamento experimental adotado foi em quadrado latino 4x4 duplicado e simultâneo, sendo os tratamentos, quatro níveis de suplementação do feno de tifton-85 (0, 0,2, 0,4 e 0,8% em relação ao peso corporal) na mistura milho grão inteiro e pellet comercial em quatro períodos experimentais, com duas repetições (oito animais). Houve influência dos níveis de feno ( $P < 0,05$ ) sobre o tempo despendido pelos animais em alimentação (TAL), ruminação (TRU) e o tempo de mastigação total (TMT), já o tempo despendido em ócio (TO) não foi afetado ( $P > 0,05$ ). As variáveis tempo mastigações por bolo (TM/bolo) e número de mastigações por bolo (NM/bolo) não apresentaram diferença entre os tratamentos ( $P > 0,05$ ), já para os números

de mastigações por dia (NM/dia) e de bolos ruminais (NBR) observou-se efeito significativo ( $P < 0,05$ ). Foi observado efeito para as eficiências de alimentação (EALMS) e ruminação (ERUMS) da matéria seca ( $P < 0,05$ ), enquanto que a eficiência de ruminação da fibra em detergente neutro (ERUFDN) e taxa de ruminação (TR), não tiveram efeito ( $P > 0,05$ ), entre os tratamentos avaliados. Os níveis suplementares de feno na dieta acarretaram maiores tempos de ruminação e mastigação.

**Palavras-chave:** mastigação, ruminação, eficiência alimentar.

## 1 INTRODUCTION

In Brazil, the male offspring of dairy milk cows are considered low in value and, in most cattle ranches, they are either disposed of or killed after birth. One alternative use for these dairy calves is their value for meat production. However, before they become a cost-effective option, these dairy calves require great care until they are beneficial in terms of productivity and economic viability to the cattle rancher. The care primarily involves nutritional management that can furnish suitable zootechnical indices to monitor their activity.

A few nutritional models employed at present for animals in confinement prescribe the extensive utilization of concentrated foods to improve the nutritional aspects of the diet, with very little or nil inclusion of bulky foods in the total ration (Macedo et al. 2007.) This section focuses on the recommendation of introducing whole grain corn and the commercial pellet, with or without the addition of bulking supplements in the normal diet of these animals. However, such diets can result in metabolic disturbances which exert a direct effect on the ingestive behavior of these cattle. Therefore, it is wiser to include a minimum fiber content, which will stimulate chewing and ensure sufficient ruminal environment that will not hamper animal performance (Mendes et al. 2010).

From this perspective, Catellam et al. (2010) suggested that a thorough investigation of the ingestive behavior can become a crucial tool in evaluating the diets of animals in confinement. It will provide insight into making the right adjustments in the feeding management of the animals and enhance their productive performance. The factors that need to be studied include the times for feeding, rumination, leisure, feed efficiency and rumination (Mendonça et al. 2004). Therefore, accurate knowledge regarding the habits of these animals can prove useful in the breeding systems, as any behavioral pattern changes could be understood as indicators that affect the management, feeding or health issues of the calves.

The objective of the present study was to assess the influence exerted by the addition of the Tifton-85 hay supplement to the diet of whole grain corn and commercial pellet, and assess the distinctive features related to the ingestive behavior of the dairy calves.

## 2 MATERIAL AND METHODS

The present study was performed in the Ruminants Nutrition Sector of the Santa Paula Experimental Farm of the Universidade Federal dos Vales do Jequitinhonha, in the city of Unaí, Minas Gerais, Brazil.

The experiment was carried out in a simple masonry shed. The shed itself was constructed in the east-west orientation, with 1.10 m high side-walls, left open at the ends, and covered with a colonial-style roof. The shed was provided with eight individual bays (9 m<sup>2</sup> each), equipped with individual masonry feeders and drinking fountains. The floor was just a bed of wood. The shed was also supplied with a trunk to hold the animals and a collective bay area (30 m<sup>2</sup>) to facilitate handling the cattle.

The study involved four experimental periods (of 14 days' duration each), with two replicates (eight animals), resulting in a design of two simultaneous Latin squares.

The inclusion levels of Tifton-85 hay (*Cynodon* spp.) were evaluated in the diet with high percentage of whole grain corn (85 %) and concentrated pellets (15 %) in the rearing phase of crossbred dairy calves (Holstein x Zebu). The treatments were as follows according to the levels of inclusion of hay: 1) without addition hay; 2) inclusion of 0.2 % of hay in relation to body weight; 3) inclusion of 0.4 % of hay in relation to body weight.; and 4) inclusion of 0.8 % of hay in relation to body weight.

The experiment took 56 days for completion, with four periods of 14 days each, which included of 11 days for adaptation and three days for each collection. The recommended 30-day pre-experimental period for the animals to adapt to the management adopted in the experiment was implemented. A total of eight calves were used in this study, with an average initial body weight of 100 ± 10 kg and average age of four months. The animals were supplied by the Ruminant Nutrition industry from the Experimental Farm at Santa Paula, Universidade Federal dos Vales do Jequitinhonha and Mucuri. To assist the animals to adapt to the experimental conditions, they were moved to the shed 30 days prior to commencement of the experiment. Deworming and administration of vitamin complex ADE were performed on the animals during this time.

Animal management was conducted, keeping them in individual bays (9 m<sup>2</sup>), which were provided with feeder, water trough and trough for mineral salt. Mineral salt and water were supplied ad libitum for the animals. The diet, however, was given only twice daily, at 7:00 a.m. and 3:00 p.m. The food consumption was quantified daily, but for the

characterization of the experiment, measurements were recorded for every 3-day collection, for each experimental period.

A mixture of the corn and commercial concentrate was provided every day, ensuring that the ratio recommended for this study, 85 % of whole grain corn and 15 % commercial concentrate (pellet), was maintained. The hay was supplied in individual trough separate from the whole corn grain and pellet mixture. The composition of the ingredients is given in Table 1.

Table 1. Chemical composition of the ingredients used in the diet.

| Variable   | Corn  | Pellet <sup>1</sup> | Hay   |
|------------|-------|---------------------|-------|
| DM (%)     | 86.50 | 87.83               | 84.46 |
| MM (% DM)  | 1.28  | 14.45               | 7.58  |
| CP (% DM)  | 7.83  | 39.00               | 12.34 |
| NDF (% DM) | 9.16  | 11.03               | 66.80 |
| ADF (% DM) | 2.54  | 3.85                | 30.17 |

DM = dry matter; MM = mineral matter; CP = crude protein; NDF = neutral detergent insoluble fiber; and ADF = acid detergent fiber; <sup>1</sup>Commercial pellet guarantee levels: Crude protein minimum 38 %; Ethereal extract minimum 1.8 %; Maximum crude fiber 14 %, Mineral matter maximum 20 %; Calcium minimum 2.4 %; Calcium maximum 3.0 %; Cobalt minimum 0.003 %; Mineral copper 0.109 %; Sulfur minimum 7.70 %; Mineral iron 0.20 %; Minimum phosphorus 8.50 %; Minimum iodine 0.007 %; Minimum magnesium 7.7 %; Minimum manganese 0.371 %; Maximum non-protein nitrogen 12.70 %; Minimum potassium 1.80 %; Minimum selenium 0.003 %; Minimum sodium 6.00 %; Monensin at least 0.12 %; Virginiamycin at least 0.17 %; *Saccharomyces cerevisiae* 2.4x10<sup>10</sup> CFU/Kg.

After the ingestive behavior of the animals was determined, they were visually observed at the end of each experimental period, in ten-minute intervals, for 24 hours (14<sup>th</sup> day), to assess the time consumed for food, rumination and leisure (Johnsone and Combs, 1991). On day 13, the animals were evaluated for three uninterrupted 2-hour periods (10:00 to 12:00 a.m.; 2:00 to 4:00 p.m.; 6:00 to 8:00 p.m.) to facilitate data collection and evaluation of the number of chews meric for rumen cake and the time taken for each chewing through d and visual observation and on the digital timer, respectively. Were observed in each period of 20 rating ruminal cakes for each animal, totaling 60 cakes per animal in each experimental period. To enable observation of the animals during the night, the environment was maintained under artificial lighting.

The variables connected with the ingestive behavior included: Feeding time (TAL, min/day); Time of water intake (TIA, min/day); Time in leisure (TO, min/day); Ruminating time (TRU, min/day); Number of merciful chews for rumen cake (NM/cake, number/cake); Time of chewing chewing by ruminal cake (TM/cake, s/cake); Number of merciful chews per day (NM/day n<sup>o</sup>/day); Number of ruminal cakes (NBR, n<sup>o</sup>/day); Total chewing time (TMT,

h/day); Feed efficiency (EAL, kg DM/h); Efficiency of rumination (ER, kg DM/h; kg FDN/h); Rumination rate (TR, %/h). The number of merit cheeses (NM/day, number/day) was derived from the relationship, as mentioned:  $NM/day = NBR * NM/cake$ , while Total chewing time (TMT, min/TRU, Feed efficiency (kg DM/h) by  $EAL = CMS/TAL$  and Efficiency of rumination (ER, kg DM/h; kg NDF/h) were by  $ERU = CMS/TRU$ ;  $ERU = CFDN/TRU$ ,  $TR = (TRU/TMT) * 100$  (Polli et al. 1996 with Mota et al. 2014).

The data were submitted to analysis of variance and the means of the treatments were described using the means of regression, selecting 5 % as the critical level of probability. The results were analyzed employing the SISVAR<sup>®</sup> software (Ferreira, 2011).

### 3 RESULTS AND DISCUSSION

The effect of the hay levels ( $P < 0.05$ ) was seen on the variables, time spent by the animals in feeding (TAL), rumination (TRU) and total chewing time (TMT). However, the variable, time spent in leisure (TO) was not affected ( $P > 0.05$ ) (Table 2).

Among the various treatments, the variables TAL, TRU and TMT presented quadratic behavior and, when the regression equation was derived, the maximum hay level to be supplied to the animals was ascertained. In this instance, 0.59 % of supplementary hay was to be added to the diet. From this point, the times spent for food and chewing rumination total began to decrease. The times for TAL, TRU and TMT are the variables of ingestive behavior which are affected by the type of diet, because the greater the fiber content, the longer the time duration spent for feeding, rumination and chewing activities.

In the current study, among the treatments assessed, the TAL, TRU and TMT revealed an increase in the duration of time spent on these activities. These findings thus appear to suggest that this extended time is a response to the added fiber supplement present in the hay, which is reflected in the increased consumption of NDF, by the animals. Van Soest (1994) proposed that the fiber content and physical nature of the diet are the principal factors that influence the rumination time. Mendes et al. (2010) in their study on the ingestive behavior of lambs reared on diets high in concentrate content (100 %) and various sources of neutral detergent fiber (14 % or 18 %) concentrate showed less rumination time when compared with the other treatments.

Although the variable TO was almost unaffected among the treatments evaluated, it is a noteworthy variable that must be assessed in the ingestive behavior of confined animals.

This is true because the energy expenditures of the animals decrease due to their idleness (Mousquer et al. 2013).

The variables time chews per cake (TM/cake) and number of chews per cake (NM/cake) also showed no alterations among the treatments ( $P > 0.05$ ), unlike the variables number of chews/day (NM/day) and number of chews ruminal cakes (NBR), which revealed a remarkable effect ( $P < 0.05$ ). In Table 3, the mean values, regression equations, determination and variation coefficients are listed.

The variables NBR and NM/day exhibited a quadratic response in response to the levels of hay supplement added to the diets. Greater numbers of ruminal cakes were reported for the treatment of 0.4 % CP of supplementary hay, with the variable NM/day showing a similar finding.

From 0.4 % of supplementary hay, the values recorded for NBR and NM/day values declined, which is explained as the maximum reaching point at the supplementation level identified between the hay supplement levels of 0.4 % and 0.8 %. After the regression equation was derived, the maximum point for the 0.53 % and 0.54 % of supplementary hay were calculated for the numbers of rumen cakes and numbers of chews per day, respectively. The hay consumption affected both the NBR and NM/day, which exhibited the same quadratic behavior as a response to the supplementary hay levels. The fiber present in the hay contributed by stimulating the consumption of more numbers of ruminal cakes and, therefore, a greater number of chews per day, as this variable is dependent on the NBR. Mertens (1997) reported that high-fiber diets increase the stimulation of masticatory muscle activity.

The influence of the levels of the hay supplement was observed on the feed efficiencies (EALMS) and rumination (ERUMS) of the dry matter ( $P < 0.05$ ), whereas the rumination efficiency of neutral detergent fiber (ERUFDN) and rumen ( $P > 0.05$ ) remained unaltered among the treatments evaluated (Table 4).

The variables dry matter feeding and rumination efficiencies were observed to show quadratic behavior as a function of the treatments assessed, in which the rise in the levels of dietary hay caused the variables EALMS and ERUMS to decrease, implying that such a reduction was the result of the increased hay consumption. Thus, the addition of supplementary hay levels in animal diets induced a decrease in the feeding and rumination efficiencies of DM.

The feeding efficiency and rumination efficiency are main variables that are influenced by animal consumption, which in turn are associated with feeding, rumination and leisure time

(Carvalho et al. 2011). In the present study, between the treatments the influence of the hay supplement on the TAL and TRU variables is evident, while the variables EALMS and ERUMS are inversely proportional to such times; therefore, the conclusion drawn is that this reduction in the feeding and rumination efficiencies occurred because of the extended feeding time and rumination induced by the supplements given. Barreto et al. (2011) reported that when the cell wall components present in the diet increased, there was a corresponding rise in the number of merciful chews per food bolus, because of the higher fiber consumed; however, the feed and rumination efficiencies decrease because of the effect of the longer time required to digest the fiber.

Rumination is a reflex action that occurs in response to mechanical stimuli and is directly linked to the nature and quantity of the diet (Degaspero et al. 2003). Therefore, the efficiency of the rumination process of the diet raises the coefficient digestibility of this food and consequently, its elimination and food intake in the future. Thus, it is evident that rumination affects future ingestion.

The increase in the hay consumed among the treatments studied showed a marked increase in times spent for chewing and rumination, number of merciful chews per day and ruminal cakes. Considering these findings, it can be understood that the rise in hay consumption also enabled the animals to break down or crush the corn grain, because of the greater fiber content from the hay. This in turn induced the increase in the number and time of chewing and thus, of rumination. This reduced the quantity of corn grain recovered from the excreta, which was visually evaluated.

From the findings of the present study, it is hypothesized that the addition of a low-quality but physically effective fiber source, meaning one which contains a higher lignin content, could induce a marked influence on increasing the breakdown of corn grain in the digestive tract of calves. In this section, the addition of straw or agricultural crop residues appeared to be a more effective option, as it would entail a shorter passage time for the fiber in the rumen, thus resulting in higher dietary degradation. Besides, the total production cost involved for the utilization of these residual feeds (straw or crop residues) would be much less when compared with the cost of using Tifton hay. This would prove to be a huge saving in terms of the final production cost of these animals and, consequently, to the cattle rancher. However, it must be remembered that these food supplements which are high in fiber content but low in nutritional quality may also directly affect the consumption, and also influence the ingestive behavior of the animal. Therefore, further research studies are necessary to assess



the potential of using a diet of whole grain corn, plus incorporating a fiber source to increase the corn degradability and thus to improve the efficiency of this production system.

In their study, Depenbusch et al. (2008) reported that from the fecal samples of 251 steers supplemented with flocculated laminate corn-based diets, a mean fecal starch value of 23 % was recorded; they found a 1.2 % minimum variation ranging up to 59.6 % as the maximum value, with a standard deviation of above 11 %. Zinn et al. (2007) in their compilation of the starch content from 32 metabolism studies revealed mean fecal starch values of 5.9 %, with a wide variation ranging from 0 to 44 %. These data clearly highlight the necessity for further research on the practical use of maize in high-grain diets, regardless of whether roughage was included as supplement or not.

Table 2. Means of the times for feeding, rumination, leisure and chewing activities, depending on the levels of hay supplement in the diet.

| Variable | Additional levels of hay (%) |        |        |        | Regression Equation                            | R <sup>2</sup> | P      | CV (%) |
|----------|------------------------------|--------|--------|--------|--|----------------|--------|--------|
|          | 0.0                          | 0.2    | 0.4    | 0.8    |  |                |        |        |
| TAL      | 91.25                        | 131.25 | 161.25 | 158.75 | $\hat{Y} = 90.3636 + 259.7159x - 217.3295x^2$  | 0.99           | 0.0018 | 23.75  |
| TRU      | 248.75                       | 365.00 | 442.50 | 435.00 | $\hat{Y} = 247.4886 + 727.5284x - 615.7670x^2$ | 0.99           | 0.0000 | 11.77  |
| TO       | 1005.00                      | 925.00 | 817.50 | 831.25 | $\hat{Y} = 894.6975$                           | -              | NS     | 15.40  |
| TMT      | 5.66                         | 8.27   | 10.06  | 9.89   | $\hat{Y} = 5.6293 + 16.4560x - 13.8863x^2$     | 0.99           | 0.0000 | 10.30  |

TAL= Feeding time (min/day); TRU = Ruminating time (min/day); TO = time in leisure (min/day); TMT = Total chewing time (h/day); R<sup>2</sup> = coefficient of determination of the regression equation; P = significance level of the regression model; CV = coefficient of variation; NS = non-significant regression model (P > 0.05).

Table 3. Time of chewing cheeses per cake, number of chewing cheeses per cake, number of chewing cheeses per day and number of rumen cakes as a function of the levels of hay supplement.

| Variable | Additional levels of hay (%) |          |          |          | Regression Equation                                 | R <sup>2</sup> | P      | CV (%) |
|----------|------------------------------|----------|----------|----------|---|----------------|--------|--------|
|          | 0.0                          | 0.2      | 0.4      | 0.8      |   |                |        |        |
| TM/cake  | 46.97                        | 49.34    | 46.35    | 47.26    | $\hat{Y} = 47.4800$                                 | -              | NS     |        |
| NM/cake  | 59.12                        | 67.76    | 64.38    | 67.71    | $\hat{Y} = 64.7425$                                 | -              | NS     | 14.83  |
| NM/day   | 7287.48                      | 13740.64 | 15517.56 | 14827.37 | $\hat{Y} = 7554.3353 + 33504.5667x - 30655.5710x^2$ | 0.98           | 0.0000 | 17.06  |
| NBR      | 137.00                       | 205.00   | 241.00   | 219.00   | $\hat{Y} = 137.0545 + 417.8636x - 394.3181x^2$      | 0.99           | 0.0001 | 16.25  |

TM/cake = time of merciful chewing by rumen cake (seconds/cake); NM/cake = Number of merciful chews for ruminal cake (number/cake); NM/day = number of merciful chews per day (n°/day); NBR = number of ruminal cakes (n°/day); R<sup>2</sup> = coefficient of determination of the regression equation; P = significance level of the regression model; CV = coefficient of variation; NS = non-significant regression model (P > 0.05).

Table 4. Mean values for feed and rumination efficiency and rumination rate as a function of the levels of hay supplement

| Variable | Additional levels of hay (%) |       |       |       | Regression Equation                      | R <sup>2</sup> | P    | CV (%) |
|----------|------------------------------|-------|-------|-------|--|----------------|------|--------|
|          | 0.0                          | 0.2   | 0.4   | 0.8   |  |                |      |        |
| EALMS    | 2.80                         | 2.24  | 1.72  | 1.82  | $\hat{Y} = 2.8318 - 3.9767x + 3.3830x^2$ | 0.0011         | 0.99 | 21.43  |
| ERUMS    | 1.58                         | 0.93  | 0.64  | 0.64  | $\hat{Y} = 1.5718 - 3.6281x + 3.0904x^2$ | 0.0040         | 0.99 | 50.63  |
| ERUFDN   | 0.10                         | 0.08  | 0.08  | 0.08  | $\hat{Y} = 0.0850$                       | NS             | 0.99 | 25.95  |
| TR       | 72.31                        | 73.70 | 73.34 | 73.33 | $\hat{Y} = 73.1700$                      | NS             | 0.70 | 9.86   |

EALMS = feed efficiency (kg DM/h); ERU = rumination efficiency (kg DM/h); ERUFDN = rumination efficiency (kg NDF/h); RT = rumination rate (%/h); R<sup>2</sup> = coefficient of determination of the regression equation; P = significance level of the regression model; CV = coefficient of variation; NS = non-significant regression model (P > 0.05).

**4 CONCLUSION**

It has been concluded that the addition of a supplementary fiber source, in the proportion of between 0.5 and 0.6 % of the body weight, to the diet based on whole grain corn is a deciding factor for the increase in the chewing and rumination times, number of ruminal cakes and chewing.

**ACKNOWLEDGEMENTS**

This research was supported by the Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq; Brasília, Brazil), the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES; Brasília, Brazil) and the Fundação de Amparo à Pesquisa do Estado de Minas Gerais (FAPEMIG; Belo Horizonte, Brazil).

**REFERENCES**

- ARRIGONI, M.B., MARTINS, C.L., SARTI, L.M.N., BARDUCCI, R.S., FRANZÓI, M.C.S., VIEIRA JÚNIOR, L.C., PERDIGÃO, A., RIBEIRO, F.A., FACTORI, M.A. Níveis elevados de concentrado na dieta de bovinos em confinamento. **Veterinária e Zootecnia**. v.20, n.4, p:539-551, 2013.
- BARRETO, L.M.G., MEDEIROS, A.N., BATISTA, A.M.V., FURTADO, D.A., ARAÚJO, G.G.L., LISBOA, A.C.C., PAULO, J.L.A., SOUZA, C.M.S. Ingestive behaviour of Moxoto and Caninde goats fed diets with two energy levels in feedlot. **Revista Brasileira de Zootecnia**. v.40, n.4, p:834-842, 2011
- CATTELAM, J., BRONDANI, I.L., ALVES FILHO, D.C., SILVA, J.H.S., SEGABINAZZI, L.R., PIZZUTI, L.A.D., MAYER, A.R., WYZYKOWSKI, A., PEREIRA, L.B., MACHADO, D.S. 2013. Padrões comportamentais de novilhos confinados com diferentes espaços individuais. **Current Agricultural Science and Technology**. v.19, n.1, p: 82-95, 2013.
- CARVALHO, G.G.P.D., GARCIA, R., PIRES, A.J.V., DETMANN, E., RIBEIRO, L.S.O., CHAGAS, D.M. T., SILVA, R.R., PINHO, B. D. Comportamento ingestivo em caprinos alimentados com dietas contendo cana-de-açúcar tratada com óxido de cálcio. **Revista Brasileira de Zootecnia**. v.40, n.8, p: 1767-1773, 2011
- DEGASPERI, S. A. R., COIMBRA, C. H., PIMPÃO, C. T., SOUZA, F. P., DARH CHI, K. D. & JUNIOR, P. G. Estudo do comportamento do gado holandês em sistema de semi-confinamento. **Revista Acadêmica: ciências agrárias e ambientais**. v.1, n.4, p:41-47, 2003.

DEPENBUSCH, B. E., NAGARAJA, T. G., SARGEANT, J. M., DROUILLARD, J. S., LOE, E. R., CORRIGAN, M. E. Influence of processed grains on fecal pH, starch concentration, and shedding of *Escherichia coli* O157 in feedlot cattle. **Journal Animal Science**. v.86, n.3, p:632-639, 2008.

FERREIRA, D. F. 2011. Sisvar: a computer statistic analysis system. **Ciência e Agrotecnologia**. v.35, n.6, p:1039-1042, 2011.

HOMEM JUNIOR, A.C., EZEQUIEL, J.M.B., GALATI, R.L., GONÇALVES, J.D.S., SANTOS, V.C. & SATO, R.A. Grãos de girassol ou gordura protegida em dietas com alto concentrado e ganho compensatório de cordeiros em confinamento. **Revista Brasileira de Zootecnia**. vol.39, n.3, p:563-571. 2010

JOHNSON, T.R., COMBS, D.K. Effects of prepartum diet, inert rumen bulk, and dietary polythyleneglicol on dry matter intake of lactating dairy cows. **Journal Dairy Science**. v.74, n.3, p:933-944, 1991.

MACEDO, C. A. B., MIZUBUTI, I. Y., MOREIRA, F. B., PEREIRA, E. S., RIBEIRO, E. L. A., ROCHA, M. A., RAMOS, B. M. O., MORI, R. M., PINTO, A. P., ALVES, T. C., CASIMIRO, T. R. Comportamento ingestivo de ovinos recebendo dietas com diferentes níveis de bagaço de laranja em substituição à silagem de sorgo na ração. **Revista Brasileira de Zootecnia**. v.36, n.6, p:1910-1916, 2007.

Mendes, C.Q., Turino, V.F., Susin, I., Pires, A.V., Morais, J.B. & Gentil, R.S. 2010. Comportamento ingestivo de cordeiros e digestibilidade dos nutrientes de dietas contendo alta proporção de concentrado e diferentes fontes de fibra em detergente neutro. *R. Bras. Zootec.* 39:3.

MENDONÇA, S. S., CAMPOS, J. M. S., VALADARES FILHO, S. C., VALADARES, R.F.D., SOARES, C.A., LANA, R.P., QUEIROZ, A.C., ASSIS, A.J., PEREIRA, M.L. Comportamento ingestivo de vacas leiteiras alimentados com dietas à base de cana-de-açúcar ou silagem de milho. **Revista Brasileira de Zootecnia**. v.33, n.3, p:723-728, 2004.

MERTENS, D.R. Creating a system for meeting the fiber requirements of dairy cows. **Journal Dairy Science**. v.80, n.7, p:1463-81, 1997.

MOTA, D. A., FRAGATA, N. P., BRITO, É. P., CASAGRANDE, D. R., ROSA, B. L., DE ALBUQUERQUE BORGES, C. R. Torta de cupuaçu na alimentação de tourinhos Nelore confinados. **Boletim Indústria Animal**. v.71, n.4, p.309-316, 2014.

MOUSQUER, C.M., FERNANDES, G.A., CASTRO, W.J.R. HOFFMANN, A., SIMIONI, T.A. & FERNANDES, F.F.D. 2013. Comportamento ingestivo de ovinos confinados com silagens. **Revista Brasileira de Higiene e Sanidade Animal**. v.7, n.2, p:301-322, 2013.

PAULINO, P.V.R., OLIVEIRA, T.S., GIONBELI, M.P., GALLO, S.B. Dietas sem forragem para terminação de animais ruminantes. **Revista Científica de Produção Animal** v.15, p:161-172. 2013.

VAN SOEST, P.J. **Nutritional ecology of the ruminant**. 2.ed. Ithaca: Cornell Univ. Press, 476 p. 1994

ZARPELON, T.G., MIZUBUTI, I.Y., RIBEIRO, E.L.A., PEREIRA, E.S., SILVA, L.D.F., PRADO-CALIXTO, O.P., TARSITANO, M.A., FÁVERO, R., PIRES, K.A., BORGES, C.A.A. Desempenho, características de carcaça e avaliação econômica da substituição do milho grão inteiro por casca de soja peletizada na alimentação de cordeiros em confinamento. **Semina: Ciências Agrárias**, v.36, n.2, p:1111-1122, 2015.

ZINN, R. A.; BARRERAS, A.; CORONA, L.; OWENS, F. N., WARE, R. A. Starch digestion by feedlot cattle: predictions from analysis of feed and fecal starch and nitrogen. **Journal Animal Science**, v.85, n.7, p: 1727-1730, 2007.