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ANIMAL PRODUCTION

Feeding behavior of categories of feedlot-finished beef cattle

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ABSTRACT. An experiment was conducted to evaluate the feeding behavior of feedlot-finished bulls and cull cows in the *Cerrado* region of Piauí State, Brazil. Forty Zebu cattle were used, of which 20 steers averaging 283.0 ± 20.82 kg initial body weight and 30 months of age; and 20 cull cows averaging 296.1 ± 17.80 kg initial body weight and 100 months of age. Animals were grouped according to the following treatments: bulls and cull cows, using a completely randomized design. Feeding behavior was evaluated by means of visual observations every five minutes during 24h. Results were subjected to analysis of variance by the F test ($p < 0.05$) using the System for Statistical and Genetic Analysis - SAEG (version 9.1). The feeding behavior was expected not to affect the feed intake of cull cows and bulls, so that feed management can be the same for both categories. For all variables, there were differences between the categories ($p > 0.05$), showing that feeding behavior is influenced by the cattle category.

Keywords: ethology, fiber, ruminants.

Comportamento ingestivo de categorias de bovinos de corte terminados em confinamento

RESUMO. Foi conduzido o experimento para avaliar o comportamento ingestivo na terminação de touros e vacas de descarte na região do Cerrado do Estado do Piauí, no Brasil. Utilizaram-se quarenta bovinos, dos quais 20 novilhos com média de 283,0 ± 20,82 kg de peso corporal inicial e 30 meses de idade; e 20 vacas de descarte com média de 296,1 ± 17,80 kg de peso corporal inicial e 100 meses de idade. Os animais foram agrupados de acordo com os seguintes tratamentos: touros e vacas de descarte, utilizando um delineamento inteiramente casualizado. O comportamento ingestivo foi avaliado por meio de observações visuais a cada cinco minutos durante 24h. Os resultados foram submetidos a análise de variância pelo teste F ($p < 0,05$), utilizando o Sistema de Análise Estatística e Genética - SAEG (versão 9.1). Para todas as variáveis, houve diferenças entre as categorias ($p > 0,05$), mostrando que o comportamento alimentar é influenciado pela categoria dos bovinos.

Palavras-chave: etologia, fibra, ruminantes.

Introduction

The study of animal behavior has played an important role in cattle production because of the changes imposed by men that can interfere with the welfare and productive performance of animals. This human interference can have consequences like stress and diseases, compromise the feed quality. Thus, research should be conducted on the feeding behavior of animals to provide producers with relevant choices so that they can determine the best dietary management strategy to be adopted at the farm, aiming at increased productivity (Argenta et al. 2013).

Analyzing the feeding behavior of animals allows the producer to adjust the dietary management in order to achieve better production performance from these animals. Consequently, the nutritional management becomes more efficient, thereby improving the profitability of the activity.

There has been a greater concern with an economically viable production management, which has fostered investigations about the feeding behavior of animals (Pinto et al. 2010).

In ruminants, the feeding behavior is characterized by the periods of activities of biological and economic importance, which are defined by the time the animal takes to consume the feed, how often it heads to the trough to eat, rumination activity, and idleness (other activities) (Schwartzkopf-Genswein et al. 2011).

In a study on the feeding behavior of ruminants, several factors (e.g., animal category, diet composition, among others) may influence their intake, because the nutritional requirement can vary from animal to animal, and the literature lacks information about the comparison between the

feeding behaviors of bulls and cull cows finished in the feedlot. Given these considerations, the present study reports an experimentin which we evaluated the feeding behavior of feedlot-finished bulls and cull cows raised in the *Cerrado* biome of Brazil.

Material and methods

This study was undertaken after acceptance by the Ethics Committee in Animal Use (*Comissão de Ética no Uso de Animais*, CEUA) of the State University of Piauí (UESPI), case no. 10920/15.

The experiment was conducted on Branquinha farm, located in the municipality of Corrente (10°26'30" S latitude and 45°9'52"W longitude). Minimum and maximum temperatures in the region are 23 and 39ºC, respectively, and the climate is hot and semi-humid. The average annual precipitation is 900 mm, and the rainy period is concentrated between November and February.

Forty Nellore crossbred cattle were used in the experiment, including 20 bulls with an average initial weight of 283.0 ± 20.82 kg, at 30 months of age, and 20 cull cows with an average initial weight of 296.1 ± 17.80 kg, at 100 months of age. Animals were separated according to the following treatments: bulls and cull cows, in a completely randomized design.

The experimental area consisted of two paddocks for confinement (compacted dirt floor, flat wire partitions, uncovered half-drum troughs, and floating valve drinkers), with an area of 20 m^2/animal. Each paddock had 200-L half-drum troughs with 50 cm per animal and masonry drinkers. All animals were vaccinated against clostridiosis and lung diseases, dewormed, and identified to be included in the experiment.

The experiment comprised the period from August to October, starting with 15 days of adaptation of the animals. The data collection period was from the end of adaptation to the moment of visual finishing for the animals in each category (86 days for uncastrated seers and 42 days for cull cows). During the 15-day adaptation period, 16 kg of sorghum silage and 1 kg concentrate were provided per animal daily, and the amount of concentrate was increased by 0.5 kg every three days, following the method of steps.

The diet was formulated aiming to meet the maintenance requirements and to provide a weight gain of 1.5 kg per day (National Research Council [NRC], 1996). The diet (Table 1) was supplied *ad libitum*, with leftovers adjusted to 10%, at four times daily: 0600, 1000, 1400, and 1800 h. The roughage-to-concentrate ratio was 54:46, and was similar across the treatments.

Table 1. Proportion of ingredients and chemical composition of the diet.

Proportion of ingredients (g kg^{-1} dietary DM)	
Sorghum silage	540
Ground corn	361
Soybean meal	70
Urea	08
Mineral-vitamin mix[1]	21
Chemical composition (g kg^{1} DM)	
Dry matter	574
Organic matter	541
Crude protein	149
Mineral matter	42
Neutral detergent fiber corrected for ash and protein	250
Acid detergent fiber	101
Non-fibrous carbohydrates	517
Ether extract	38
Total digestible nutrients (estimated)	744

[1]Composition per kg: calcium - 180 g, phosphorus- 20 g, iodine - 25 mg, magnesium - 17 g, manganese - 840 mg, monensin - 833 mg, selenium - 7 mg, sodium - 86 g, virginiamycin - 500 mg, cobalt - 25 mg, copper - 420 mg, iron - 490 mg, vitaminA - 83,200 IU, vitamin D3 - 10,400 IU, vitamin E - 242 IU, zinc - 2,000 mg.

Samples of the feed supplied and leftovers were collected weekly and grouped to form a composite sample. Subsequently, they were packed in labeled plastic bags and stored at −10ºC for later analyses.

Samples of feed, leftovers, and feces were pre-dried in a forced-air oven at 55ºC for 72h. The dry matter (DM), crude protein (CP), mineral matter (MM), and ether extract (EE) contents were analyzed according to the Association of Official Analytical Chemists [AOAC] (2000). Neutral detergent fiber corrected for ash and protein (NDFap) and acid detergent fiber (ADF) were analyzed by the sequential method, following Van Soest, Robertson and Lewis (1991). The non-fibrous carbohydrates (NFC) were calculated by the equation proposed by Hall (2000), as follows: NFC = 100 − [(%CP − % CP from urea + % urea) + % NDF + % EE + % ash]

The estimated total digestible nutrients content (TDN_{est}) was calculated according to Capelle, Valadares Filho, Silva, & Cecon (2001), using the following equation for the total diet: TDN_{est} = 91.0246 – 0.571588 ⋆ NDF, where TDN_{est} - estimated total digestible nutrients; NDF - neutral detergent fiber.

Feeding behavior was assessed visually by four trained observers, with two evaluators for each treatment, each one observing the behavior of 10 animals. The studied behavioral variables were feeding time, rumination time, and time spent on other activities (rest, water intake, interactions). The behavioral activities were considered mutually exclusionary. To record the time spent on each of the above-described activities, the animals were observed visually every five minutes (Carvalho et al. 2011), for a period of 24h. Digital watches were used to mark the time spent on each activity.

Time series were discretized directly on data collection worksheets, by counting the discrete

periods spent feeding, ruminating, and on other activities. The average duration of each discrete period was obtained by dividing the daily times of each activity by the number of discrete periods of the same activity. In all behavioral variables, one animal represented one experimental unit.

To determine the number of chews per ruminated cud (NCRC) and the time spent to ruminate each cud (TRC), visual observations were performed in two periods of the day (morning and afternoon), with three replications per period (Bürger et al. 2000).

The variables cuds ruminated per day (CRD), chewing speed (CS), time per rumination chew (TRCh), and rumination chews per day (RChD) were calculated by the equations described below:

$$CRD = RT/TRC,$$
$$ChS = ChRC/TRC,$$
$$TRCh = TRC/ChRC, \text{ and}$$
$$RChD = CRD \times ChRC,$$

where CRD(n/day); RT (s/d) - rumination time; TRC (s) - time per ruminated cud;ChS (s); ChRC(n) - chews per ruminated cud; TRCh(s); ChRC(n) - chews per ruminated cud;RChD (n day^{-1}).

Results were subjected to analysis of variance using the 'F' test at the 0.05 probability level, using the System for Statistical and Genetic Analyses - SAEG (version 9.1).

Results and Discussion

The cull cows (CC) consumed more sorghum silage and concentrate than the bulls (BUL) (Table 2) ($p < 0.05$). The higher intake of CC compared with US can be explained by the higher maintenance and production requirements of the former. In the uncastrated steers, the energy reserve is larger than that of cull cows, because cows have a compensatory gain (Moura et al. 2013).

Table 2. Intake and feeding behavior of feedlot-finished beef cattle categories.

Item	Category		CV (%)	p-value
	BUL	CC		
Silage intake (kg DM)	4.59	5.50	15.3	0.0054
Concentrate intake (kg DM)	3.96	4.76	12.8	0.0063
Total intake (kg DM)	8.55	10.26	13.4	0.0064
Feeding time (min.)	169.17	111.67	19.30	0.0000
Rumination time (min.)	401.67	310.83	24.61	0.0188
Time on other activities (min.)	869.17	1 017.50	10.93	0.0019
Total chewing time (min.)	570.84	422.50	21.42	0.0254
FEDM(g $min.^{-1}$)	50.54	91.88	12.33	0.0023

CV = coefficient of variation; BUL = bulls; CC = cull cow; FEDM = feed efficiency of dry matter. Means at $p < 0.05$ differ by the F test at the 5% significance level.

Significant differences were found for the feeding behavior variables between the categories ($p < 0.05$). Bulls showed a longer feeding time than cull cows. Because they were younger and also because of the presence of hormones acting in the acceleration of the metabolic rate, especially testosterone, which promotes the anabolism, bulls showed a superior metabolism than cull cows (Wysocki, Katz, & Bernhard, 1983). Under this hormonal effect, the nutritional requirement increases considerably, especially for energy. As a response, steers extend their feeding time to increase their intake in an attempt to meet their nutritional requirements.

Bulls spent more time ruminating compared with cull cows ($p < 0.05$). The presence of fiber in the diet of feedlot animals is aimed at stimulating the buffer effect, providing energy and improving performance. The buffer effect occurs through salivation, which is stimulated by rumination, and it is dependent upon the time spent ruminating (Oliveira et al. 2012).

In the present study, the time spent on other activities was the behavior of greatest expression among all parameters assessed, which suggests that the fact that the animals were confined contributed to this result. Cull cows spent more time on other activities, because they were mutually exclusionary, and an increase or reduction of feeding time results in alterations in the time spent on other activities. Bulls showed the lowest time spent on other activities, which was already expected, given the longer time they took feeding and ruminating. According to Missio et al. (2010), the increased time on other activities lead to a reduction of physical activity, thereby decreasing the energy spent, which in turn can contribute to a better animal performance.

The feed efficiency of dry matter (FEDM) was lower in the cull cows ($p < 0.05$), which consumed more dry matter per time unit than the uncastrated steers. Missio et al. (2010) evaluated contemporary intact cattle of the Charolais and Nellore breeds and found a negative correlation between feed efficiency and feeding time ($r = -0.86$). This was also found in the present study, in which the US had a longer feeding time and a lower feed efficiency of dry matter ($p < 0.05$) than the females.

Gomes, Siqueira, Ballou, Stella and Leme (2011) evaluated the residual feed intake of Nellore heifers and bulls and did not observe significant differences between the two categories for residual feed intake, despite the fact that the bulls had heavier weights at the beginning and end of the performance trial and higher feed intakes.

For the variables number of feeding periods (NFP), number of rumination periods (NRP), and

number of periods on other activities (NPO), there was no significant difference between the categories ($p > 0.05$) (Table 3). Bulls and cull cows head towards the trough to eat with the same frequency, and the diets were similar, especially in effective fiber content.

There were significant differences for the times, in minutes, per feeding period (TFP), per rumination period (TRP), and per period on other activities (TPO) between the categories ($p < 0.05$). The time per feeding period was longer in uncastrated steers, because their feed intake is lower than that of cull cows. In a balanced diet, the more feed an animal consumes, the higher its intake of effective fiber, which is responsible for the rumen motility and rumination. Consequently, animals that spend a longer period feeding will also spend more time ruminating. Bulls and cull cows have different nutritional requirements and body tissue deposition dynamics, which affect their feed intake (NRC 1996).

Table 3. Discrete periods and rumination aspects of the feeding behavior of feedlot-finished beef cattle categories.

Item	Category		CV (%)	**p**-value
	BUL	CC		
Discrete period				
NFP	13.17	13.75	19.27	NS
NRP	20.92	21.25	20.85	NS
NPO	30.42	30.08	16.80	NS
TFP (min.)	13.45	8.17	27.60	0.0003
TRP (min.)	19.15	14.76	17.51	0.0015
TPO (min.)	29.23	35.80	29.13	0.1034
Rumination aspect				
NChRC	55.47	54.50	17.59	NS
TChRC (s)	56.43	60.97	15.41	NS
ChS (s)	0.99	0.89	9.96	0.0204
ChT (s)	1.03	1.13	9.89	0.0334
NRChD (n)	23817.31	16626.16	26.26	0.0031
NCRD (n)	438.60	309.47	31.15	0.0126

CV = coefficient of variation; BUL = bulls; CC = cull cow; NS = not significant; NFP = number of feeding periods; NRP =number of rumination periods; NPO =number of periods on other activities; TFP = time per feeding period, in minutes; TRP =time per rumination period, in minutes; TPO =time per period on other activities, in minutes; NChRC = number of chews per ruminated cud; TChRC = time spent on chews per ruminated cud, in seconds; ChS = chewing speed; ChT = chewing time; NRChD = number of rumination chews per day; NCRD = number of cuds ruminated per day. Means at $p < 0.05$ differ by the F test at the 5% significance level.

Lage, Paulino and Pires (2012) evaluated intact Zebu males, intact females, and ovariectomized females and did not observe significant differences between the categories for intake, digestibility of dry matter, organic matter, crude protein, ether extract, neutral detergent fiber, non-fibrous carbohydrates, total digestible nutrients, feed efficiency, and carcass characteristics. The authors concluded that the category had no effect on the evaluated characteristics.

The number of chews per ruminated cud and the time spent chewing each ruminated cud did not differ significantly ($p > 0.05$) between the cattle categories. However, the bulls (BUL) showed higher chewing speed, number of rumination chews per day, and number of cuds ruminated per day than cull cows (CC), though the chewing time was longer for the latter ($p < 0.05$). Bulls are slower in the rumination activities when compared with cull cows. This difference is a function of the number of rumination chews for a certain time. Animals that consume a larger amount of feed spend less time chewing each cud and have fewer ruminated cuds.

These effects may have a direct impact on the animal performance, and since bulls have a greater ability to use their feed, they may achieve higher weight gains than cull cows.

Paulino et al. (2008) evaluated Nellore cattle under the effects of category and concentrate levels with respect to their performance, intake, and digestibility of nutrients and found that the intact males were more efficient, as they showed a higher final empty body weight as a result of their higher growth rate in relation to females and castrated males, which had an intermediate position. These authors concluded that the intakes of dry matter and other nutrients were higher in females than in intact males. Castrated males were once again in an intermediate position, which proves that the category affected the growth and intake capacity of the animals.

Conclusion

The feeding behavior is influenced by the cattle category. The differences in age and in the anatomy of the digestive system between the categories indicate that the study of feeding behavior is fundamental to improve the dietary management of the animal category considering its particularities, thereby improving its feed efficiency and performance.

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