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Influence of concentrate levels in diet and body biotypes on productive variables of Guzera beef cattle

Influência do nível de concentrado na dieta e do biotipo corporal sobre variáveis produtivas de bovinos de corte da raça Guzerá

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Abstract

The goal of this study was evaluate diets (50 or 80% of concentrate) and body biotypes (late or early) on performance, behavior, carcass condition, meat quality, and feed cost estimates in feedlot finishing Guzera beef cattle. Use of concentrates in the diet may improve performance and carcass fat scores in ruminant animals, but Guzera beef cattle may be more efficient in forage conversion, which directly influences the economic viability of the production system. We evaluated 32 non-castrated male Guzera beef cattle at 32±2 months of age. The experimental design was completely randomized with four treatments and six replicates in a 2 × 2 factorial design (2 diets × 2 body biotypes). Initial and final body weights were 459.4±31.2 kg and 566.7±40.8 kg, respectively. There was no change ($P > 0.05$) in dry matter intake, feed conversion, or daily weight gain when the concentrate in the diet was increased to 80%. Animals fed a diet with 80% of concentrate spent less time ($P < 0.05$) ruminating (17.8±6.3 vs. 6.3±2.7% of the assessed time). Body biotype did not alter the variables. The rise from 50 to 80% in the proportion of dietary concentrate increased carcass fat, with positive returns in the production process, even given the reduction in rumination, which can lead to poor welfare of animals consuming 80% of dietary concentrate. Body biotype did not affect the variables studied, but it is worth emphasizing that the age at slaughter of these animals probably influenced this result. Thus, selection of the best diet should be based on feeding cost, and in accordance with the cost estimated in this study, the diet with 80% of concentrate is the most suitable for feedlot finished Guzera beef cattle.
Key words: Behavior. Carcass condition. Costs. Feedlot. Meat quality. Performance.

Resumo

O objetivo deste estudo foi avaliar a dieta (50 ou 80% de concentrado) e o biótipo corporal (precoce

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ou tardio) sobre o desempenho, comportamento, carcaça, qualidade de carne e estimativas de custos com alimento na terminação de bovinos de corte da raça Guzerá confinados. Aumentar os níveis de concentrado na dieta pode melhorar o desempenho e a gordura na carcaça em animais ruminantes, porém animais de corte da raça Guzerá podem ser mais eficientes na conversão de forragem, o que influenciaria diretamente a viabilidade econômica do sistema de produção. Foram utilizados 32 bovinos de corte da raça Guzerá, machos não castrados com 32±2 meses de idade. O delineamento experimental foi inteiramente casualizado com 4 tratamentos e 6 repetições, em esquema fatorial 2x2 (2 dietas x 2 biótipos corporais). O peso corporal inicial e final foi de 459,4±31,2 kg e 566,7±40,8 kg, respectivamente. Não houve alteração (P > 0,05) no consumo de matéria seca, conversão alimentar e ganho de peso diário pelo aumento de 80% de concentrado na dieta. Animais alimentados com 80% de concentrado na dieta passou um tempo menor (P < 0,05) em ruminação (17,8±6,3 vs 6,3±2,7% do tempo avaliado). O biótipo corporal não modificou (P > 0,05) as variáveis estudadas. O aumento de 50 para 80% na proporção de concentrado na dieta aumenta a gordura na carcaça, com retorno positivo no processo de produção, mesmo com uma redução de ruminação, o que pode levar a uma redução no bem-estar nos animais que consomem 80% de concentrado na dieta. O biótipo corporal não afeta as variáveis estudadas, mas é importante ressaltar que a idade de abate desses animais pode, provavelmente, ter influenciado essa resposta. Neste sentido, para escolha da dieta deve-se considerar o custo de alimentação, e de acordo com o custo estimado neste estudo, a dieta com 80% de concentrado é mais adequada para o abate de bovinos de corte da raça Guzerá.

Palavras-chave: Carcaça. Confinamento. Comportamento. Desempenho. Custos. Qualidade de carne.

Introduction

In Brazil, finishing feedlot cattle are important tools for production system improvement, with the goal of higher quantity and quality of meat on the market. The demand for a better quality product has increased in recent years, leading cattle ranchers to use a high proportion of concentrate in diets to achieve more efficient production systems (OLIVEIRA et al., 2009; PARRA, 2011). High levels of concentrate in the diet of feedlot animals promote higher production performance and subcutaneous and marbling fat deposition, thus influencing carcass size and meat quality. However, animal response may increase with higher levels of dietary concentrate because of problems related to rumen dysfunction caused by the excess of rapidly fermentable carbohydrates (GONZÁLEZ et al., 2012).

Previous studies show that increases in the proportion of concentrate in the diet result in better performance, with greater weight gain, higher dry matter intake, and better feed conversion. Conversely, other studies have detected no responses in cattle from increasing the level of concentrate in the diet (VÉRAS et al., 2000; RESENDE et al., 2001; ÍTAVO et al., 2002; SILVA et al., 2005; COSTA et al., 2005).

Over time, the selection of animals with certain growth characteristics has resulted in animals that are heavier at maturity, and consequently, have higher nutritional requirements and lower subcutaneous fat deposition (KOURY FILHO, 2001).

The goal of this study was to evaluate diets (50 or 80% of concentrate) and body biotypes (late or early) on performance, behavior, carcass condition, meat quality, and estimated feed costs in feedlot finishing Guzera beef cattle.

Material and Methods

The feedlot experiment was conducted for 90 days to assess the effects of the proportion of concentrate in the diet (50 or 80%) and body biotype (early or late) in 32 non-castrated male Guzera beef cattle. The cattle had a mean age of 32±2 months and average initial body weight of 459.4±31.2 kg. Animals were housed in individual pens (12.5 m^2) with cement floors and partial roofs. The animals received diet with 12.5% CP (Table 1) to allow for a daily weight gain of 1.10 kg, according to

recommendations of Valadares Filho et al. (2012). Feed was provided twice daily (0800 and 1600 h), using sorghum silage as roughage. Animals were allowed to acclimate to the facilities and diet for 21 days.

Animals were classified according to body biotype using the method reported by Koury Filho (2001). Body biotypes were defined as Early with precocity and muscling scores ≥4, or Late with precocity and muscling scores <4.

Table 1. Composition of diets (%DM).

Ingredient	Diet	
	50%C	80%C
Sorghum silage	50.0	20.0
Ground corn grains	41.9	75.5
Cottonseed meal	6.6	2.6
Urea	0.63	0.89
Limestone	0.78	0.90
Ammonium sulfate	0.08	0.08
Nutrient		
DM, %	61.9	81.2
CP, %	12.6	12.5
RDP, %CP	55.3	50.0
NDF	36.3	21.0

C, concentrate; DM, dry matter; CP, crude protein; RDP, rumen degradable protein; NDF, neutral detergent fiber.

Following acclimation, animals were monitored for 10 periods over 3 months in the feedlot to observe the following: rumination (RUM), feed intake (FEE), idleness (IDL), and water intake (WAT). Observations began after first meal were taken and occurred every 20 min between 0830 h to 1110 h and 1430 h to 1710 h, totaling 18 daily observations, using focal sampling and instant collection (MARTIN; BATENSON, 1986). Behavioral data were expressed as a percentage of the observation period. The intake efficiencies (IE) and rumination efficiencies (RE) were calculated by the ratio of dry matter intake (g) and intake time (min) and rumination (min).

The weight of animals was determined at the beginning of the experiment and every 28 days thereafter, after solid fasting for 16 h. The performance variables evaluated were daily weight gain (DWG, kg day^{-1}), daily dry matter intake expressed as % body weight (IBW) and kg day^{-1} (DMI), and feed conversion (FC).

Animals were slaughtered in a commercial meat-packing slaughterhouse in Ilha Solteira, State of São Paulo. After gutting, the carcasses were divided into two half-carcasses and carcass yield was calculated by hot carcass weight divided by fasting body weight.

Three trained evaluators supplied visual evaluation of carcasses, and averages was calculated. Visual evaluations of the carcasses were performed to determine the fat and muscularity score, according to Felício (1999): muscularity score: 5 = convex; 4 = sub-convex; 3 = straight; 2 = sub-straight; 1 = concave; fat score: 1 = total absence of fat; 2 = 1 to 3 mm; 3 = 3 to 6 mm; 4 = 6 to 10 mm; 5 = more than 10 mm subcutaneous fat.

Analyses for water-holding capacity (HAMM, 1960), cooking losses, and shear force of the meat in kg cm^{-2} (PINHEIRO et al., 2008) were performed using samples of Longissimus dorsi et thoracis from between the 5^{th} and 6^{th} ribs. Color parameters, L* (lightness), a* (redness), and b * (yellowness), were determined using a colorimeter, Minolta, Chrome Meter CR-410, calibrated with a white standard tile. The color of the Longissimus dorsi et thoracis was determined 30 min after cutting the muscle to expose myoglobin to oxygen. We measured pH with a digital potentiometer, Testo, model 205, by introducing the electrode directly into the muscle.

Feed costs were estimated for treatments with 50 or 80% of concentrate in the diet using 0.17 or 0.21 US cents per kg of dry matter supplied, respectively, using the conversion of 3.25 Brazilian real to 1 US dollar. Total cost (TC) was calculated by multiplying

the dry matter intake during confinement by the price of dry matter of food. The cost per kilogram of weight gain (CWG) was calculated by dividing TC by weight gain. The cost per kilogram of weight gain in the hot carcass (CHC) was calculated by dividing CWG by hot carcass yield.

The animals were distributed in a completely randomized design with 4 treatments and 6 replicates in a 2 × 2 factorial design (2 diets, 50 or 80% of concentrate, and 2 body biotypes, late or early). Data were tested by analysis of variance using the GLM procedure of SAS (2002). Initial body weight was a covariate for comparisons between treatments. The significance level used to detect differences between treatments was 0.05.

Results and Discussion

No effect was detected for the interaction diet × body biotype (P > 0.05) for any of the variables evaluated. Thus, only the main effects are listed in the tables. Initial and final body weights were 459.4±31.2 kg and 566.7±40.8 kg, respectively. There was no change (P>0.05) in dry matter intake, feed conversion, or daily weight gain because of the increase to 80% of concentrate in the diet (Table 2).

Table 2. Performance and behavior in the fattening of feedlot beef cattle Guzera with two levels of concentrate in the diet and two body biotypes.

Item	Diet		Body biotype		*P Value*			SEM
	50%C	80%C	early	Late	diet	biotype	dxb[1]	
IW, kg	465.5±39.7	453.4±18.9	463.5±37.1	454.9±23.2	-	-	-	-
FW, kg	578.1±45.4	555.4±33.2	571.1±43.6	561.8±38.2	0.13	0.20	0.93	12.7
IBW,%	2.3±0.2	1.9±0.2	2.1±0.2	2.1±0.3	0.13	0.97	0.81	0.2
DMI, Kg	11.3±1.0	9.0±1.1	10.3±1.3	9.9±1.8	0.13	0.95	0.81	1.3
DWG, kg d^{-1}	1.6±0.1	1.4±0.3	1.5±0.2	1.5±0.3	0.13	0.20	0.93	0.2
FC	7.1±0.8	6.1±0.9	6.8±0.7	6.5±1.2	0.79	0.20	0.72	0.6
RUM, % d^{-1}	17.8±6.3	6.3±2.7	12.6±7.0	11.4±8.3	0.03	0.88	0.76	3.3
FEE, % d^{-1}	30.4±6.6	32.4±6.4	33.6±6.3	28.9±5.9	0.12	0.26	0.29	4.5
IDL, % d^{-1}	49.3±6.5	57.8±6.1	50.8±7.9	56.6±6.0	0.27	0.27	0.33	4.7
WAT, % d^{-1}	2.6±1.3	3.5±2.2	3.1±1.8	3.0±2.0	0.24	0.99	0.46	1.9
IE, g min^{-1}	27.2±7.1	20.1±5.5	22.2±5.5	25.3±8.7	0.15	0.51	0.48	6.6
RE, g min^{-1}	50.5±19.3	125.1±70.7	73.1±32.7	104.5±84.6	0.23	0.59	0.71	74.1

[1]Interaction of diet x body type; IW, initial weight; FW, final weight; DWG, daily weight gain; IBW, dry matter intake as % body weight; DMI, dry matter intake in kg; FC, feed conversion; RUM, ruminating; FEE, feed intake; IDL, idleness; WAT, drinking water; IE, intake efficiency; RE, rumination efficiency; SEM, square error mean.

Previous studies showed that the increase from 20 up to 40% concentrate in the diet might result in increased daily weight gain of Guzera beef cattle (ROSA et al., 2010) and dry matter intake will linearly reflected the increase from 20 to 65% diet concentrate ratio (PEREIRA et al., 2007a). However, our results did not support the theory that increasing the dietary concentrate improved the rate of degradation and the passage of food, favoring an increase in consumption (VAN SOEST, 1994). Although our results did not indicate a significant reduction in dry matter intake, we observed a difference of approximately 20% in the consumption of diets. This difference may reflect a

greater economic return in feedlot systems.

The time spent by animals in rumination was shorter (P<0.05) with 80% of concentrate in the diet (Table 2). According to Goulart et al. (2011), an increase in the proportion of concentrate in the diet resulted in a linear decrease of ingestion and rumination in dairy cows. The increase in the proportion of concentrate in the diet reduced the physical effective fiber concentration, thus causing a reduction in rumination time (WELCH; HOOPER, 1988; PEREIRA et al., 2007b; SANTANA JÚNIOR et al., 2013).

Brief rumination may be indicative of poor animal welfare, a fact that has been increasingly observed by modern consumers looking for not only a product with nutritional quality, but also one that meets welfare principles related to feeding habits of animals. However, there were no changes (P > 0.05) in the efficiency of intake or ruminating.

There was no effect of diet on hot carcass weight or carcass yield. Body biotype did not change the HCW or HCY, with average values of 315.2±27.5 kg and 55.7±1.5%, respectively. According to visual assessment of the carcasses, greater fat scores (P<0.05) were observed for carcasses of animals fed the 80% of concentrate diet. However, body biotype did not alter the score of the muscularity and fat of carcasses (Table 3).

Table 3. Carcass evaluation in the fattening of feedlot beef cattle Guzera with two levels of concentrate in the diet and two body biotypes.

Item	Diet		Body biotype		*P value*			SEM
	50%C	80%C	early	late	diet	biotype	dxb[1]	
HCW, kg	324.2±31.3	306.3±20.3	320.0±29.2	309.0±25.3	0.86	0.41	0.78	26.3
HCY, %	56.2±1.5	55.3±1.4	56.0±1.5	55.5±1.6	0.99	0.91	0.77	2.4
FS	3.5±0.6	3.9±0.3	3.6±0.5	3.7±0.6	0.03	0.85	0.24	0.51
MS	3.2±0.5	3.1±0.5	3.2±0.5	3.1±0.5	0.76	0.76	0.29	0.52

[1]Interaction of diet x biotype; HCW, hot carcass weight; HCY, hot carcass yield; FS, fat score; MS, muscularity score; SEM, square error mean.

Increasing the concentrate from 50 to 80% could result in a greater amount of body fat provided by differences in the energetic supply related to the increase in the concentrate (ROSA et al., 2010; LAGE et al., 2012). According to Duarte et al. (2011), an increase from 40 to 80% of concentrate had no effect on cold carcass weight, but increased carcass yield from 52 to 55%. This differed from our results, possibly because of the initial weight (240 kg) of animals used by these authors.

Color (L = 34, a = 17, and b = 10), pH (5.67), cooking losses (31%), and meat shear force (5.1 kg cm^{-2}) were not altered (P>0.05) by differences in the proportion of concentrate, 50 or 80%, or by body biotype (Table 4). According to Lage et al. (2012), there were no changes in meat quality variables when concentrate supplementation increased from 0.8 to 1.2% of body weight of different genetic groups: Nellore, Angus x Nellore, and Simmental x Nellore. Duarte et al. (2011) reported that an increase from 40 to 80% in the concentrate promoted no alteration in cooking losses or shear force, with values of 36.8% and 5.5 kg cm^{-2}, respectively, which were very similar to those obtained in our study.

Table 4. Meat quality variables in the fattening of feedlot beef cattle Guzera with two levels of concentrate in the diet and two body biotypes.

Item	Diet		Body biotype		*P value*			SEM
	50%C	80%C	early	late	*diet*	biotype	dxb[1]	
L*	34.6±1.8	34.1±1,4	34.3±1.7	34.4±1.4	0.47	0.89	0.53	1.6
a*	16.8±2.4	17.2±1.5	16.9±1.3	17.1±2.6	0.62	0.82	0.86	2.1
b*	9.8±1.5	9.9±1.0	9.6±1.2	10.2±1.2	0.83	0.20	0.11	1.2
pH	5.7±0.2	5.7±0.1	5.7±0.1	5.7±0.1	0.81	0.98	0.89	0.2
WHC,%	65.3±2.4	64.5±2.2	65.3±2.6	64.5±2.0	0.33	0.38	0.70	2.4
CL, %	31.8±6.4	30.5±5.8	29.9±6.7	32.4±5.1	0.55	0.25	0.55	6.1
SF, kgf cm^{-2}	5.1±1.9	5.2±1.6	5.2±1.5	5.0±2.1	0.92	0.73	0.28	1.8

[1]Interaction of diet x biotype; L, lightness, a*, redness, b*, yellowness; WHC, water holding capacity; CL, cooking losses; SF, shear force; SEM, square error mean.

In the assessment of costs, only those related to diet price, weight gain, and hot carcass yield were considered. There was no interaction (P>0.05) between diet × body biotype for analysis of feeding costs. The biotype did not change (P>0.05) the cost of feeding feedlot animals. The ratio of 80% of concentrate in the diet proved to be the most suitable to achieve lowest total cost (P<0.05; Table 5).

Table 5. Cost of feeding in the fattening of feedlot beef cattle Guzera with two levels of concentrate in the diet and two body biotypes.

Cost, US$	Diet		Body biotype		*P value*			SEM
	50%C	80%C	early	late	diet	biotype	dxb[1]	
TC	137.9±12.2	101.5±17.0	120.1±20.3	119.2±28.0	0.01	0.06	0.16	1.2
CWG	1.2±0.1	1.0±0.2	1.1±0.1	1.2±0.3	0.42	0.57	0.77	0.1
CHC	2.2±0.2	1.9±0.5	2.0±0.2	2.1±0.5	0.42	0.47	0.83	0.2

[1]Interaction of diet x biotype; SEM, square error mean. TC, total costs of food; CWG, costs per kilogram of weight gain.

It is known, that in the feedlot, feeding costs are the highest in the system, and the concentrate is more expensive than the roughage (PACHECO et al., 2006, 2014); however, the difference (approximately twenty percentage points; P>0.05) in dry matter intake in animals fed the diet containing 80% of concentrate resulted in lower total costs.

This favorable result when using 80% of concentrate in finishing feedlot Guzera beef cattle can be modified depending on the purchase prices of concentrate ingredients, especially the corn grains that make up much of the diet.

The increase from 50 to 80% in the proportion of dietary concentrate increased fat in the carcass, with positive returns in the production process, even given a reduction in rumination, which could lead to poor welfare in animals consuming 80% of concentrate in their diet.

Body biotype did not affect the variables studied, but it is worth emphasizing that the age at slaughter of these animals probably influenced this response. Therefore, selection of the best diet should take into account feeding cost. In accordance with the cost estimated in this study, the diet with 80% of concentrate was the most suitable for feedlot

finished Guzera beef cattle.

Ethics and Biosafety Committee

This work was conducted in accordance with the guidelines of the National Council for Animal Experimentation Control (CONCEA) and approved by the Ethics Committee on Animal Use (CEUA) of this Institution of Education, under the protocol 05/2014.

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