Acta Scientiarum. Animal Sciences
ISSN: 1806-2636
eduem@uem.br
Universidade Estadual de Maringá
Brasil

Rezende, Pedro Leonardo de Paula; Restle, João; Padua, João Teodoro; Fernandes, Juliano José de Resende; Lino, Fabíola Alves; Guimarães, Tiago Pereira

Carcass morphometry of crossbred steers subjected to different nutritional strategies in the growing and finishing phases

Acta Scientiarum. Animal Sciences, vol. 35, núm. 2, abril-junio, 2013, pp. 187-192
Universidade Estadual de Maringá
.png, Brasil

Available in: http://www.redalyc.org/articulo.oa?id=303128120011

- How to cite
- Complete issue
- More information about this article
- Journal's homepage in redalyc.org

redalyc.org
Scientific Information System
Network of Scientific Journals from Latin America, the Caribbean, Spain and Portugal
Non-profit academic project, developed under the open access initiative

Acta Scientiarum

http://www.uem.br/acta
ISSN printed: 1806-2636
ISSN on-line: 1807-8672
Doi: 10.4025/actascianimsci.v35i2.17904

Carcass morphometry of crossbred steers subjected to different nutritional strategies in the growing and finishing phases

Pedro Leonardo de Paula Rezende[1*], João Restle[2], João Teodoro Padua[1], Juliano José de Resende Fernandes[1], Fabíola Alves Lino[1] and Tiago Pereira Guimarães[1]

*[1]Departamento de Produção Animal, Escola de Veterinária e Zootecnia, Universidade Federal de Goiás, Campus Samambaia, 131, 74001-970, Goiânia, Goiás, Brazil. [2]Escola de Medicina Veterinária e Zootecnia, Universidade Federal do Tocantins, Araguaína, Tocantins, Brazil. *Auhtor for correspondence. E-mail: pedrozootec@hotmail.com*

ABSTRACT. The present study aimed to evaluate the effects of different nutritional strategies in growing and finishing phases on the carcass morphometry of 24 crossbred steers, ½ Holstein/Zebu, slaughtered at 15 months of age and 395.0kg live weight. In the growing phase, animals were maintained grazing on *Brachiaria brizantha*, receiving two levels of energy supplementation in quantities equivalent to 0.5 or 1.0% live weight. Then, animals were finished in feedlot receiving diets composed of 50 or 80% concentrate. The percentage of primary cuts was not influenced by feed levels in the growing and finish phases. The high supplementation level in the growing phase resulted in a higher ($p < 0.05$) carcass length (134.48 *vs*. 131.43 cm). The food levels did not influence the conformation of the carcasses, however the highest level in the growing and finishing phases resulted in a higher ($p < 0.05$) cushion thickness (23.46 *vs* 21.26 cm). It was found a significant interaction between feeding levels in the different phases for the leg length and arm perimeter with increase of 14.78 and 4.80%, respectively for animals given high energy levels in both phases. The high feeding level in the growing phase was more attractive owing the positive effects on some important measures of carcass, especially in the length.

Keywords: arm perimeter, conformation, carcass length, cushions thickness, energy, supplementation.

Morfometria da carcaça de novilhos mestiços submetidos a diferentes estratégias nutricionais na recria e terminação

RESUMO. Objetivou-se avaliar os efeitos de diferentes estratégias nutricionais na recria e terminação sobre a morfometria da carcaça de 24 bovinos mestiços ½ Holandês/Zebu, abatidos aos 15 meses de idade com 395,0kg de peso vivo. Na fase de recria os animais foram mantidos em pastagem de Brachiaria *brizantha* recebendo dois níveis de suplementação energética em quantidade equivalente a 0,5 ou 1,0% do peso vivo. Posteriormente, os animais foram terminados em confinamento com dietas compostas por 50 ou 80% de concentrado. Os percentuais dos cortes primários não foram influenciados pelos efeitos estudados. O nível alto de suplementação na recria proporcionou maior ($p < 0,05$) comprimento de carcaça (134,48 *vs* 131,43 cm). Os níveis alimentares não influenciaram a conformação das carcaças, entretanto o maior nível de suplementação na recria e de concentrado na terminação proporcionaram maior ($p < 0,05$) espessura de coxão (23.46 *vs* 21.26 cm). Constatou-se interação significativa entre níveis alimentares nas diferentes fases para o comprimento de perna e perímetro de braço com aumento de 14,78 e 4,80%, respectivamente, em favor dos animais que receberam alto nível de alimentação em ambas as fases. O nível alimentar alto na recria mostrou-se tecnicamente melhor pelos seus efeitos positivos sobre algumas medidas importantes da carcaça, notadamente o comprimento.

Palavras-chave: perímetro de braço, conformação, comprimento da carcaça, espessura de coxão, energia, suplementação.

Introduction

The State of Goiás has the fourth largest herd of dairy cattle in the country (IBGE, 2012) and it is estimated that about 5 million male calves from the dairy herd are born every year, usually of Holstein/Gir crossbred. In most cases, this category represents a problem for the producer, because they need to ingest significant amounts of milk (4 to 6 kg day^{-1}) in the beginning of their development.

Many of the 7.5 million male calves from the dairy herds born every year in Brazil (ANUALPEC, 2012) are slaughtered in the first few days of life or sold for irrelevant prices. When these animals remain on the farms, they are generally raised under poor feed, which leads to mortality rates of approximately 20% and results in slow development, affecting carcass production.

The reduction in the slaughter age of beef cattle by using appropriate strategies of feeding in the different phases of life results in the improvement of meat quality, particularly in the tenderness (VAZ; RESTLE, 2003), as well as in higher proportion of carcass muscle (MÜLLER; PRIMO, 1986). Besides, the reduction in the slaughter age is related to a production system of technical and biological efficiency based on the composition of weight gain of young animals during the growth phase (RESTLE et al., 1999). In this phase, the body growth occurs as a function of hypertrophy of bones and muscular tissues, which require less energy to develop (BERG; BUTTERFIELD, 1979). According to Rezende et al. (2012), it is possible to improve the meat quality of crossbred dairy steers, mainly the color and the tenderness through feeding strategies.

The development after the onset of the animal growth affects the carcass morphometry. According to Vaz and Restle (2003) and Vaz et al. (2004), animals with lower weight gain, before seven months of age, presented carcass with lower percentage of special hindquarter cut.

This study evaluated the effects of different feeding plans on the carcass morphometry of crossbred dairy cattle according to the levels of energy ingestion during the growing and finishing phases.

Material and methods

The experiment was carried out from February to December 2008 at the farm school, Department of Animal Production of the Federal University of Goiás, located in Goiânia, Goiás State, Brazil, with 721-m of elevation, at the latitude 16º 35' South and longitude 49º 17' West.

The study was conducted to evaluate the carcass morphometry of 24 crossbred steers, ½Holstein/Zebu, from dairy cattle. The animals were taken from the same dairy herd. During the growing phase, between six and eleven months of age, the animals were maintained under rotational grazing on Brachiaria *brizantha*, in 17 plots of 2.4 hectares, changing the rotation when the grazing height was lower than 20 cm. In this phase the animals received two levels of energy supplementation, corresponding to 0.5 and 1.0% live weight. In such phase, the supplement was composed of ground corn grains added with a blend of minerals and formulated according to NRC (1996). After this period, between 11 and 15 months of age, the animals were finished in individual feedlot. They were fed with isonitrogen diets of medium (M) and high (H) energetic density due to the inclusion of concentrate, between 50 and 80%, in the dry matter (DM) of the total diet, resulting in four feeding strategies:

Diet with high energy level from growing to finishing phase.

Diet with medium energy level in the growing phase and high energy level in the finishing phase.

Diet with high energy level in the growing phase and medium energy level in the finishing phase.

Diet with medium energy level in both growing and finishing phases.

In feedlot, the animals were previously adapted to the diets (Table 1) and to the facilities before beginning the trial for 14 days and fed daily at 8 a.m. and 5 p.m.

Table 1. Chemical composition and percentage of ingredients on dry matter basis of experimental diets during the feedlot finishing phase.

% Nutrients	Concentrate		Roughage	Total Diet	
	50%	80%		50%	80%
DM	85.90	85.75	25.56	55.73	79.75
CP	24.77	17.91	7.63	16.20	16.57
NDF	13.69	13.38	59.20	36.44	17.99
ADF	7.14	4.60	38.60	22.87	8.26
EE	2.63	2.21	1.90	2.27	2.22
ASH	7.45	4.45	3.81	5.63	4.68
TDN*	-	-	-	69.00	80.00
	Concentrate Level in feedlot diet				
Ingredients,%	50%			80%	
Sorghum silage	50.0			20.0	
Ground corn	29.0			66.4	
Soybean meal	18.5			11.6	
Urea	0.50			0.40	
Mineral/ionophores**	2.0			1.6	

DM (dry matter); CP (crude protein); NDF (neutral detergent fiber); ADF (acid detergent fiber); EE (ether extract); *Estimated; **Phosphate 13.56%; Calcite 50.53%; Micro-mineral nucleus 9.86%; Salt 24.65%; Virginiamycin 0.81%; Ionophore 0.59%.

The expected slaughter weight of 395 kg was achieved in 84, 105, 126 and 126 days of feedlot for the strategies 1, 2, 3 and 4, respectively. Animals were weighed after fasting for 12 hours, shortly before the shipment of animals to the slaughterhouse, inspected by the Federal Inspection Service (SIF).

The conformation and physiological maturity evaluations of carcasses were carried out according to the methodology described by Müller (1987) through subjective evaluation, following a scale of 18 points, in which a higher value indicates a better conformation. The weight of primary cuts (hindquarter, forequarter and side cut) was taken from the right half of the carcass and the percentage was expressed at the ratio of weight of cold carcass. The hindquarter comprises the posterior region of the carcass, separated from the forequarter by the 5 and 6^{th} ribs and from the side cut by a distance of approximately 22 cm from the spine. The forequarter includes the neck, shoulder, arm and five ribs. The side cut encompasses the ribs from the 6^{th} rib, separated for approximately 22 cm from the spine, and abdominal muscles.

The following measures were obtained from the right-half of the carcass: carcass length (using a measuring tape from the cranial border of the middle portion of the first rib to the cranial border of the pubic bone), leg length (from the pubic bone to the tibiotarsal joint), cushion thickness (measured with a caliper, placing one end at the external part of the inner round and the other end on the external part of the leg), and arm length and perimeter (using a measuring tape from the olecranon tuberosity to the distal end of the humerus, involving the muscles that cover the region).

The experimental design was completely randomized in a 2 x 2 factorial arrangement, with two levels of energy supplementation in the growing phase and two levels of concentrate in the diet for the feedlot finishing phase. In the analysis of variance, for all the parameters studied, every animal constituted an experimental unit. The differences between mean values were detected by *t*-test at 5% probability using the following mathematical model:

$$Y_{ijk} = \mu + a_{i(1;2)} + b_{j(1,2)} + (a*b)_{ij} + E_{ijk}$$

where:

Y_{ijk} = observations on the dependent variable corresponding to the supplementation level in the growing phase of order i and concentrate level in the finishing phase in feedlot of order j and repetition k; μ = average of all observations; a_i = effect of supplementation level of order i, being 1 = 0.5% LW and 2 = 1.0% LW; b_j = effect of concentrate level in the finishing phase of order j, being 1 = 50% DM and 2 = 80% DM; (a*b) = effect of interaction between the supplementation level in the growing phase of order i and the concentrate level in the finishing phase of order j; E_{ik} = experimental error relative to the observation of supplementation level in the growing phase of order i, concentrate level in the finishing phase of order j and repetition k. The normality of data distribution was tested by Shapiro-Wilk test (SAS, 2002).

Results and discussion

The percentage of forequarter and hindquarter relative to the weight of cold carcass was not affected ($p > 0.05$) by the effects studied with averages ranging from 38.85 to 38.33% and from 48.16 to 47.68%, respectively, showing that the animals presented a proportional growth rate in the different feeding strategies. The interaction ($p < 0.05$) was verified between the nutritional levels in the different phases for the side cut percentage. The animals that previously received supplementation in the growing phase equivalent to 1% LW, combined with 50% of concentrate in the diet in the feedlot finishing phase, presented higher percentage of side cut ($p < 0.05$) compared with animals given high nutritional level in both phases (Table 2).

Table 2. Mean values and standard error for yield of primary cuts according to the level of supplementation in the growing phase and according to the level of concentrate in the finishing phase.

Supplementation in the growing phase (%LW)	Concentrate level in the finishing phase, %		Mean
	Forequarter, %		
	80	50	
1.0	39.32 ± 35	38.16 ± 38	38.74 ± 26
0.5	38.39 ± 38	38.51 ± 35	38.45 ± 26
Average	38.85 ± 26	38.33 ± 26	
	Hindquarter, %		
1.0	48.35 ± 51	47.78 ± 57	48.06 ± 38
0.5	47.98 ± 56	47.59 ± 52	47.78 ± 38
Average	48.16 ± 38	47.68 ± 38	
	Side cut, %		
1.0	12.22 [B] ± 31	13.41 [A] ± 35	12.81 ± 23
0.5	12.92 [AB] ± 35	12.69 [AB] ±31	12.80 ± 23
Average	12.57 ± 23	13.05 ± 23	

[A,B]Means followed by different letters for each characteristic are significantly different by *t*-test ($p < 0.05$).

Kabeya et al. (2002) studied crossbred steers; Holstein/Zebu crossbred, subjected to different feeding plans, and verified higher yields for hindquarter and similar yields for forequarter and side cut. These authors did not observe effect of the feeding level on the proportion of primary cuts, and they observed mean values of 39.30, 60.90 and 13.36 kg for forequarter, hindquarter and side cut, respectively. However, it is remarkable that the animals were slaughtered with the mean weight of 440 kg, higher than the weight for the present study. Ferreira et al. (2000) examined Simenthal/Nellore steers with concentrate levels of 25.0, 37.5, 50.0, 62.5 and 75.0%, observing similarity between primary cuts of carcasses as a function of the concentrate level in the diet.

Similar percentages of primary cuts were found by Alves et al. (2004) studying the carcass characteristics of Zebu cattle and Holstein/Zebu crossbred in the growing and finishing phases with average yields of 38.89, 48.35 and 12.75 for forequarter, hindquarter and side cut, respectively.

The results obtained in the present study are in line with Berg and Butterfield (1979) who stated that, under normal conditions, the animals tend to show balance between the forequarter and hindquarter; thus, the animals that present higher weight in the posterior quarter of the body also present higher weight in the anterior quarter, whereas side cut shows a greater variability.

The physiological maturity (PM) was not affected by the studied effects (Table 3). The values ranged from 13.5 to 14.0 points, which was expected considering the similar slaughter age (15 months). According to this methodology of evaluation (MÜLLER, 1987), the lowest values for a scale of 1-15 points indicate a more advanced physiological maturity. The animals given medium level of supplementation in the growing phase were slaughtered 31 days after other animals, which did not result in significant differences for the evaluation.

According to Shahin and Berg (1985), the cattle can be classified as: small animals or at early physiological maturity, medium or at intermediate physiological maturity and large size or at late physiological maturity. This classification considers the maturity and the body weight and is related to the body development, and the sexual and physiological maturity. Thus, according to maturity, the classification is not related to the weight gain rate, but to a genetic group of mean weight in which the process begins.

Table 3. Mean values and standard error of conformation, physiological maturity according to the supplementation level in the growing phase and to the concentrate level in the finishing phase.

Supplementation in the growing phase (%LW)	Concentrate level in the finishing phase, %		Mean
	80	50	
	Conformation (points)		
1.0	10.35 ± 31	10.74 ± 34	10.55 ± 23
0.5	10.74 ± 34	9.86 ± 31	10.12 ± 23
Average	10.37 ± 23	10.30 ± 23	
	Physiological maturity (points)		
1.0	13.49 ± 23	13.61 ± 26	13.55 ± 17
0.5	13.60 ± 26	13.99 ± 23	13.79 ± 17
Average	13.54 ± 17	13.80 ± 17	

The score of carcass conformation (Table 3) varied from 9.8 to 10.8 points, and the nutritional levels in the different phases had no effect ($p > 0.05$) on this parameter. According to Müller (1987), the subjective evaluation of conformation estimates the muscular expression level of carcass. Carcasses with better conformation are preferred by slaughterhouses, due to their association with a greater muscular hypertrophy and a higher yield of meat when deboning carcasses (SANTOS et al., 2008). Rodrigues et al. (2008) evaluated the carcass conformation of crossbred steers, Holstein/Zebu, through the same methodology, and verified the lack of effect of diet energy levels on this parameter.

Brondani et al. (2004) studied the quantitative aspects for the carcasses of cattle fed with different energy levels in feedlot finishing, and found that animals given the highest energy level had better carcass conformation (10.8 vs. 10.5 points). The authors also showed that this variable is associated with the amount of muscle in the carcass ($r = 0.89$, $p < 0.0033$) and the arm perimeter ($r = 0.92$, $p < 0.0011$). Similar values were also described by Costa et al. (2002), recording 10.3 points for animals of similar age, fed with 44% concentrate.

Caplis et al. (2005) investigated the effects of the concentrate level on the carcass characteristics of steers, registering an increase in the conformation with the concentrate level and linear and quadratic effects were significant. The authors explained the results based on the concomitant increase in the live weight at slaughter, increasing the concentrate level. Costa et al. (2002) found positive correlations between the slaughter weight and the conformation. Such a correlation did not occur in the present study because all the animals were slaughtered with similar weight.

The cushion thickness (CT) was influenced separately by the level of supplementation in the growing phase and by the level of concentrate in the finishing phase (Table 4). Animals given high nutritional levels in both phases showed higher CT ($p < 0.05$) (23.5 vs 21.0 in the growing and

23.8 vs 21.3 in the finishing). Significant interaction ($p < 0.05$) between the nutritional levels in the different phases was found for the arm perimeter (AP). Animals given high nutritional levels in the growing phase associated with higher concentrate level in the finishing (HH) presented higher AP (36.0 cm) than the other treatments.

The carcass length (CL) was affected ($p < 0.05$) by the level of supplementation in the growing phase (Table 4).

Higher level in the growing period produced greater length of carcass (CL) (134.5 *vs* 131.4 cm). Caplis et al. (2005) studying the effects of the concentrate level on carcass characteristics of steers, and found that the carcass length tended to linearly increase ($p < 0.07$) with increased concentrate level. Significant interaction ($p < 0.05$) between the nutritional levels in the different phases was found for the leg length (LL). Animals given medium supplementation level in the growing phase and high concentrate level in the finishing phase presented smaller leg length ($p < 0.05$). In the study of Caplis et al. (2005), the leg length and width were not significantly affected by the concentrate level; but, both leg circumference and thickness increased with increased concentrate level, with linear and quadratic effects being significant for both.

Table 4. Mean values and standard error of carcass and objective measures according to the supplementation level in the growing phase and to the concentrate level in the finishing phase.

Supplementa-tion in the growing phase (%LW)	Concentrate level in the finishing phase, %		Mean
	80	50	
	Carcass length, cm		
1.0	133.33 ± 1.32	135.64 ± 1.45	134.48^{A} ± 0.98
0.5	131.49 ± 1.45	131.37 ± 1.32	131.43^{B} ± 0.98
Mean	132.41 ± 98	133.51 ± 98	
	Leg length, cm		
1.0	69.87^{A} ± 1.24	68.96^{A} ± 1.35	69.41 ± 0.92
0.5	60.87^{B} ± 1.36	67.25^{A} ± 1.24	64.06 ± 0.92
Mean	65.37 ± 92	68.11 ± 92	
	Arm length, cm		
1.0	39.57 ± 49	38.75 ± 53	39.16 ± 0.36
0.5	38.15 ± 54	39.50 ± 49	38.83 ± 0.36
Mean	38.86 ± 36	39.12 ± 36	
	Arm perimeter, cm		
1.0	36.01^{A} ± 42	33.69^{B} ± 46	34.85 ± 31
0.5	34.54^{B} ± 46	34.87^{B} ± 42	34.70 ± 31
Mean	35.27 ± 31	34.28 ± 31	
	Cushion thickness, cm		
1.0	25.34 ± 74	22.18 ± 81	23.46^{A} ± 55
0.5	21.59 ± 81	20.34 ±74	20.96^{B} ± 55
Mean	23.76^{A} ± 55	21.26^{B} ± 55	

^{A,B}Mean values followed by different letters are significantly different by *t*-test ($p < 0.05$).

According to Restle et al. (1999), the linear objective measures such as CL are related to the bone growth of the animal, which occurs more intensely during the first months of age, and in the present study occurred during the supplementation on the pasture. The perimeter measures are associated with the muscle development which occurs in all phases of the animal life to achieve maturity. Thus, probably higher availability of net energy for growth coming from the higher supplementation level in the growing period and/or of concentrate in the finishing period favored the bone and the muscle development, resulting in greater CL and LL as well as CT. By studying the physical development of crossbred steers on the pasture, at different levels of supplementation, Rezende et al. (2011) found higher body growth for animals fed diets of higher energy density. In a study, Santos et al. (2008) associated lower muscular development for two-years-old steers with lower growth in the growing phase, which occurred before the feedlot finishing phase.

Conclusion

The high supplementation level in the growing phase of dairy crossbred cattle is technically attractive due to positive effects on some important carcass characteristics, producing higher carcass length. The high level of concentrate in the finishing phase produced higher cushion thickness and arm perimeter.

According to the results, it is possible to significantly improve the quantitative characteristics of carcass of dairy crossbred steers through adequate feeding strategies.

References

ALVES, D. D.; PAULINO, M. F.; BACKES, A. A.; VALADARES FILHO, S. C.; RENNÓ, L. N. Características de Carcaça de Bovinos Zebu e Cruzados Holandês-Zebu (F1) nas Fases de Recria e Terminação. **Revista Brasileira de Zootecnia**, v. 33, n. 5, p. 1274-1284, 2004.

ANUALPEC-Anuário da Pecuária Brasileira. 1. ed. São Paulo: Instituto FNP, 2012.

BERG, R. T.; BUTTERFIELD, R. M. **Nuevos conceptos sobre desarrollo de ganado vacuno**. Zaragoza: Acribia, 1979.

BRONDANI, I. L.; SAMPAIO, A. A. M.; RESTLE, J.; BERNARDES, R. A. L. C.; PACHECO, P. S.; FREITAS, A. K.; KUSS, F.; PEIXOTO, L. A. O. Aspectos quantitativos de carcaças de bovinos de diferentes raças, alimentados com diferentes níveis de energia. **Revista Brasileira de Zootecnia**, v. 33, n. 4, p. 978-988, 2004.

CAPLIS, J.; KEANE, M. G.; MOLONEY, A. P.; O'MARA, F. P. Effects of supplementary concentrate level with grass silage, and separate or total mixed rationfeeding, on performance and carcass traits of finishing steers. **Irish**

Journal of Agricultural and Food Research, v. 44, n. 3,
p. 27-43, 2005.

COSTA, E. C.; RESTLE, J.; VAZ, F. N.; FILHO, D. C. A.; BERNARDES, R. A. L. C.; KUSS, F. Características da carcaça de novilhos Red Angus superprecoces abatidos com diferentes pesos. **Revista Brasileira de Zootecnia**, v. 31, n. 1, p. 119-128, 2002.

FERREIRA, M. A.; VALADARES FILHO, S. C.; MUNIZ, E. B. Características das carcaças, biometria do trato gastrintestinal, tamanho dos órgãos internos e conteúdo gastrintestinal de bovinos F1 Simental x Nelore, alimentados com dietas contendo vários níveis de concentrado. **Revista Brasileira de Zootecnia**, v. 29, n. 4, p. 1174-1182, 2000.

IBGE-Instituto Brasileiro de Geografia e Estatística. **Produção da pecuária municipal**. Rio de Janeiro: IBGE, 2012. (v. 35, p. 1-62).

KABEYA, K. S.; PAULINO, M. F.; DETMANN, E.; FILHO, S. C. V.; CECON, P. R.; QUEIROZ, D. S.; JÚNIOR, P. G.; PEREIRA, O. G. Suplementação de novilhos mestiços em pastejo na época de transição água-seca: desempenho produtivo, características físicas de carcaça, consumo e parâmetros ruminais. **Revista Brasileira Zootecnia**, v. 31, n. 1, p. 213-222, 2002.

MÜLLER, L. **Normas para avaliação de carcaças e concurso de carcaças de novilhos**. 2. ed. Santa Maria: UFSM, 1987.

MÜLLER, L.; PRIMO, A. T. Influência do regime alimentar no crescimento e terminação de bovinos e na qualidade da carcaça. **Revista Brasileira de Zootecnia**, v. 21, n. 4, p. 445-453, 1986.

NRC-National Research Council. **Nutrient requirement of beef cattles**. 7th ed. Washington, D.C.: National Academy, 1996.

RESTLE, J.; VAZ, F. N.; PASCOAL, L. L.; SENNA, D. B.; VAZ, R. Z.; FEIJÓ, G. L. D. Efeito do desmame precoce na carcaça de novilhos terminados em pastagem e abatidos aos 24 meses. **Pesquisa Agropecuária Brasileira**, v. 34, n. 11, p. 2129-2136, 1999.

REZENDE, P. L. P.; RESTLE, J.; FERNANDES, J. J. R.; PADUA, J. T.; NETO, M. D. F.; ROCHA, F. M. Desempenho e desenvolvimento corporal de bovinos leiteiros mestiços submetidos a níveis de suplementação em pastagem de *Brachiaria brizantha*. **Ciência Rural**,
v. 41, n. 8, p. 1453-1458, 2011.

REZENDE, P. L. P.; RESTLE, J.; FERNANDES, J. J. R.; NETO, M. D. F.; PRADO, C. S.; PEREIRA, M. L. R. Carcass and meat characteristics of crossbred steers submitted to different nutritional strategies at growing and finishing phases. **Ciência Rural**, v. 42, n. 5, p. 875-881, 2012.

RODRIGUES, K.; ROSSI JUNIOR, P.; MOLETTA, J. Avaliação das características de carcaça de bovinos mestiços Purunã, alimentados com diferentes níveis de energia na dieta. **Archives of Veterinary Science**, v. 13, n. 4, p. 265-273, 2008.

SANTOS, A. P.; BRONDANI, I. L.; RESTLE, J.; MENEZES, L. F. G.; OLIVEIRA, L.; SILVEIRA, S. R. L. Características quantitativas da carcaça de novilhos jovens e superjovens com peso de abate similares. **Ciência Animal Brasileira**, v. 9, n. 2, p. 300-308, 2008.

SAS Institute. **SAS/STAT user's guide**: statistics. 6th ed. Version 8. Cary: SAS, 2002. v. 2.

SHAHIN, K. A.; BERG, R. T. Growth patterns of muscle, fat and carcass composition of double and normal cattle. **Canadian Journal of Animal Science**, v. 65, n. 2, p. 279-294, 1985.

VAZ, F. N.; RESTLE, J. Ganho de peso antes e após os sete meses no desenvolvimento e nas características de carcaça e da carne de novilhos Charolês abatidos aos dois anos. **Revista Brasileira de Zootecnia**, v. 32, n. 3, p. 699-708, 2003.

VAZ, F. N.; RESTLE, J.; VAZ, R. Z.; BRONDANI, I. L.; PÁDUA, J. T.; PACHECO, P. S.; SANTOS, A. P. Ganho de peso antes e após os sete meses no desenvolvimento e características quantitativas da carcaça de novilhos Nelore abatidos aos dois anos. **Revista Brasileira de Zootecnia**, v. 33, n. 4, p. 1029-1038, 2004.

Received on July 12, 2012.
Accepted on October 1, 2012.

License information: This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.