



Performance, carcass and meat characteristics of two cattle categories finished on pasture during the dry season with supplementation in different forage allowance

[Desempenho, características da carcaça e carne de duas categorias de bovinos de corte terminados em pastagem durante a estação seca com suplementação em diferentes ofertas de forragem]

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ABSTRACT

The objective this paper was to evaluate the effect of two categories of beef finished in pasture with supplementation with two herbage allowance on performance, carcass and meat characteristics. Thirty-six Guzera cattle were used, 18 steers and 18 heifers with an initial age of 20 months. There was significant difference in daily weight gain for animal category and the herbage allowance, which were higher in males and animals submitted to high herbage allowance. Steers showed higher final weight, carcass weight and forequarter yield compared with the heifers, although the hindquarter yield was higher in the heifers, however the herbage allowance did not influence these characteristics. There were not statistical differences for carcass yield, ribeye area, backfat thickness and marbling score for the animal categories and herbage allowance. The meat chemical composition of the steers did not differ of the heifers, however, the animals submitted to high herbage allowance was increase in ether extract and pH, decrease in protein percentage. It was concluded that the animal category and the herbage allowance changed the animal performance, improving performance in males and cattle submitted to high herbage allowance.

Keywords: animal supplementation, meat quality, weight gain

RESUMO

O objetivo do presente trabalho foi avaliar o efeito de duas categorias de bovinos terminados em pastagem com suplementação em duas ofertas de forragem no desempenho, na qualidade da carcaça e da carne. Foram utilizados 36 bovinos Guzera, 18 novilhos e 18 novilhas, com idade inicial de 20 meses de idade. Observou-se diferença significativa no ganho de peso diário para categoria animal e ofertas de forragem, que foram superiores nos machos e nos animais submetidos à oferta alta de forragem. Os novilhos apresentaram maior peso final, peso de carcaça e rendimento de dianteiro em comparação com as novilhas, embora o rendimento do traseiro tenha sido maior para as novilhas, entretanto as ofertas de forragem não influenciaram essas características. Não houve diferenças estatísticas para rendimento de carcaça, área de olho de lombo, espessura de gordura subcutânea e marmorização para categorias de animais e ofertas de forragem. Quanto à composição química, a carne de novilhos não diferiu das novilhas. Os animais submetidos à alta oferta de forragem tiveram aumento no extrato etéreo e pH, redução na porcentagem de proteína. Conclui-se que a categoria animal e os níveis de forragem alteram o desempenho animal, melhorando, assim, o desempenho nos machos e nos bovinos submetidos à alta oferta de forragem.

Palavras-chave: ganho de peso, qualidade da carne, suplementação animal

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INTRODUCTION

According to the Anuário (2016), approximately 84% of the total number of cattle slaughtered in Brazil in 2015 was finished in pastures and other animals (16%) were finished in feedlot systems or semi-feedlot. Brazil has favorable climatic characteristics during the summer for production of tropical forages, and consequently, has suitable conditions for beef cattle production on grasslands. (Barbero *et al.*, 2017).

The seasonal production of forage is the principal factor responsible for the low national livestock productivity, reducing the forage production in periods when decreased photoperiod, average temperature, and rainfall. These three factors together decrease the forage growth throughout the year, resulting decrease in quantitative and qualitative forage availability, affecting performance and meat quality of animals kept on pasture (Reis *et al.*, 2006).

Under these conditions, especially during the dry period, limit the growth of forages require strategies, such as the use of supplementation (Barbero *et al.*, 2017). The supplementation is alternative to accelerate weight gain and increase the use of available forage resources (Euclides *et al.*, 2009).

However, for the effectiveness of supplementation the forage availability is important, since this takes priority over the stocking rate, so that similar stocking rates may result in differences in animal performance (Sollenberger *et al.*, 2005).

In the literature, there are many papers with supplementation during the dry period related to the performance, carcass, and meat quality characteristics (Euclides *et al.*, 2009, Garcia *et al.*, 2014, Barbero, *et al.*, 2017), however, there is little information using different herbage allowance. In addition, the majority of the papers are with males and the evaluation of supplementation in different animal categories also deserves attention. Heifers, when not used for the replacement of the herd, were finished for beef production and the meat is sold in significant quantities to the consumer.

Therefore, the objective of the study is to evaluate the effects of supplementation in beef

cattle categories (steers and heifers) finished in pasture during the dry season and submitted two herbage allowance (high and medium) on performance, carcass traits and meat quality.

MATERIALS AND METHODS

The experiment was conducted in Agência Paulista de Tecnologia dos Agronegócios - Andradina, SP. The predominant climate in the region is the Aw, according Koppen, the annual precipitation of the region is around 1,257mm, concentrating 78% of the rains in October-April and 22% May-September, characterizing the dry season.

Thirty-six Guzera cattle with initial age of 20 months, were divided into 18 heifers and 18 steers in growing and finishing stages, with average initial weight of 370kg and 330kg for steers and heifers, respectively. The experiment was carried in accordance with the ethical principles for animal experimentation (Protocol 35/2011) determined by the Ethics Committee on Animal Use of the.

The design was a randomized block with three replicates (paddock) in a 2 x 2 factorial, with two categories of beef cattle (steers and heifers) and two herbage allowance (average of 7kg DM 100⁻¹kg BW and high, with 13kg DM 100⁻¹kg BW), distributed in four treatments. The experiment was 3 animals for paddock, totaling 9 animals per treatment. The paddocks size were 1,7ha.

The experimental period was 140 days (08/07 to 25/11/2011), divided into five periods of 28 days. The percentage of concentrated supplement ingredients provided for animals was 48.8% soybean hulls, 30.2% citrus pulp, 17% soybean meal, 2.0% mineral supplement and 2% urea (percentages are expressed on dry matter) with 22% crude protein and 74.5% total digestible nutrients. The nutritive value analyzes of the forage were evaluated for grazing simulation, every 28 days, according to the method proposed by Sollenberger and Cherney (1995). The determination of the neutral detergent fiber (NDF) and the acid detergent fiber (ADF) was followed the methodology proposed for Van Soest (1994) and crude protein according (CP) Silva and Queiroz *et al.* (2002). The average values in the experimental period of NDF were 71.79 and 70.30%, and FDA 33.83 and 32.51,

Performance, carcass...

respectively, for medium and high herbage allowance.

The percentage of crude protein of the forage in the experimental period was 5.9% and the supplement was calculated to supplied the expected performance of 0.7kg/day, based on supplementation of 0.8% of body weight. Diets were formulated by Supercrac 4.7 for beef cattle and based on the Nutrient (1996). The adaption period of the animal was two weeks for the supplement, initially receiving 1.5kg of concentrate per animal, increasing it gradually until reaching 0.8% of body weight. The supplements were provided daily between 11a.m. and 1p.m., trying not to change the behavior and grazing cycles. The supplement intake was restricted according to the animal weight, adjusted every 28 days after weighing.

The grazing method was the continuous stocking with stocking rate adjustment to maintain the herbage allowance required in each experimental unit. The pasture used was *Urochloa brizantha* cv. Marandu and the dry mass of average total forage recorded during the experimental period was 4,278 and 5,207kg DM/ha for medium and high herbage allowance, respectively.

The average daily weight gain was calculated by the difference between the initial and final weights divided by the number of experiment days. At the end of the experiment, the animals were slaughtered at a commercial slaughterhouse after solid fasting (16 hours). At slaughter, carcasses were identified, weighed and refrigerated for 24 hours at a temperature of 0°C. After 24 hours, the carcass was weighed and the carcass dressing, hindquarter, and forequarter yields were calculated.

Samples were collected from the *Longissimus thoracis* muscle for subsequent laboratory analysis. The determinations of ribeye area, fat thickness and marbling score were measured between the 12th and 13th ribs, after cooling the carcass according to the methodology described by United (Official..., 1997).

The meat color was determined in *Longissimus thoracis* muscle between the 12th and 13th ribs, by reading at three different points in muscle using the Minolta colorimeter CR- 400 Chroma Meter model. The CIELAB system has been considered, according to the methodology described by Honikel (1998).

The shear force was evaluated in the *Longissimus thoracis* muscle between the 12th and 13th ribs and the assessment was done by a texturometer TAXT - Plus Texture Analyser 2i, equipped with Warner-Bratzler device. The device descent speed was 20cm/min (Research..., 1995). The analyzes of shear force and color were made in the laboratory of the Department of Economics, Sociology and Technology (DEST), Faculty of Agricultural Sciences of the São Paulo State University "Julio de Mesquita Filho" (UNESP), *Campus* of Botucatu/SP.

The chemical composition, was used the *Longissimus thoracis* muscle between 11th to 12th ribs; the analysis was conducted in analyzes was: moisture, protein, ether extract and ash, according to the method recommended by the Association (Official..., 1990). The meat pH was determined in the *Longissimus thoracis* muscle, between the 11th and 12th ribs, after 24 hours of cooling.

The data were analyzed using the software SAS 9.2 (2008) for the analysis of variance (F test). Because interactions (categories x herbage allowance) were not detected, the results are reported as least square means and according to categories and herbage allowance. Differences were considered significant if $P < 0.05$.

RESULTS

The performance parameters and carcass traits are shown in Tab. 1, interaction between the animal category and herbage allowance was not found ($P > 0.05$), thus the results were presented separately and demonstrating that the categories studied did not show differences in these parameters for different forage levels.

Table 1. Performance and carcass traits of two cattle categories finished on pasture during the dry season supplementation in different herbage allowance

Item	Category			Herbage allowance		
	Steers	Heifers	CV ³ (%)	Medium	High	CV ³ (%)
Final Weight (kg)	450.8 ^A	382.7 ^B	3.71	408.7 ^A	424.8 ^A	9.32
ADG ¹ (g/day)	649.0 ^A	476.0 ^B	18.02	510.0 ^B	615.0 ^A	22.51
HCW (%) ²	244.5 ^A	205.3 ^B	4.56	220.5 ^A	229.3 ^A	10.34
Carcass yield (%)	53.3 ^A	52.8 ^A	1.82	53.2 ^A	52.9 ^A	1.88
Hindquarter yield (%)	60.5 ^A	62.0 ^B	1.14	61.1 ^A	61.3 ^A	1.82
Forequarter yield (%)	39.5 ^B	37.9 ^A	1.80	38.8 ^A	38.6 ^A	2.87
Ribeye area (cm ²)	65.7 ^A	59.6 ^A	9.02	64.0 ^A	61.3 ^A	10.24
Backfat thickness (mm)	4.1 ^A	3.8 ^A	40.76	3.7 ^A	4.1 ^A	40.65
Marbling Score	2.5 ^A	2.0 ^A	17.21	2.2 ^A	2.3 ^A	20.69

¹ADG= Average daily gain.²HCW= Hot Carcass weight.³CV= Coefficient of variation.^{A, B}Least square means in the same row with superscripts differ at P<0.05.

Regarding animal categories, the steers had higher final weight, daily weight gain, hot carcass weight and forequarter yield compared to heifers (P<0.05). Only the hindquarter yield was higher in heifers compared to steers (P<0.05). No significant differences were observed in carcass yield, ribeye area, and backfat thickness between animal categories (P>0.05). There was a statistical difference for the average daily gain

and animals subjected to high level had higher mean values compared with animals of the medium level (P<0.05) regarding herbage allowance.

There was no interaction between the animal category and herbage allowance for the meat quality parameters (P>0.05) and the data were shown separately in Tab. 2 and 3.

Table 2. Chemical composition of *Longissimus thoracis* muscle of two cattle categories finished on pasture during the dry season with supplementation in different herbage allowance

Item	Category			Herbage allowance		
	Steers	Heifers	CV ¹ (%)	Medium	High	CV ¹ (%)
Moisture (%)	74.30 ^A	75.15 ^A	1.06	74.41 ^A	75.04 ^A	1.14
Protein (%)	24.06 ^A	23.04 ^A	6.28	24.67 ^A	22.44 ^B	4.26
Ether extract (%)	1.82 ^A	1.50 ^A	19.28	1.46 ^B	1.86 ^A	17.59
Ash (%)	1.16 ^A	1.15 ^A	1.92	1.15 ^A	1.15 ^A	1.97

¹CV= Coefficient of variation.^{A, B}Least square means in the same row with superscripts differ at P<0.05.

No significant differences were observed between meat chemical composition in different animal categories (P>0.05). The meat of animals submitted to the medium herbage allowance showed greater protein and ether extract

percentage compared to animals on high herbage allowance (P<0.05). The moisture and ash content of the meat did not differ between the allowance (P>0.05) (Tab. 2).

Table 3. Shear force, cooking loss, pH and color of *Longissimus thoracis* muscle of two cattle categories finished on pasture with supplementation during the dry season in different herbage allowance

Item	Category			Herbage allowance		
	Steers	Heifers	CV ³ (%)	Medium	High	CV ³ (%)
WBSF ¹ (kgf)	5.68 ^A	6.50 ^A	15.87	6.03 ^A	6.16 ^A	17.48
Cooking loss (g)	20.32 ^A	21.85 ^A	12.22	20.86 ^A	21.30 ^A	12.80
pH	5.76 ^A	5.71 ^A	2.22	5.65 ^B	5.82 ^A	1.14
L* ²	35.15 ^A	34.06 ^A	6.40	34.26 ^A	34.96 ^A	6.54
a* ²	19.08 ^A	18.03 ^A	8.73	18.59 ^A	18.51 ^A	9.26
b* ²	8.72 ^A	8.26 ^A	14.17	8.45 ^A	8.53 ^A	14.47

¹WBSF= Warner-Bratzler shear force.

²L*= Lightness; a*= Redness; b*= Yellowness.

³CV = Coefficient of variation.

^{A, B} Least square means in the same row with superscripts differ at P<0.05.

The shear force parameters, cooking loss, pH and color of the meat measured by for a*, b* and L* were not different between the animal categories (P>0.05). In the herbage allowance, the meat pH of animals in high herbage allowance were higher compared to medium allowance (P<0.05). For the other parameters of meat quality, no significant differences between the two herbage allowances were observed (P>0.05), as shown in Tab. 3.

DISCUSSION

Performance data shows that the heifers had lower final weight compared to steers, this fact occurred due the lower initial weight and less weight gain in that category which also resulted in lower hot carcass weight. The low weight gain can be justified because heifers reach maturity earlier (in weight and age) decreasing muscle growth and favoring fat deposition earlier than steers, making this category less efficient in weight gain (Berg and Butterfield, 1976). The lower performance of heifers compared to steers was also evidenced by Vaz *et al.* (2010) that evaluated these two categories of cattle with initial average weight of 184.8 and 183.2kg, respectively, and observed differences in final weight (365.8kg in steers and 310.3kg in heifers) and hot carcass weight (203.4kg in steers and 168.6kg in heifers), fact explained by Di Marco (1993) as a reflection of higher growth caused by androgenic hormones, principally testosterone,

present in high amount in males. Although the steers of this study have been castrated, there is yet production of testosterone by the adrenal glands, which were possibly responsible for higher performance in this category.

Regarding the forage levels, the animals exhibit greater weight when subjected to high level, showing that the weight gain of the animals supplemented with concentrates during the dry period is directly related to the amount of herbage allowance provided. The high forage supply increased the weight gain due to the greater forage mass, which allowed increase in the consumption and better selectivity of the forage consumed, furthermore the lower levels of NDF and ADF (71.79 and 70.30%, and ADF 33.83 and 32.51, respectively, for medium and high herbage allowance) and superior crude protein (6.04% e 5.76%, respectively for medium and high herbage allowance), resulting in higher nutrient consumption. According Bortolo *et al.* (2001) that the herbage allowance affects directly the energy consumption, which can affect performance. This statement was proven in this study where in animals submitted to the high herbage allowance consumed more, being this fact evidenced by higher average daily gain.

Regarding carcass characteristics, the steers had higher hot carcass weight and forequarter yield compared to the heifers. However, the hindquarter yield was lower, possibly due these

animals were castrated with approximately 19 months old, which favored the sexual dimorphism and the muscle hypertrophy of forequarter and consequently the higher forequarter yield and lower hindquarter. The carcass yield, ribeye area, backfat thickness and marbling score did not differ between animal categories and between herbage allowances.

Regarding the carcass yield, the data were similar when comparing previous literature with animals subjected to the same conditions, 53.7% found by Barbero *et al.* (2017), respectively. The ribeye area can be used as an indicator trait of carcass composition associated with muscularity and yield of high value-added cuts (Baldassini *et al.*, 2017). Borges *et al.* (2014) observed ribeye area of 65.62cm², in Nelore cattle similar value to the results obtained in this paper.

Carcasses with adequate backfat thickness decrease the effects of the cold shortening caused by cooling, which reduced meat tenderness (Felício, 1998). The animals of the present study had adequate back fat thickness to avoid the cold shortening (Tab. 1). Intramuscular fat was classified with marbling traces and this low score is related to the breed used, Zebu animals usually have meat with low marbling compared with British breeds.

On the chemical composition analysis of steers meat and heifers significant differences were not observed in moisture, protein, ether extract and ash. However, in herbage allowance, protein and lipid contents were different, the medium level showed higher protein content and lower lipids content and the high level resulted in a higher lipids content and lower protein content. This lower protein percentage in *Longissimus thoracis* muscle can be explained by the greater availability of forage in this treatment and consequently greater energy density of diet, which favored the greater deposition of fat, reducing the protein content. However, the amount of protein observed in the study is in agreement with Fidelis *et al.* (2017) that found values of the 23,5% in Nelore bulls.

The parameters that evaluated for meat quality characteristics were not different between categories and between herbage allowances, except the pH of *Longissimus thoracis* muscle from animals subjected to high herbage

allowance level, which were lower than medium level. Therefore, the results of this study are according to regulations of the European Union, Circular No. 192 (Brasil, 1998), in which that carcasses with pH above 5.9 should be disqualified for export, therefore, the values found are within the pH required for export.

Rodas-Gonzalez *et al.* (2009) affirmed that for customer panelists, steaks with a Warner-Bratzler shear values less than 4.09kgf would produce a customer satisfaction as high as 81%. This suggests that 4.09kgf can be considered as the tenderness threshold (segregate tough to tender) thus, the animals of this paper had meat with shear force above the recommended by the author, which can be explained due the cattle was finished on pasture. Robinson *et al.* (2001), reported that pasture finished cattle has less tender than feedlot finished cattle. Another factor that may be related to shear force values is marbling, according to Li *et al.* (2006), is that high values of marbling reduce the cooking loss, inhibit shortening of muscle fibers, increasing the softness of meat. In this context, the greater shear force and high cooking loss content this study are also due to little marbling present in the meat.

Muchenjea *et al.* (2009) in a review about meat color, described that in beef, the average of lightness vary from 33.2 to 41.0, the average a* is between 11.1 to 23.6 and the average b* is between 6.1 and 11.3. Thus, the average values for the meat color into the treatments of this study were within the standards proposed by Muchenjea *et al.* (2009) and suitable for human intake.

CONCLUSION

Animal categories and herbage allowance influence animal performance, males showed higher performance. Thus, this category showed the highest weight of hot carcass, but the meat characteristics did not change, except for proteins, ether extract and pH. The animals submitted to high herbage allowance, which showed decrease in protein content and increase of ether extract and pH. However, for all parameters, the meat of these animals may be considered suitable for consumers.

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