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Carcass Characteristics, Chemical Composition and Fatty Acid Profile of *Longissimus* Muscle of Bulls and Steers Finished in a Pasture System Bulls and Steers Finished in Pasture Systems

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ABSTRACT : This experiment was carried out to study the carcass characteristics, chemical composition and fatty acid profile of the *Longissimus* muscle (LM) of bulls (10) and steers (17) finished in a pasture system. Animals (1/2 Zebu vs. 1/2 Aberdeen Angus) were fed in a pasture system (*Hermatria altissima*) and with a supplement of soybean meal, cracked corn, urea, limestone and mineral salts, twice a day. Both animal groups were slaughtered at 27 months of age, with an average 508.88 kg of live weight. Final weight, hot carcass weight and texture were similar ($p>0.05$) between bulls and steers. Carcass dressing, fat thickness, color and marbling were higher ($p<0.02$) in steers. Conversely, the *Longissimus* area was greater ($p<0.05$) in bulls. Moisture levels were higher ($p<0.01$) in bulls. Ash, crude protein, total lipids and total cholesterol levels were higher ($p<0.10$) in steers. C14:0, C16:0, C16:1 *n*-7 and C18:1 *n*-9 fatty acids percentages were higher ($p<0.06$) in steers. C16-1 *n*-10, i 17:0, C19:0, C18:2 *n*-6, C18:3 *n*-3, C20:2 *n*-3 C20:4 *n*-6, C20:5 *n*-3, C22:1 *n*-7, C22:4 *n*-6 and C22:5 *n*-3 fatty acids percentages were higher ($p<0.05$) in bulls. The percentage of the other fatty acids was similar ($p>0.05$) in bulls and steers. The levels of monounsaturated fatty acids were higher ($p<0.02$) in steers while polyunsaturated fatty acids, *n*-3, *n*-6, PUFA/SFA and *n*6:*n*3 ratios, were higher ($p<0.05$) in bulls. The CLA contents (mg/g lipids) were similar ($p>0.10$) in bulls and steers. (**Key Words :** Beef, Bulls, Chemical Composition, CLA, *Longissimus* Muscle, Steers)

INTRODUCTION

Brazil has the largest commercial cattle herd in the world, with approximately 159 million animals and a production of approximately 8.2 million tons of carcass each year (Anualpec, 2007). From this total, about 30% (2.4 million tons) is exported to several countries around the world. Nevertheless, it will be essential that Brazil employs new technologies in order to increase production and improve meat quality, aiming to satisfy domestic and foreign demand, and thus consolidating current markets and gaining access to new ones.

Today, the food industry prefers to buy steers, because they have carcasses with higher fat deposits, as already indicated by fat thickness and marbling (Moreira et al., 2003). On the other hand, ranchers prefer to raise bulls because they grow faster (Fritsche and Steinhart, 1998). Emasculation alters the growth rate and the carcass characteristics due to modifications in hormonal status (Anderson et al., 1988; Lee et al., 1990; Hunt et al., 1991). Otherwise, the faster growth rate of bulls may be caused by the gradual increase of hormonal secretion along their growth period; it seems that this higher growth rate is caused by anabolic hormones produced by the testicles (Lee et al., 1990).

Additionally, some qualitative characteristics, like protein and fat ratios, are also influenced by steroid hormones (Gariépy et al., 1990). The management of bulls in an early-weaning system, using high energy diets,

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Table 1. Scale for marbling evaluation

Marbling	Plus	Mean	Minus	Marbling	Plus	Mean	Minus
Abundant	18	17	16	Small	9	8	7
Moderate	15	14	13	Light	6	5	4
Mean	12	11	10	Traces	3	2	1

Source: Müller (1980).

Table 2. Point scale evaluation for meat texture and color

Texture	Points	Color	Points
Very fine	5	Cherry red	5
Fine	4	Red	4
Slightly coarse	3	Slightly dark red	3
Coarse	2	Dark red	2
Very coarse	1	Dark	1

Source: Müller (1980).

enables early intramuscular deposits of fat, fast and efficient animal growth and the production of lean carcasses of high quality (Schoonmaker et al., 1999).

Fatty acid diversity is illustrated by the occurrence of iso and anti-iso acids, which are partly explained by biohydrogenation in the rumen (Tamminga and Doreau, 1991). *Longissimus* muscle (LM) of bulls has the highest content (Padre et al., 2006) of 18:1 t-11 (vaccenic acid), which is an important intermediary produced by microrganisms in the rumen. Fatty acids may also be transformed into CLA (18:2 *c*-9, *t*-11 - rumenic acid) in animal tissues (Bauman et al., 1999) shortly after their absorption, although the fatty acids usually found in bull and steer muscles are oleic, palmitic and stearic acids (Prado et al., 2003), which sometimes appear in unusual ratios due to emasculation effects. Analyzing the LM of crossbred Nellore bulls and steers finished on pastures, Ruiz et al. (2005) observed no difference either in palmitic acid levels of steers (26.58%) in comparison with bulls (25.13%) or in the levels of oleic acid, which appeared at 34.04% and 35.17%, respectively.

The objective of this work was to evaluate the effects of emasculation on the carcass characteristics, chemical composition and fatty acid profile in the *LM* of crossbred Zebu×Aberdeen Angus cattle with an average age of 27 months and finished in a pasture system.

MATERIAL AND METHODS

Animal management and sampling

The Committe of Animal Production at the State University of Maringá approved this experiment, which was carried out at the Experimental Farm of the Agronomic Institute of Paraná, in the city of Lapa, south Brazil.

Animals (1/2 Zebu×1/2 Aberdeen Angus) were fed in a pasture system (*Hermatria altissima*) and with one supplement consisting of soybean meal, cracked corn, urea, limestone and mineral salts twice a day. Both groups were fed with an appropriate diet following the NRC requirements for fattening of beef cattle (NRC, 1996). On slaughtering day, they were weighed after 12 hours fasting. On average, final weight of bulls and steers was 513.7 kg and 502.06 kg, respectively.

Carcass characteristics

The animals were slaughtered at a commercial slaughterhouse 100 km away from the Lapa Research Farm, following the usual practices of the Brazilian beef industry. Thereafter, the carcasses were identified and weighed before cooling at 4°C for 24 h. After cooling, the right part of the carcass was used to determine the quantitative characteristics. Twenty-four hours later, LM samples were taken by a complete cross-section between the 12th and 13th ribs. The fat thickness was discarded and the muscle portion was frozen at -20°C for further analyses.

Hot carcass weight : was determined before cooling. The percentage of individual animal dressing was defined by the ratio of hot carcass weight to live weight.

The *Longissimus* area at the right part of the carcass was measured after a transverse cut between the 12th and 13th ribs, using a compensating planimeter which measures the area of objects with irregular shapes.

Fat thickness (FT) : was taken by a caliper averaging three points between the 12th and 13th ribs but over the LM.

Marbling (MAR) : was measured in the *LM* between the 12th and 13th ribs following the scores in Table 1.

Texture (TXT) : was determined through the size of the fascicle (muscle "grain" size) and evaluated by a point scale for marbling (Table 2).

Color (COR) : means the muscle color after the cooling for 24 h (Table 2). Coloration was evaluated according to a point scale from 1-5 using a color table (Müller, 1980).

Chemical composition

Laboratory analyses of beef were carried out four months after sampling. The samples were thawed at 0°C, ground, homogenized and analyzed in triplicate.

Beef moisture and ash contents were determined according to AOAC (Cunniff, 1998). Crude protein content was obtained through the Kjeldahl method (Cunniff, 1998). Forage and beef total lipids were extracted by the Bligh and Dyer method (1959) with a chloroform/methanol mixture. Fatty acids methyl esters (FAME) were prepared by triacylglycerol methylation according to ISO method 5509 (1978). All reagents and solvents used in the analysis were

of analytical reagent quality and were purchased from Merck (Darmstadt, Germany).

Cholesterol analysis was carried out through direct saponification according to Al-Hasani et al. (1993). A 60% (w/v) solution of potassium hydroxide was added to the samples in quantities equivalent to 2 ml/g of sample and saponified under 1 h reflux. The residue was dissolved again in 2 ml hexane containing 0.2 mg/ml 5-alpha-cholestane internal standard (Sigma Chemical Co., St. Louis, MO, USA).

Chromatographic analysis and cholesterol quantification

Cholesterol content was analyzed in a 14-A gas chromatograph (Shimadzu, Japan), equipped with a flame ionization detector and a fused silica capillary column (25 m long, 0.25-mm internal diameter, and 0.20 μm Ohio Valley-30). Injector, column, and detector temperatures were 260, 280, and 280°C, respectively. Ultra-pure gas fluxes (White Martins) of 1.5 ml/min H_2 as carrier gas, 30 mL/min N_2 as make-up gas, 300 ml/min synthetic gas and 30 ml/min N_2 for flame were used. The sample injection split mode was: 1:150. Peak integration was carried out with a CG-300 computing integrator (CG Instruments, Brazil) and cholesterol was identified by comparison with standards from Sigma (USA). Sample cholesterol quantification was carried out after verification of method linearity. Standard cholesterol solutions (Sigma, USA) were prepared with concentrations 0.0; 0.4; 0.8; 1.6, and 2.0 mg/ml, all containing 0.20 mg/ml 5α-cholestane (Sigma, USA), and analyzed. The ratio of the areas of cholesterol and 5-α cholestane was plotted against the cholesterol concentration for injected volumes of 0.0; 2.0; 3.0; 4.0, and 5.0 μl. The curve obtained was used for cholesterol analysis in mg 100 g^{-1}.

Fatty acid methyl esters analysis

Fatty acid methyl esters (FAMEs) were analyzed in a gas chromatograph (Varian, USA) equipped with flame ionization detector and fused silica capillary column CP-7420 Select FAME (100 m, 0.25 mm, and 0.25 μm film, Varian, USA). Column temperature was programmed at 165°C for 18 min, 180°C (30°C/min) for 22 min and 240°C (15°C/min) for 20 min. The injector and detector were kept at 220°C and 245°C, respectively. The gas fluxes (White Martins) used were: 1.4 ml/min (45 psi) for the carrier gas (H_2); 30 ml/min for the make-up gas (N_2), and 30 ml/min and 300 ml/min for H_2 and the synthetic flame gas, respectively. Sample injection split mode was 1/80. Fatty acids were identified by comparing sample relative retention times of FAME peaks with those of FAME standard-spiked samples (Sigma Chemical Co., St. Louis, MO, USA). The peak areas were determined by Star software (Varian).

The quantification of FAME followed the recommendation of ACS (1980) and methods proposed by Ackman (1972) and Joseph and Ackman (1992). Standard FAME solutions were prepared in concentrations 4.50; 3.60; 2.57; 1.69; 1.13; 0.90; 0.64; 0.45; 0.30; 0.23; 0.16; 0.11; 0.08; 0.06; 0.04; 0.02 mg/ml of n-heptane, all containing 0.25 mg/ml of the Tricosanoic Acid Methyl Ester (Internal Standard). The ratio of the areas of FAME and internal standard were plotted against the FAME concentration, over a 0.02 to 4.50 mg/ml range (Rowe et al., 1999; Milinsk et al., 2005).

Quantification of CLA isomers

CLA isomers were identified by comparison of relative retention times (O-5632, CLA mixture, Sigma Chemical Co., St. Louis, MO, USA). CLA content was reported in mg/g of lipid by using the following formula:

$$\text{CLA (mg/g LT)} = \frac{(A_X)(W_{IS})(CF_X)}{(A_{IS})(W_X)(1.04)} \times 1{,}000$$

where: A_x is the peak area of CLA, A_{IS} the peak area of the internal standard (IS) (tricosanoic acid, 23:0), W_{IS} is the weight (mg) of IS added to the sample (in mg), CF_x is the theoretical correction factor based on IS (equivalent to 1/RRF), RRF is the relative response factor = $(A_x/A_{IS})\cdot(W_{IS}/W_x)$, W_x is the weight of the sample, 1.04 = conversion factor necessary to express results as mg of fatty acids per gram of lipids rather than as methyl esters (Mendoza et al., 2005; Padre et al., 2006).

Experimental design and statistical analysis

The experimental design with 2 treatments (bulls and steers) and 27 replications (animals) were completely randomized. The data were submitted to an analysis of variance using SAS statistical software (2000), according to the following mathematical model:

$$Y_{ij} = \mu + t_i + e_{ij}$$

In which:
Y_{ij} = observation of animal j, subjected to treatment i;
μ = overall constant;
t_i = treatment effect i = 1, 2;
e_{ij} = random error associated with each observation.

RESULTS AND DISCUSSION

Carcass characteristics

Final live body-weight and hot carcass weight were similar ($p>0.05$) between bulls and steers (Table 3). The obtained weights were high for animals with an average age

Table 3. Carcass characteristics of bulls and steers finished on pasture system

Parameters	Bulls	Steers	CV[1]	p>f
Final live weight (kg)	502.06	513.70	11.76	NS
Hot carcass weight (kg)	251.47	249.40	12.67	NS
Hot carcass dressing (%)	50.07[a]	48.50[b]	2.98	0.02
Fat thickness (mm)	1.90[b]	3.47[a]	54.35	0.02
Longissimus area (cm^2)	64.41	64.70	10.15	NS
Color (points)	3.33[b]	4.00[a]	16.99	0.02
Texture (points)	4.12	4.20	13.08	NS
Marbling score (points)	3.80[b]	5.77[a]	49.38	0.06

[1] Coefficient of variation; different letters in the same line are significantly different.

of 27 months. Moreira et al. (2006) observed a lower weight for animals with an average age of 25 months (437 kg). However, it must be emphasized that the animals were finished in a pasture system, but with additional supplementation which would increase slaughter weight (Moreira et al., 2003; Moreira et al., 2005). Perotto et al. (2000) observed a close slaughter weight in animals with similar bloodlines, age at slaughter and finishing system as observed in this work. The Brazilian domestic market demands a carcass weight close to 225 kg and cover fat thickness between 3-6 mm (Luchiari Filho, 2000). Therefore, the carcass weight of the different genetic groups meets the demands of the Brazilian market. Foreign markets demand a higher carcass weight (above 250 kg).

On the other hand, proportion of hot carcass yield, although low at around 50%, was greater ($p<0.02$) for bulls compared to steers. The lower carcass yield observed in steers could be due to carcass cleaning practices. In general, bulls feature greater weight gain and lower carcass fat deposition due to the presence of male hormones, especially testosterone, present in the animals' tissues (Lee et al., 1990; Webb et al., 2006). There is the possibility that the greater hot carcass yield is due to proportionately greater visceral content in steers (Butterfield et al., 1984). The low carcass yield can be related to the thorough carcass cleaning methods employed by commercial slaughterhouses in Brazil. Prado et al. (1995) also found carcass yields close to 50% in crossbred animals finished and slaughtered in similar conditions to this experiment.

Cover fat thickness was lower ($p<0.02$) in bulls compared to steers. This lower cover fat thickness in bulls is due to the presence of male hormones in these animals, which hampers carcass fat deposition and increases muscle tissue deposition. Castration results in greater carcass fat deposition as a result of the absence of testosterone (Lee et al., 1990; Knight et al., 2000).

Color and marbling were better ($p<0.06$) in steers than bulls. The poorer coloring of meat observed for bulls is due to the presence of testosterone, which results in greater connective tissue deposition (Gerrard et al., 1987; Gariépy et al., 1990; Luchiari Filho, 2000). The meat color is dependent on ultimate pH which, when higher, causes darker meat. Bulls have more hemoglobin in the meat and this can result in a dark meat (Mancini et al., 2005). The greater marbling for steers is related directly to a greater fat deposition in these animals, as a result of lower level of hormones related to muscle tissue deposition (Webb et al., 2006).

The *Longissimus* muscle area, which characterizes the muscle levels of beef cattle, was similar ($p>0.05$) between bulls and steers. It should be emphasized that there could be a negative effect of castration on the *Longissimus* muscle area. Shoonmarker et al. (1990) did not observe any effect of castration on the *Longissimus* muscle area in cattle finished in similar handling and feeding conditions as a result of male hormone concentrations.

Similarly, no effect was observed ($p>0.05$) on meat texture between bulls and steers. In general, castrated animals feature better texture as a result of the absence of male hormones and a greater deposition of marbling fat (Gerrard et al., 1987).

Chemical composition

The moisture percentage was higher ($p<0.01$) in bulls in comparison with steers (Table 4). This higher percentage is related to the lower levels of total lipids in intact specimens

Table 4. Effect of emasculation on moisture, ash, crude protein, total lipids and cholesterol in *Longissimus* muscle of bulls finished in pasture system

Parameters	Bulls	Steers	CV[1]	p>f
Moisture (%)	76.19[a]	73.05[b]	1.49	0.01
Ash (%)	1.01[b]	1.07[a]	7.10	0.05
Crude protein (%)	22.93[b]	23.75[a]	6.12	0.10
Total lipids (%)	0.95[b]	1.96[a]	33.73	0.01
Total cholesterol (mg/100 g LM)	45.83[b]	52.72[a]	9.79	0.01

[1] Coefficient of variation; different letters in the same line are significantly different.

Table 5. Effect of emasculation on fatty acids profile (% of total of fatty acids) of *Longissimus* muscle of animals finished in pasture system

Fatty acids	Bulls	Steers	CV[1]	p>f
14:0	1.30[b]	1.72[a]	22.95	0.01
ai 15:0	0.18	0.20	22.39	NS
i 15:0	0.15[b]	0.21[a]	40.26	0.05
15:0	0.25	0.26	23.84	NS
15:1 *n*-10	0.38	0.43	16.81	NS
i 16:0	0.21	0.22	16.86	NS
16:0	23.45[b]	25.08[a]	7.28	0.03
16:1 *n*-10	0.21[a]	0.12[b]	64.25	0.03
16:1 *n*-9	0.20	0.18	25.47	NS
16:1 *n*-7	2.22[b]	2.53[a]	17.89	0.10
ai 17:0	0.61	0.63	13.88	NS
i 17:0	0.21[a]	0.13[b]	71.42	0.07
17:0	0.99	1.03	13.05	NS
17:1 *n*-10	0.56	0.56	12.33	NS
18:0	19.05	19.36	8.98	NS
18:1 *t*-11	2.63	2.58	12.95	NS
18:1 *n*-9	31.94[b]	34.07[a]	8.21	0.06
18:1 *n*-7	0.88	0.90	26.17	NS
18:1 *n*-4	0.11	0.12	45.44	NS
18:1 *n*-3	0.20	0.21	24.70	NS
19:0	0.12[a]	0.07[b]	50.27	0.02
18:2 *n*-6	6.62[a]	4.16[b]	34.18	0.01
18:2 *n*-4	0.13	0.12	28.26	NS
18:3 *n*-6	0.01	0.01	0.54	NS
18:3 *n*-3	1.23[a]	0.58[b]	48.85	0.01
18:4 *n*-3	0.01	0.01	0.54	NS
18:2 *c* 9 *t* 11	0.50	0.53	16.16	NS
18:2 *c* 11 *t* 13	0.13	0.12	19.34	NS
18:2 *t* 10 *c* 12	0.13	0.15	22.74	NS
18:2 *c* 8 *c* 10	0.03	0.02	154.46	NS
18:2 *c* 9 *c* 11	0.03	0.02	153.90	NS
18:2 *c* 10 *c* 12	0.03	0.02	153.90	NS
18:2 *c* 11*c* 13	0.03	0.02	153.90	NS
18:2 *t* 8 *t* 10	0.02	0.02	86.45	NS
18:2 *t* 9 *t* 11	0.02	0.02	86.45	NS
18:2 *t* 10 *t* 12	0.02	0.02	86.45	NS
18:2 *t* 11 *t* 13	0.02	0.02	86.45	NS
20:0	0.05	0.03	90.54	NS
20:3 *n*-6	0.16	0.15	41.46	NS
20:2 *n*-3	0.52[a]	0.34[b]	26.80	0.01
20:4 *n*-6	2.54[a]	1.60[b]	33.59	0.01
20:5 *n*-3	0.42[a]	0.28[b]	36.79	0.01
22:1 *n*-7	0.15[a]	0.10[b]	33.04	0.01
22:4 *n*-6	0.20[a]	0.15[b]	30.19	0.01
22:5 *n*-3	0.98[a]	0.60[b]	24.59	0.01
22:5 *n*-6	0.03	0.02	84.51	NS
22:6 *n*-3	0.07	0.06	49.52	NS

[1] Coefficient of variation; different letters in the same line are significantly different.

as a result of the action of testosterone, which determines greater deposition of muscular tissue (Gerrard et al., 1987; Gariépy et al., 1990). Rodrigues and Andrade (2004) also observed more lipids and less moisture content in the LM of steers. The lowest fat and the highest protein contents found in bulls are due to testosterone, as this hormone is related to higher capacity for muscle growth in bulls (Field, 1971).

The ash, crude protein, total lipids and total cholesterol contents were higher ($p<0.05$) in steers than bulls (Table 4). The lower ash level is related to the lower total lipid level in bulls, as fats feature only traces of ash. However, the values observed for bulls (1.01%) and steers (1.07%) are close to the results found in the literature for animals in this category (Moreira et al., 2003; Prado et al., 2003; Padre et al., 2006 and 2007).

The higher levels of crude protein observed in bulls were reported by Prado et al. (2003) and Padre et al. (2006 and 2007). The greater protein deposition in bulls could be related to the presence of male hormones (testosterone), which would contribute to a greater retention of nitrogen in carcass muscles (Gerrard et al., 1987; Gariépy et al., 1990). However, the values observed for bulls (22.93%) and steers (23.75%) are close to those observed for crude protein in animals finished in similar systems, weights, ages and physiological conditions (Moreira et al., 2003; Prado et al., 2003; Padre et al., 2007).

The higher percentage of total lipids in steers as compared to bulls is related to the greater cover fat thickness and marbling of the *Longissimus* muscle in steers. Finished bulls feature lower levels of total lipids as a result of lower fat deposition, which is determined by their sexual condition (Gerrard et al., 1987; Gariépy et al., 1990).

The higher cholesterol levels in steers as compared to bulls are associated with greater fat deposition. Rule et al. (1997) suggested that some differences in cholesterol contents might be associated with changes in the cellular structure of the muscle.

Fatty acid profile

The proportion of fatty acids in the intramuscular fat is indicated in Table 5. The diversity of fatty acids is partly explained by biohydrogenation reactions in the rumen (Tamminga and Doreau, 1991; Zhang et al., 2006). The levels of C16:0 were higher ($p<0.03$) in steers than bulls. This fatty acid is regarded as non-beneficial to human health. The levels of C18:1 *n*-9 were higher ($p<0.06$) in steers. The high content of oleic acid (18:1 *n*-9) in the steer muscles could be due to the high concentration of monounsaturated fatty acids (31.94/36.22% units) (Table 6). The LM of steers had the highest content of vaccenic acid (18:1 *t*-11), an important intermediate produced by microrganisms in the rumen and transformed into CLA (18:2 *c*-9, *t*-11 - rumenic acid) in the muscular tissue of ruminants (Bauman et al., 1999).

The levels of C18:2 *n*-6, C18:3 *n*-3 were higher ($p<0.01$) in bulls. The majority of adipose deposits into animal tissues are synthesized by lipogenesis, because ruminant diets are poor in fat components; fatty acids are elongated up to 18:0 and converted into 18:1 by

Table 6. Effect of castration on saturated fatty acids (SFA), monounsaturated fatty acids (MUFA), polyunsaturated fatty acids (PUFA), *n*-6, *n* 3, PUFA/SFA and *n*-6/*n*-3 ratio of *Logissimus* muscle of animals finished in pasture system

Fatty acids	Bulls	Steers	CV[1]	p>f
SFA	46.10	47.44	4.38	NS
MUFA	36.22[b]	39.38[a]	8.08	0.02
PUFA	14.10[a]	7.95[b]	23.03	0.01
n-3	3.56[a]	2.03[b]	29.01	0.01
n-6	8.48[a]	6.04[b]	25.73	0.01
PUFA/SFA	0.29[a]	0.19[b]	33.49	0.01
n-6/*n*-3	2.38[b]	2.98[a]	24.85	0.01
Quantification	---------- mg/g lipids ----------			
18:2 *c* 9 *t* 11	2.09	2.31	40.23	NS
18:2 *c* 11 *t* 13	0.42[b]	0.57[a]	38.58	0.06
18:2 *t* 10 *c* 12	0.51[b]	0.70[a]	46.44	0.11
cis, cis	0.23	0.23	44.76	NS
trans, trans	0.22	0.20	47.70	NS
CLA total	2.87[b]	3.86[a]	36.54	0.06

[1] Coefficient of variation; different letters in the same line are significantly different.

desaturation (Rule et al., 1997). The deposits of 18:1 are also increased, while 18:0 is reduced along the deposit period.

The levels of total CLA were greater ($p<0.06$) for steers (Table 6). The levels of saturated fatty acids were similar ($p>0.02$) between bulls and steers (Table 6). The average percentage for both groups was 46.77%. This value has been observed in bovines finished in feedlot and pasture systems (Moreira et al., 2003; Prado et al., 2003; Padre et al., 2006 and 2007). These high saturated fatty acid (SFA) estimates were caused by biohydrogenation in the rumen, although the animal diet had high levels of polyunsaturated fatty acid (PUFA) (Tamminga and Doreau, 1991).

However, the levels of monounsaturated fatty acids were greater ($p<0.05$) in steers as compared to bulls and were similar to values found by Moreira et al. (2003) and Muaramoto et al. (2005).

Conversely, the levels of polyunsaturated fatty acids were greater ($p<0.01$) in bulls than steers. Muramoto et al. (2005) and Padre et al. (2006) also observed higher percentages of polyunsaturated fatty acids in bulls finished in pasture systems.

The average PUFA/SFA ratio of bulls and steers was 0.24; this value is close to 0.40, which is recommended by the English Health Department (HMSO, 1994). This PUFA/SFA ratio has been significant for health care, because it reduces the risk of coronary diseases, although the optimal ratio has been a matter of debate (Hu, 2001).

Ruiz et al. (2005) observed a higher PUFA/SFA ratio in the muscles of bulls (0.25) than of steers (0.16); both values were close to those found in the current study.

Steers had a higher *n*-6/*n*-3 ratio in muscles than bulls, with an average of 2.68 ($p<0.01$); the *n*-6 and *n*-3 fatty acids have a significant role in reducing the risk of coronary heart disease, but it is still a matter of debate (Hu, 2001).

IMPLICATIONS

Castration is a commonly used method in the Brazil beef cattle industry and results in lower weight gains as a result of the reduction in plasma testosterone levels, thus reducing the secretion of growth hormone (IGF-I) and the action of insulin. On the other hand, castration enabled a better carcass quality in terms of coloring and marbling, as a result of the greater deposition of thickness fat and intramuscular fat in *Longissimus*. Similarly, castration increased total lipid deposition and total cholesterol. However, it was observed that bulls featured a better deposition of *n*-3 and *n*-6 fatty acids, as well as a better ratio of polyunsaturated/saturated fatty acids. Conversely, steers featured higher depositions of CLA.

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