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Fatty acid profile, and chemical composition of *Longissimus* muscle of bovine steers and bulls finished in pasture system

Roseli das Graças Padre [a], Juliana Aparecida Aricetti [a], Fernanda Barros Moreira [b], Ivone Yurika Mizubuti [b], Ivanor Nunes do Prado [c], Jesuí Vergílio Visentainer [a], Nilson Evelázio de Souza [a], Makoto Matsushita [a,*]

[a] *Departamento de Química, Universidade Estadual de Maringá, Av. Colombo, 5790, CEP 87020-900 – Maringá, PR, Brazil*
[b] *Departamento de Zootecnia, Universidade Estadual de Londrina, Campus Universitário, CEP 86051990 – Londrina, PR, Brazil*
[c] *Departamento de Zootecnia, Universidade Estadual de Maringá, Av. Colombo, 5790, CEP 87020-900 – Maringá, PR, Brazil*

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Abstract

The objective of this work was to evaluate the conjugated linoleic acid content (CLA), the fatty acid profile, and the chemical composition of the *Longissimus* muscle (LM) of steers and bulls finished in pasture systems. Fourteen 1/2 Nelore × 1/2 Aberdeen Angus cattle were studied. The animals were slaughtered at approximately 20 months of age, with an approximate final liveweight of 480 kg. Moisture, ash, fat, crude protein, cholesterol, and fatty acid contents of *Longissimus* muscle were determined. Steer muscle had a higher lipid content (3.38%) than that of bulls (1.71%). Total $n-3$ fatty acids were higher in bulls. The amounts of CLA in steer and bull fat were similar, but the CLA content in steer muscle was higher (47.99 mg 100 g^{-1} in LM) than that in bull muscle (23.24 mg 100 g^{-1} in LM).

Keywords: CLA; Meat; Fat; Nelore; ω3; ω6

1. Introduction

Beef has an excellent nutritional quality because it has proteins of high biological value, it is rich in vitamin contents, specially B-complex, it is associated to a high mineral content, especially iron, in high bioavailability form (Saucier, 1999). Beef contains all the essential amino acids in about the right proportions required by humans (Pensel, 1998).

However, beef is considered one of the factors that may lead to the development of human cardiovascular diseases, obesity, hypertension, and cancer, especially due to the presence of saturated fat and cholesterol. However, low fat contents (less than 5% relative to muscle) and low cholesterol contents (less than 75 mg 100 g^{-1}) have been observed in beef chemical analyses, ranging from one third to one half of the daily recommended cholesterol intake (Jiménez-Colmenero, Carballo, & Cofrades, 2001).

Conjugated linoleic acid refers to a mixture of positional and geometric isomers of linoleic acid with two double bonds separated by one single bond. Furthermore, each double bond can be in the *cis* or *trans* configuration (McGuire & McGuire, 1999). The main form present in ruminant products is the *cis*-9, *trans*-11 CLA, known as rumenic acid (Kramer et al., 1998).

In terms of their benefits to human health, products containing CLA (considered nutraceutic or functional) have anticarcinogens (especially rumenic acid; Ip et al., 1999) and anti-obesity properties (isomer *t*-10, *c*-12; Evans, Brown, & Mcintosh, 2002). These products also help prevent arteriosclerosis, they are antioxidants due to the conjugated double bonds, and they contribute to prevent non-insulin dependent diabetes mellitus (Sebédio, Gnaeding, & Chardigny, 1999).

* Corresponding author. Tel.: +55 44 3261 4368; fax: +55 44 3261 4125.
E-mail address: mmakoto@uem.br (M. Matsushita).

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Manipulation of animal feed has been used as an alternative method to improve the dietary quality of meat. Bovine feeding in pasture systems leads to an increase in $n-3$ polyunsaturated fatty acids (PUFA) in meat in comparison to their contents in bovines fed on grain-based diets (Enser, 2000; Yang, Lanari, Brewster, & Tune, 2002). Furthermore, diets rich in forage favor the growth of fibrolytic microorganisms responsible for the rumen production of CLA (Madron et al., 2002). According to Realini, Duckett, Brito, Dalla Rizza, and Mattos (2004), animals fed forage have higher concentrations of linolenic, stearic, arachidonic (20:4 $n-6$), eicosapentaenoic (20:5 $n-3$, EPA), and docosapentaenoic (22:5 $n-3$, DPA) acids in meat than those fed concentrate.

The Brazilian food industry has a preference for steer carcasses because they present higher fat carcass deposition, as fat thickness and marbling (Vaz & Restle, 2000). On the other hand, producers prefer bulls as they present a larger weight gain capacity and can be slaughtered sooner (Vaz et al., 2001).

The objective of this work was to determine the conjugated linoleic acid isomers, fatty acid profile, and chemical composition of *Longissimus* muscle (LM) of bulls and steers finished in pasture system.

2. Materials and methods

2.1. Animal management and sampling

This study was carried out in the northern region of Paraná State, south Brazil. Fourteen 1/2 Nelore × 1/2 Aberdeen Angus cattle with an average age of 20 months were studied.

The animals were kept in an exclusive pasture system from weaning to slaughter. After 14 months on pasture, they were randomly divided in two groups: Seven were uncastrated and 7 were surgically castrated. After castration, each group was kept in a fenced pasture with Mombaça grass (*Panicum maximum* Jacq. Cv. Mombaça) until slaughtering (5th May 2004) at an average age of 20 months.

Two Mombaça grass fenced pastures with an experimental area of 18 ha were used. The steers and bulls were kept separate in each paddock. The animals were alternated between pastures every 14 days so that both treatment groups (bulls and steers) remained in both fenced pastures every 28 days. Animals were handled by continuous grazing. The fenced pastures had 4000-L drinking troughs and sheltered troughs for salt supplementation with an area of 17 cm^2 per animal.

Four samples of forage of 0.25 m^2 were collected from each fenced pasture every 28 days (Holderbaun & Sollenberg, 1992). Samples were cut at ground level and dried at 55 °C for 72 h. After drying, the samples were ground in a 1-mm grinder, put together in one sample and used for future chemical analyses.

The animals were weighed just before castration and on the day before slaughtering after 6-h fasting. The average liveweight at castration was 319 kg and the average liveweight at slaughter was 447 kg (steers) and 496 kg (bulls).

The animals were slaughtered at a commercial slaughterhouse 10 km away from the farm, according to industrial practice in Brazil. After slaughter, the carcasses were identified and cooled for 24 h at 2 °C. LM samples were taken by complete cross-section between the 12th and 13th ribs and were immediately taken to the laboratory. Cover fat was discarded and the muscle portion was frozen at −18 °C for later analysis.

2.2. Chemical composition

Laboratory analyses of beef were carried out four months after sampling. The samples were unfrozen at room temperature (20 °C), grounded, homogenized, and analyzed in triplicate.

Beef moisture and ash contents were determined according to AOAC (Cunnif, 1998). Crude protein content was obtained through Kjeldahl method (Cunnif, 1998). Total lipids of forage and beef were extracted by the Bligh and Dyer method (1959) with a chloroform/methanol mixture. Fatty acid methyl esters (FAME) were prepared by methylation of triacylglycerols according to ISO method 5509 (1978).

Cholesterol analysis was carried out by the modified Rowe, Macedo, Visentainer, Souza, and Matsushita (1999) method. A 60% (w/v) solution of potassium hydroxide was added to the samples in quantities equivalent to 2 mL g^{-1} of sample under 1-h reflux. The residue was dissolved again in 2 mL hexane containing 0.2 mg mL^{-1} 5α-cholestane internal standard (IS) (Sigma, EUA).

2.3. 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 OhioValley-30). Injector, column, and detector temperatures were 260, 280, and 280 °C, respectively. Ultra-pure gas fluxes (White Martins) of 1.5 mL min^{-1} H_2 as carrier gas, 30 mL min^{-1} N_2 as make-up gas, 300 mL min^{-1} synthetic gas, and 30 mL min^{-1} H_2 for flame were used. The sample injection split mode was 1:150. Peak integration was carried out with CG-300 computing integrator (CG Instruments, Brazil) and cholesterol was identified by comparison with standards from Sigma (EUA). Sample cholesterol quantification was carried out after verification of the method linearity. Standard cholesterol solutions (Sigma, USA) were prepared with concentrations 0.0; 0.4; 0.8; 1.6, and 2.0 mg mL^{-1}, all containing 0.20 mg mL^{-1} 5α-cholestane (Sigma, USA), and analyzed. The ratio of the areas of cholesterol and 5-α-cholestane were 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}.

2.4. Analysis of fatty acid methyl esters

The fatty acid methyl esters (FAMEs) were analyzed in a gas chromatograph (Varian, USA) equipped with a flame ionization detector and a fused silica capillary column CP-7420 (100 m, 0.25 mm and 0.39 μm o.d., Varian, USA) Select Fame. column temperature was programmed at 165 °C for 18 min, 180 °C (30 °C min^{-1}) for 22 min, and 240 °C (15 °C min^{-1}) for 20 min, with 45-psi pressure. The injector and detector were kept at 220 °C and 245 °C, respectively. The gas fluxes (White Martins) used were: 1.4 mL min^{-1} for the carrier gas (H_2); 30 mL min^{-1} for the make-up gas (N_2), and 30 mL min^{-1} and 300 mL min^{-1} for H_2 and the synthetic flame gas, respectively. Sample injection split mode was 1/80. Fatty acids were identified by comparing the relative retention times of FAME peaks of the samples with fatty acid methyl ester standards from Sigma (USA) by spiking samples with standards. The peak areas were determined by Star software (Variam). The data were expressed as percentages of the normalized area of fatty acids (Milinsk et al., 2005; Rowe et al., 1999).

2.5. Quantification of CLA isomers

CLA isomers were identified by comparison of relative retention times (O-5632, CLA mixture, SIGMA). CLA content is reported in mg g^{-1} of intramuscular lipid by using the following formula:

$$\mathrm{CLA(mg/g\ LT)} = \frac{(A_x)(W_{IS})(CF_x)}{(A_{IS})(W_x)(1.04)} \times 1000$$

where LT = total lipid, 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), WS is the sample weight (in mg), CF_x is the theoretical correction factor calculated based on IS (equivalent to $1 \times RRF^{-1}$), RRF is the relative response factor = $(Ax \times A_{IS}^{-1}) \cdot (W_{IS} \times W_{ES}^{-1})$, W_{ES} is the weight of the sample, 1.04 = conversion factor necessary to express results as mg of fatty acids g^{-1} of lipids rather than as methyl esters (Mendoza et al., 2005).

2.6. Experiment design and statistical analysis

The experiment design was 2 treatments and 7 repetitions (animals) per treatment. The results were submitted to Student *t*-test at 5%; 1%; and 0.1% significance levels with Statistica 7.0 software (StatSoft, USA, 2005).

3. Results and discussion

3.1. Chemical composition

Table 1 show the chemical composition results of LM of bulls and steers. Steer LM had lower meat moisture, ash, and crude protein content in comparison to that of bulls.

Table 1
Chemical composition of *Longissimus* muscle of steers and bulls finished in pasture system ($n = 14$)[a]

	Bulls[b]	Steers[c]	SE	Effect
Moisture (%)	73.73	72.34	0.464	–*
Ash (%)	1.03	0.90	0.027	–***
Crude protein (%)	21.45	20.43	0.297	
Total lipid (%)	1.71	3.38	0.515	–**
Cholesterol (mg/100 g intramuscular fat)	45.79	45.65	0.672	NS

NS, no significant difference between means ($P > 0.05$).
[a] Means are from seven triplicate samples.
[b] Carcass weight: 263 kg; fat thickness: 1.7 mm.
[c] Carcass weight: 235 kg; fat thickness: 3 mm.
* Significant at 5% level.
** Significant at 1% level.
*** Significant at 0.1% level by Student' s *t*-test.

In contrast, lipid content was higher in steers than in bulls. Cholesterol contents were similar for bulls and steers, with an overall mean value of 45.72 mg 100 g^{-1} muscle.

Meat moisture content is inversely related to its lipid content. Rodrigues and Andrade (2004) observed a higher lipid content in steers (20.8%) comparatively to bulls (9.9%), and lower moisture content in steers LM (71%) in comparison to that of bulls (73.6%).

The lower fat content and the higher protein content in bull beef is due to the presence of testosterone, as the presence of testicular hormones are related to greater muscle growth capacity in bulls (Field, 1971).

The fat content observed in this experiment was similar to that observed by Ruiz, Matsushita, Visentainer, Hernandez, and Ribeiro (2005), who observed values of 1.23% for Nelore-cross bull LM, while Nelore-cross steer LM fat content was 2.17%.

LM cholesterol content did not differ between bulls and steers. Rule, Macneil, and Short (1997) emphasized that breed, nutrition, and sex do not affect the cholesterol concentration of bovine skeletal muscle. These authors suggested that differences in muscle cholesterol concentration would probably be associated with marked changes in the structure of the muscle cells. Thus, altering cholesterol concentration in muscle may require a marked redistribution of membrane fatty acids (Rule et al., 1997).

The present study also highlights the low cholesterol concentration of a common serving of beef. Therefore, the consumption of 200 g LM analyzed in the present study represents a cholesterol intake of 91.44 mg, which corresponds to 30.48% of the recommended maximum daily cholesterol intake (300 mg day^{-1}, Greene & Feldman, 1991).

3.2. Fatty acid composition

The fatty acid profile of Mombaça grass is presented in Table 2.

The fatty acid profile of tropical fodder is rich in PUFA, especially *n*−3 fatty acids (French et al., 2000). Diets with

Table 2
Fatty acid profiles (% of total fatty acids) of *Panicum maximum* Jacq. Cv. Mombaça sampled from the paddocks

Fatty acid	Panicum maximum Jacq.
Polyunsaturated	44.57
Monounsaturated	24.95
Saturated	30.48
$\sum n-6$	16.67
$\sum n-3$	27.90

high PUFA levels could lead to an increase in these fatty acids in meat. However, in ruminants, fatty acids are hydrogenated when they pass through the rumen to form mainly 18:0 and 18:1 acids (Tamminga & Doreau, 1991). Therefore an increase in dietary PUFA does not lead to a direct increase in these fatty acids in meat.

The proportion of fatty acids in LM intramuscular fat is shown in Table 3. Fatty acids diversity is illustrated by the presence of iso and anti-iso acids. This diversity is partly explained by the biohydrogenation that occurs in the rumen (Tamminga & Doreau, 1991).

Bull LM contained a higher content of 18:1 *t*-11, in comparison to that of steers. This fatty acid (vaccenic acid) is an important intermediate produced by microorganisms in the rumen. After its absorption, this fatty acid can be transformed into CLA (18:2 *c*-9, *t*-11-rumenic acid) in the tissue of ruminants (Bauman, Baumgard, Corl, & Griinari, 1999).

Most part of the fatty acids in bull beef was in the form of oleic acid (18:1 *c*-9), stearic acid (18:0), and palmitic acid (16:0). In steer beef, most fatty acids were in the form of oleic acid (18:1 *c*-9), palmitic acid (16:0), and stearic acid (18:0).

Castration affected the proportions of palmitic, stearic, and oleic acids (Table 3). Steer beef contained higher 16:0 and 18:1 contents, while bull beef had higher 18:0 levels. Analyzing LM of Nellore-cross bulls and steers finished on pasture, Ruiz et al. (2005) observed no difference in 16:0 content between steers (26.58%) and bulls (25.13%), this similarity was also observed for 18:1 content, 34.04% in steers and 35.17% in bulls.

In their analysis of LM of castrated Nelore, Prado, Moreira, Matsushita, and Souza (2003) found 16:0, 18:0, and 18:1 contents of 23.24%, 15.76%, and 39.59%, respectively. Scheeder et al. (2001) studied the proportion of fatty acids in confined Brown Swiss bulls and observed 23.55% (16:0), 21.08% (18:0), and 38.77% (18:1 *c*-9).

By comparing Nelore-cross bulls and steers finished on *Brachiaria brizantha* pasture, Ruiz et al. (2005) observed higher 18:2 *n*−6 content in bulls (5.05%), when compared to steers (3.47%). In addition, the 18:3 *n*−3 values found by the authors were higher for bulls (1.80%) than for steers (0.83%).

As ruminant diets contain low fat concentration, the majority of the adipose tissue is from de novo lipogenesis. Fatty acids are elongated up to 18:0 and are converted into

Table 3
Fatty acid profiles (% of total fatty acids) of *Longissimus* muscle of steers and bulls finished in pasture system ($n = 14$)[a]

Fatty acid	Bulls	Steers	SE	Effect
10:0	0.09	0.11	0.005	NS
12:0	0.07	0.07	0.004	NS
Iso 14:0	0.11	0.08	0.007	−**
14:0	2.09	2.36	0.073	−*
Anteiso 15:0	0.41	0.34	0.014	−**
Iso15:0	0.19	0.38	0.033	−***
15:0	0.43	0.32	0.019	−***
15:1 *n*−10	0.61	0.52	0.019	−*
Iso16:0	0.35	0.27	0.015	−***
16:0	23.18	24.90	0.332	−***
16:1 *n*−10	0.14	0.07	0.016	−*
16:1 *n*−9	0.31	0.18	0.036	−*
16:1 *n*−7	1.68	2.73	0.197	−***
Anteiso 17:0	0.25	0.29	0.028	NS
Iso17:0	0.87	0.85	0.012	NS
17:0	1.34	1.17	0.036	−**
17:1 *n*−10	0.67	0.76	0.027	NS
18:0	26.65	20.19	1.279	−***
18:1 *n*−11	3.98	3.22	0.160	−**
18:1 *c*-9	28.52	33.73	1.024	−**
18:1 *n*−7	0.53	0.64	0.029	−*
18:1 *n*−5	0.02	0.01	0.001	−*
18:1 *n*−4	0.07	0.18	0.020	−***
18:1 *n*−3	0.35	0.35	0.010	NS
18:2 *t*-9, *t*-11	0.12	0.12	0.008	NS
18:2 *c*-9, *t*-11	0.09	0.13	0.007	−**
19:0	0.31	0.23	0.017	−**
18:2 *t*-9, *c*-11	0.31	0.27	0.010	NS
18:2 *n*−6	1.68	1.27	0.077	−*
18:2 *n*−4	0.20	0.20	0.007	NS
20:0	0.20	0.17	0.015	NS
18:3 *n*−3	0.85	0.53	0.062	−**
20: 2 *n*−6	0.05	0.05	0.002	NS
20:2 *n*−3	0.14	0.17	0.010	NS
20:3 *n*−6	0.12	0.12	0.008	NS
22:0	0.07	0.07	0.007	NS
20:4 *n*−6	0.53	0.38	0.030	−**
22:2 *n*−6	0.08	0.09	0.006	NS
20:5 *n*−3	0.33	0.25	0.026	−*
22:4 *n*−6	0.06	0.07	0.006	NS
22:5 *n*−6	0.05	0.05	0.003	NS
22:5 *n*−3	0.34	0.31	0.012	NS
22:6 *n*−3	0.02	0.03	0.001	NS

NS, no significant difference between means ($P > 0.05$).
[a] Means are from seven triplicate samples.
* Significant at 5% level.
** Significant at 1% level.
*** Significant at 0.1% level by Student's *t*-test.

18:1 by desaturation (Rule et al., 1997). As the formed adipose tissue increases, the high deposition of 18:1 reduces the 18:0 content. This could explain why steers present higher levels of 18:1 when compared to bulls.

Oleic acid increases human HDL-cholesterol and decreases LDL-cholesterol concentrations in blood (Katan, Zock, & Mensink, 1994). Studies have demonstrated a strong relationship between LDL-cholesterol levels and human cardiovascular diseases and that HDL-cholesterol has an inverse relation with the risk of cardiovascular diseases (Kwiterovich, 1997). Therefore, the production of

meat rich in oleic acid could result in a positive impact on human health.

In the PUFAs group, 18:2 *n*−6 and 18:3 *n*−3 predominated. bulls showed higher 18:2 *n*−6 and 18:3 *n*−3 content in comparison to steers. PUFA total content in LM of the bulls and steers studied was similar. However, MUFA content was higher among steers in relation to bulls. SFA content was higher for bulls than for steers. Bulls also presented higher *n*−6 and *n*−3 contents than steers did (Table 4).

Although the animal diet contained high levels of PUFA, the meat presented high values of SFA due to biohydrogenation in the rumen. Ruiz et al. (2005) found a higher PUFA content (11.98%) and lower SFA content (47.27%) in bulls in relation to steers (8.16% PUFA and 52.24% SFA). It is worth pointing out that SFA, MUFA, and PUFA contents found by the authors were similar to those reported in the present experiment.

In this study, PUFA content was similar to that found by French et al. (2000), 5.35%, and lower than that found by Prado et al. (2003) (10.40%), both for steers kept in pasture systems.

Table 4
Concentration of groups of fatty acids and ratios of fatty acids in *Longissimus* muscle of steers and bulls finished in pasture system ($n = 14$)[a]

	Bulls	Steers	SE	Effect
PUFA[b]	6.43	5.82	0.196	–*
MUFA[c]	36.89	42.39	1.211	–**
SFA[d]	56.68	51.79	0.959	–*
n−6[e]	3.02	2.60	0.154	–*
n−3[f]	3.02	1.27	0.254	–***
n−6/*n*−3	1.69	2.05	0.164	NS
PUFA/SFA	0.11	0.11	0.011	NS
CLA (mg/g intramuscular fat)				
c-9, *t*-11 – 18:2	7.04	8.75	0.294	–*
c-11, *t*-13 – 18:2	1.32	1.54	0.052	NS
t-10, *c*-12 – 18:2	1.99	2.27	0.070	NS
c, *c* – 18:2[g]	1.18	1.26	0.059	NS
t, *t* – 18:2[h]	1.77	1.58	0.057	NS
Total CLA	13.59	14.61	0.544	NS
CLA (mg/100 g muscle LD)				
c-9, *t*-11 – 18:2	12.52	28.99	0.475	–***
c-11, *t*-13 –18:2	2.25	5.19	0.089	–***
t-10, *c*-12 – 18:2	3.40	7.67	0.120	–***
c, *c* – 18:2	2.01	4.27	0.100	–***
t, *t* – 18:2	3.02	5.33	0.098	–***
Total CLA	23.24	47.99	0.930	–***

NS, no significant difference between means ($P > 0.05$).
[a] Means are from seven triplicate samples.
[b] Polyunsaturated fatty acids (% from total fatty acids).
[c] Monounsaturated fatty acid (% from total fatty acids).
[d] Saturated fatty acid (% from total fatty acids).
[e] Total of *n*−6 fatty acid (% from total fatty acids).
[f] Total of *n*−3 fatty acid (% from total fatty acids).
[g] Sum of CLAs *cis*, *cis* (8,10;9,11;10,12;11,13).
[h] Sum of CLAs *trans, trans* (8,10;9,11;10,12;11,13).
* Significant at 5% level.
** Significant at 1% level.
*** Significant at the 0.1% level by Student's *t*-test.

The ratios of *n*−6/*n*−3 and PUFA/SFA were similar for steers and bulls (Table 4). The mean *n*−6/*n*−3 ratio was 1.87, a value within the maximum range (4.0) recommended by the English health department (HMSO, 1994). *n*−6 and *n*−3 fatty acids have important roles in reducing the risk of coronary heart disease; however, the optimal balance between these two classes of fatty acids is still a matter of debate (Hu, 2001).

Ruiz et al. (2005) observed a higher PUFA/SFA ratio in bulls (0.25) in comparison to steers (0.16), both values are higher than that of this study, which was closer to that of French et al. (2000) for steers finished on pasture (0.13) and lower than the results of Prado et al. (2003), who found 0.28 for Nelore steers finished on pasture.

3.3. Quantification of CLA isomers

The concentrations of CLA isomers in the purified fat of LM and CLA isomers in LM of steers and bulls are presented in Table 4.

It was possible to separate isomers *c*-9, *t*-11; *c*-11, *t*-13 and *t*-10, *c*-12. However, those with double bonds in positions 8.10; 9.11; 10.12; 11.13 were grouped in the *cis*, *cis* and *trans*, and *trans* classes (Table 4).

The isomer in largest concentration was 18:2 *c*-9, *t*-11, with difference between bulls and steers. Isomer 18:2 *c*-9, *t*-11 represented 51.80% of the total CLA content of bull LM and 59.85% of total CLA content of steer LM. Mendoza et al. (2005) analyzed LM of different crossings of Zebu and European breeds fed on *Braquiária* spp. pasture and observed a CLA content of 68.71% for isomer 18:2 *c*-9 *t*-11. It is important to emphasize that this concentration of isomer 18:2 *c*-9, *t*-11 was observed in LM of steers and bulls finished in a tropical pasture system.

The CLA content obtained in both bulls and steers (mean of 14.10 mg g^{-1} TL) was larger than that found by Mendoza et al. (2005), who obtained 1.01 mg g^{-1} TL *c*-9, *t*-11 and 0.47 mg g^{-1} TL for *t*-10, *c*-12 with a total CLA content of 1.47 mg g^{-1} TL for crossings of Zebu and European breeds fed on *Braquiária* spp. pasture. Elmore et al. (2004) also found lower total CLA contents of 4.8 mg 100 g^{-1} muscle for Aberdeen Angus and 7.6 mg 100 g^{-1} muscle for Holstein-Friesian steers fed on grass silage.

French et al. (2000) evaluated CLA in intramuscular (i.m.) fat of steers grazed on either grass or grass silage or fed concentrate-based diets. They showed that the decrease in the amount of concentrate in diet caused a linear increase in intramuscular CLA concentration. The proportion of CLA in the muscles of cattle finished on pasture was 10.8 mg g^{-1} TL, while in those fed 4 kg concentrate day^{-1}, the proportion was 4.7 mg g^{-1} TL.

The analysis of the CLA isomer concentration in LM revealed that steers presented higher values than bulls. This was due to the higher muscle fat content of steers in comparison to that of bulls. Thus the consumption of 100 g steer LM results in an intake of 47.99 mg CLA, while the

consumption of 100 g bull LM results in an intake of 23.24 mg CLA.

4. Conclusion

There are only slight differences between fatty acid profiles of the *Longissimus* muscle of bulls and steers finished in tropical pasture system.

Although there was no difference in the concentration of CLA in lipid in *Longissimus* muscle of steers and bulls, steer meat had a higher CLA content due to the higher lipid content.

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