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Analysis of fatty acids in *Longissimus* muscle of steers of different genetic breeds finished in pasture systems

Roseli das Graças Padre [a], Juliana Aparecida Aricetti [a], Sandra Terezinha Marques Gomes [a], Rafael Henrique de Tonissi Buschinelli de Goes [b], Fernanda Barros Moreira [c], Ivanor Nunes do Prado [d], 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 Maringá/ Campus Umuarama, CEP 87507-190 — Umuarama, PR, Brazil*
[c] *Departamento de Zootecnia, Universidade Estadual de Londrina, Campus Universitário, CEP 86051990 — Londrina, PR, Brazil*
[d] *Departamento de Zootecnia, Universidade Estadual de Maringá, Av. Colombo, 5790, CEP 87020-900 — Maringá, PR, Brazil*

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Abstract

The chemical composition, the fatty acids profile, and conjugated linoleic acids content in *Longissimus* muscle (LM) of steers have been determined. For such, 18 steers (6, Nellore, NEL) and their Simmental (6, NSI), and Santa Gertrudes (6, NSG) crossbreds finished in pasture system with *Brachiaria brizantha* cv. marandu for about 3 months with approximate weight at slaughter of 480 kg at average age approximate of 25 months. The lipid content increased in the following order influenced by genetic groups: Nellore, F1 Nellore × Simmental and F1 Nellore × Santa Gertrudes crossbreds. The lipid content increased while moisture, ash and protein contents decreased. The content of saturated fatty acids (SFA) was affected by genetic groups. The conjugated linoleic acids contents (CLA) in fat were similar in the genetic groups, but the quantity of CLA concentrations in muscle lipids of steers with larger total lipid was higher. The predominant CLA was CLA *cis*-9, *trans*-11.

Keywords: Beef; Conjugated linoleic acids; Crossbreds; *Longissimus*; Pasture

1. Introduction

Beef consumption is taking third place to pork and poultry in the world, mainly due to its higher cost in relation to other types of meat, larger space requirements for breeding in comparison to those required for swine and poultry, and also due to beef fat association to human health problems. However, low fat contents (less than 5% relative to muscle) and low cholesterol contents (less than 75 mg/100 g) have been observed in beef chemical analyses, ranging from one third to one half of the daily recommended cholesterol intake (Jiménez-Colmenero et al., 2001).

Beef is one of the main protein sources with high nutritional value, source of fat soluble vitamins E, A and

* Corresponding author. Tel.: +55 44 3261 3655; fax: +55 44 3261 4125.
E-mail address: mmakoto@uem.br (M. Matsushita).

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D, being an excellent source of Complex B vitamins, and of minerals like iron and zinc (Saucier, 1999). In addition, beef presents conjugated linoleic acids (CLA), an important constituent related to a series of beneficial effects to health (Khanal, 2004).

CLA consists of a group of geometric and positional isomers of linoleic acid. CLA is used as a collective term because all known isomers have double bonds with a single carbon bond in between (conjugated double bounds) instead of the usual methylene separations (Schimid et al., 2006). There are 56 potential geometric and positional CLA isomers (Yurawecz et al., 2001), with variations in double bonds position and geometry (*cis* or *trans* configurated). Two of the isomers (*cis*-9, *trans*-11 and *trans*-10, *cis*-12) are known to possess biological activity (Pariza et al., 2001). The interest in CLA research is associated to its positive effects on cancer, cardiovascular disease, diabetes, body composition, lipid metabolism, immune system, bone health and oxidation (Pariza et al., 2001; Khanal, 2004; Wahle et al., 2004; Wang and Jones, 2004; Scollan et al., 2006).

A host of factors appear to affect the CLA content in milk and meat from ruminants. Such factors could be divided into three broad categories: diet related, animal related and post-harvest related (Khanal and Olson, 2004). Pasture feeding resulted in significantly increased concentrations of the sum of CLA isomers in the tissue lipids (Dannenberger et al., 2005). According to Realini et al. (2004), pasture-fed animals have a higher concentration PUFA (polyunsaturated fatty acids), stearic (18:0), linoleic (LA), linolenic (LNA), arachidonic (20:4 n-6, AA), eicosapentaenoic (20:5 n-3, EPA), and docosapentaenoic (22:5 n-3, DPA) acids than animals fed concentrate. Additionally, breed differences affect the lipid content in tissue of animals, which is indirectly related to CLA content. Some breeds that have a tendency to deposit higher amounts of fat on muscle produce a higher quantity of CLA (Mir et al., 2004).

While Brazil, a tropical country, offers unfavorable weather conditions for European breeds, as they are more susceptible to diseases and to the hot weather, it is better suited to more resistant Asian breeds such as Nellore. As a result, crossbreeding is rather beneficial.

The objective of this work was to evaluate the chemical composition, the fatty acids profile, and to quantify conjugated linoleic acids isomers in *Longissimus* muscle (LM) of Nellore steers and their crossbreds with Simmental and Santa Gertrudes finished in *Brachiaria brizantha*, cv. marandu pasture.

2. Materials and methods

2.1. Animal management and sampling

The experiment was carried out in Brazil, in a region with predominantly equatorial hot humid climate, (9°53′02″ latitude South, 56°14′38″ longitude West, 288 m above sea level). The experimental area of 10 ha of *B. brizantha* grass was divided into three paddocks provided with covered double-access troughs with mineral food supplementation and water troughs for each group of animals. Three animal groups were kept apart.

Eighteen steers with average initial and final ages of 22 and 25 months, F1 Santa Gertrudes × Nellore (NSG; $n=6$), F1 Simmental × Nellore (NSI; $n=6$), and Nellores (NEL; $n=6$) were studied. The animals from the different breeds were identified and assigned homogeneously and randomly to paddocks. The animals were weighed before the experiment and every 21 days.

The finishing period lasted three months. The average slaughter weight was 490 kg for NSG steers, and 471 kg for NSI and NEL steers.

Five forage samples were collected from an area of 0.25 m^2 of each fenced pasture every 28 days (Holderbaun and 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 for later chemical analyses.

The animals were slaughtered at a slaughterhouse 10 km away from the farm, according to industrial practice in Brazil. After slaughter, the carcasses were 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 laboratory. Cover fat was discarded and the muscle portion was frozen at −18 °C for later analysis.

2.2. Chemical composition

Laboratory beef analyses were carried out four months after sampling. The samples were unfrozen at 0 °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). 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 methylation of triacylglycerols 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 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).

2.3. Chromatographic analysis and cholesterol quantification

Cholesterol content was analyzed in a 14-A gas chromatograph (Shimadzu, Japan) equipped with flame ionization detector and fused silica capillary column (25 m length, 0.25 mm internal diameter, and 0.25 μm OV-5, Ohio Valley, USA). 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 a carrier gas, 30 mL/min N_2 as make-up gas, 300 mL/min synthetic gas, and 30 mL/min 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 (Sigma Chemical Co., St. Louis, MO, USA). Sample cholesterol quantification was carried out after verification of method linearity. Standard cholesterol solutions were prepared in concentrations 0.0; 0.4; 0.8; 1.6, and 2.0 mg/mL, all containing 0.20 mg/mL 5-alpha-cholestane (Sigma, USA), and analyzed. The ratio of the areas of cholesterol and 5-alpha-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.

2.4. Analysis of fatty acids methyl esters

Fatty acids methyl esters (FAME) 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 the FAME followed the recommendation of the 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, between a 0.02 to 4.50 mg/mL interval.

2.5. 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 is reported in mg/g of lipid by using the following formula:

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

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 calculated 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

Table 1
Chemical composition of *Longissimus* muscle of steers from different genetic groups finished in pasture system ($n=18$)[a]

	NEL[b]	NSI[c]	NSG[d]	SE	Effect
Moisture (g/kg)	741[E]	739[E,F]	733[F]	0.215	*
Ash (g/kg)	10.5[E]	10.2[E,F]	9.8[F]	0.014	**
Crude protein (g/kg)	234[E]	230[E,F]	227[F]	0.148	*
Total lipid (g/kg)	26.5[F]	31.2[F]	36.4[E]	0.115	**
Cholesterol (mg/100 g muscle)	46.44[F]	46.90[F]	48.29[E]	0.017	*

[a] Means of six triplicate samples; [b] Nellore breed; carcass weight: 255.3 kg; fat thickness: 5.04 mm. [c] F1 Simmental × Nellore crossbreed; carcass weight: 248.1 kg; fat thickness: 3.9 mm. [d] F1 Santa Gertrudes × Nellore crossbreed; carcass weight: 255.6 kg; fat thickness 3.42 mm; NS, no significant difference between means ($P>0.05$); different letters in the same line are significantly different; * significant at 5%-level; ** significant at 0.1%-level by Tukey's test.

Table 2
Fatty acid profiles (g/kg total fatty acids) of *Brachiaria brizantha* sampled paddocks

Fatty acid	*Brachiaria brizantha*
Polyunsaturated	451
Monounsaturated	252
Saturated	297
Σn-6	169
Σn-3	282

rather than as methyl esters (Mendoza et al., 2005; Padre et al., 2006).

2.6. Experiment design and statistical analysis

The experiment design involved 3 treatments and 6 repetitions per treatment. The results were submitted to variance analysis (ANOVA) at 5% significance level with Statistica 7.0 software (StatSoft, 2005) by Tukey's test.

Table 3
Fatty acid profiles (g/kg of total fatty acids) of *Longissimus* muscle of steers from different genetic groups finished in pasture system ($n=18$)[a]

Fatty acid	NEL[b]	NSI[c]	NSG[d]	SE	Effect
14:0	$20.4^{J,K}$	21.9^{K}	28.3^{J}	0.098	*
16:0	240^{K}	242^{K}	258^{J}	0.315	**
18:0	179	179	189	0.248	NS
18:1 n-9	384^{J}	382^{J}	371^{K}	0.218	*
19:0	0.9^{K}	1.8^{J}	1.5^{J}	0.012	**
18:2 t-9,c-12	1.6	2.1	2.3	0.014	NS
18:2 n-6	29.8^{J}	22.0^{K}	25.3^{K}	0.128	*
18:3 n-3	7.4	6.5	7.8	0.039	NS
20: 2 n-6	1.3	1.9	1.7	0.013	NS
20:3 n-6	3.3^{J}	2.1^{K}	2.0^{K}	0.015	***
22:1 n-7	1.7^{J}	1.2^{K}	$1.4^{J,K}$	0.008	*
22:5 n-3	7.1^{J}	4.3^{K}	5.1^{K}	0.036	***
22:6 n-3	1.6^{J}	0.7^{K}	1.1^{J}	0.009	*
PUFA[e]	73.3^{J}	65.7^{J}	45.7^{K}	0.304	NS
MUFA[f]	456	457	446	0.375	NS
SFA[g]	470^{J}	477^{J}	508^{K}	0.521	*
n-6[h]	46.6	36.7	40.7	0.162	NS
n-3[I]	20.9^{J}	15.6^{K}	18.1^{J}	0.142	*
n-6/n-3	2.23	2.35	2.25	0.216	NS
PUFA/SFA	0.15	0.14	0.09	0.010	NS

[a] Means of six triplicate samples; [b] Nellore breed; carcass weight: 255.3 kg; fat thickness: 5.04 mm. [c] F1 Simmental × Nellore crossbreed; carcass weight: 248.1 kg; fat thickness: 3.9 mm. [d] F1 Santa Gertrudes × Nellore crossbreed; carcass weight: 255.6 kg; fat thickness 3.42 mm. [e] Polyunsaturated fatty acids. [f] Monounsaturated fatty acids. [g] Saturated fatty acids. [h] Total of n-6 fatty acids. [i] Total of n-3 fatty acids. NS, no significant difference between means ($P>0.05$); different letters in the same line are significantly different; * significant at 5%-level; ** significant at 1%-level; *** significant at 0.1%-level by Tukey's test.

3. Results

3.1. Chemical composition

The results showed, that the chemical composition of *Longissimus* muscle (LM) was different between genetic groups (Table 1). Nellore (NEL) breed presented higher moisture, ash, and crude protein concentration when compared to F1 Nellore Santa Gertrudes (NSG) breed, while F1 Nellore Simmental (NSI) animals did not present differences ($P<0.05$) in relation to the two other genetic groups. The total lipid and cholesterol concentration were lower for NEL and NSI genetic group when compared to NSG group.

3.2. Fatty acids profile

The fatty acids profile of *B. brizantha* grass is presented in Table 2. This grass is rich in PUFA, most of which from the n-3 fatty acids, resulting in a n-6/n-3 ratio of 0.60.

Table 3 shows the fatty acids profile of LM of NEL, NSI, and NSG steers feed *B. brizantha* during three months finishing. The NEL breed presented lower 16:0 acid and higher 18:1 acid when compared to NSG. The NSG breed presented the highest SFA proportion and the lowest PUFA proportion.

Upon analysis of the total n-3 series fatty acids, it was detected that differences ($P<0.05$) for NEL and NSG breeds were in contrast to NSI. The total n-6 series was similar between genetic groups.

As observed in Table 4, in general, NSG animals presented a larger content of two isomers with biological functions, CLA *cis*-9, *trans*-11 and CLA *trans*-10, *cis*-12.

Table 4
Concentrations of CLA isomers in fat of *Longissimus* muscle of steers from different genetic groups finished in pasture system ($n=18$)[a]

	NEL[b]	NSI[c]	NSG[d]	SE	Effect
CLA (mg/g fat)					
c-9, t-11 — 18:2	8.43^{F}	9.24^{F}	9.94^{E}	0.244	*
t-10, c-12 — 18:2	2.86^{F}	$3.18^{E,F}$	3.88^{E}	0.130	**
CLA (mg/100 g LD)					
c-9, t-11 — 18:2	19.32^{G}	22.95^{F}	31.20^{E}	1.324	**
t-10, c-12 — 18:2	6.55^{G}	7.98^{F}	12.57^{E}	0.668	**

[a] Means of six triplicate samples; [b] Nellore breed; carcass weight: 255.3 kg; fat thickness: 5.04 mm. [c] F1 Simmental × Nellore crossbreed; carcass weight: 248.1 kg; fat thickness: 3.9 mm. [d] F1 Santa Gertrudes × Nellore crossbreed; carcass weight: 255.6 kg; fat thickness 3.42 mm; different letters in the same line are significantly different; * significant at 5%-level; ** significant at the 0.1%-level by Tukey's test.

4. Discussion

4.1. Chemical composition

The present study highlights the low fat content of a *Longissimus dorsi* beef from cattle finished in pasture systems. Moreira et al. (2003) found for Nellore steers finished in star grass pasture similar *Longissimus dorsi* lipid content (18.7 g/kg) and lower cholesterol content (39.24 mg/100 g). The cholesterol value found in this work are close to those found by Rule et al. (2002) for crossbred steer and bison beef, which presented values of 43.8, 52.3 mg/100 g LM, respectively, for pasture animals of Italy.

The present study also highlights the low cholesterol concentration of a common serving of beef. Therefore, the consumption of 200 g LM from NEL analyzed in the present study represents a cholesterol intake of 92.88 mg.

Mir et al. (2004) reported that genetic factors are important to determine the quantity of fat at a certain weight as an increase in fat level of up to 50% is found for different breed. Costa et al. (2002) observed a positive correlation between carcass fat percent and cholesterol content in beef, indicating that carcasses with higher fat content also present larger amounts of cholesterol. The high total cholesterol level for NSG can be explained by the increase in the total lipid levels in the muscle.

4.2. Fatty acids profile

The PUFA contents obtained in *B. brizantha* grass (Table 2) was lower than those found by Moreira et al. (2003), who obtained for two tropical climate pastures, 658 (millet), and 681 g/kg (star grass). Although the animal diet contained high levels of PUFA, the meat presented high values of SFA and low values of PUFA due to biohydrogenation in the rumen, forming mainly 18:0 and 18:1 acids (Tamminga and Doreau, 1991).

The results of Table 3 showed that saturated fatty acids varied from 10 to 20 carbon atoms, predominating 16:0 in this class, with values for the analyzed genetic groups higher that those of Varela et al. (2004), who analyzed *Gallega rubia* steers, with 171 g/kg for animals feed in pasture, and 200 g/kg for animals fed concentrate plus corn silage, a content lower than that obtained by Noci et al. (2005), comparatively to 264 g/kg for animals fed grass silage. Another SFA predominant was 18:0, with values close to those obtained by Varela et al. (2004), with 194 g/kg (pasture), and 180 g/kg (corn silage), and higher than the obtained by Noci et al. (2005) 151 g/kg (grass silage).

In the MUFA class, C18:1cis fatty acids presented the highest value. It has a positive effect (reduces LDL and increases HDL in the organism, Katan et al., 1994). Clinical trials and observational studies have associated low fat diet with lower risk of cardiovascular diseases. A study was done to evaluate the effects of a low-fat eating pattern on the risk of colorectal cancer (Beresford et al., 2006), on the incidence of cardiovascular disease (Howard et al., 2006) and on the breast cancer incidence (Prentice et al., 2006) in postmenopausal women during an 8.1 year average follow-up period. Although the dietary intervention reduced the fat intake, there were only small but significant decreases on cardiovascular risk factors like decreases in body weight, waist circumference, LDL level (Howard et al., 2006). However, a diet with low fat content did not result in a statistically significant reduction in the risk of colorectal cancer (Beresford et al., 2006), in the incidence of cardiovascular disease (Howard et al., 2006) and in the breast cancer incidence (Prentice et al., 2006) in postmenopausal women during an 8.1 year average follow-up period. This study suggests that more focused diet and life style interventions may be needed to reduce these diseases risks.

Relative to PUFA, 18:2 n-6 and 20:4 n-6 predominated in LM of all animals studied, besides the presence of long chain fatty acids resulting from the elongation of acids 18:2 n-6 and 18:3 n-3. The value of 18:2 n-6 was lower than that found by Noci et al. (2005) and Varela et al. (2004), who found 47 g/kg and 51 g/kg, respectively, for animals finished in pasture and 20:4 n-6 value of 11 and 19 g/kg, respectively. 18:3 n-3 and 20:5 n-3 did not differ between genetic classes, Varela et al. (2004) obtained 24 and 16 g/kg, respectively, for the same fatty acids. The authors also found larger PUFA content, 118 g/kg, values close to that of MUFA, 454 g/kg, and lower for SFA, 424 g/kg, comparatively to those found in this study.

Aharoni et al. (2004) studied Frisiam calves fed diets with high (65.60% of forage) and low (33.80% of forage) forage level with soybean supplementation. These authors found high PUFA concentration when the diet was rich in forage (79 g/kg) when compared to diets with low level of forage (55 g PUFA/kg of fatty acids). These data indicate that the PUFA could be increased when cattle were finished in pasture systems. In this experiment, the mean PUFA was 62 g/kg, a proportion similar to the one obtained by Aharoni et al. (2004).

The mean n-6/n-3 found in this experiment was 2.28, a value within the maximum range (5.0) recommended by Simopoulos (2004). N-3 and n-6 fatty acids have important roles in reducing the risk if coronary heart

disease; however, the optimal balance between theses two classes of fatty acids is still a matter of debate (Hu, 2001).

The predominant CLA isomer was CLA *c*-9, *t*-11. Padre et al. (2006) evaluating LM of steers finished in pasture system, found 59.89% of total CLA as CLA *c*-9, *t*-11. Mendoza et al. (2005) evaluated the LM of different Zebu crossbreds with European breed fed *Brachiaria* spp., and observed a CLA content of 74.44% for the CLA *c*-9 *t*-11 isomer. The same authors did not find differences on CLA *c*-9 *t*-11 isomer proportion for bulls and steers. However, Dannenberger et al. (2005) found for bulls finished in pasture system higher proportion of CLA *c*-9, *t*-11 (91% of total CLA as CLA *c*-9, *t*-11).

The CLA contents of all genetic groups analyzed in this study were higher than those found by Mendoza et al. (2005), who found 1.01 mg/g intramuscular lipids of CLA *c*-9, *t*-11 and 0.47 mg/g intramuscular lipids for CLA *t*-10, *c*-12. The total CLA content was 1.47 mg/g intramuscular lipids in animals of different Zebu crossbreds with European breeds fed *Brachiaria* spp. pasture. Elmore et al. (2004) also found lower CLA contents for Aberdeen Angus steers (4.8 mg/100 g muscle) and Holstein–Frisian steers (7.6 mg/100 g muscle) fed grass silage.

French et al. (2000) evaluated the CLA content in fat of steers finished on grass pasture, grass silage, and concentrate based diets and observed that a decrease in concentrate in diet is associated to a linear increase in CLA content in fat. The CLA value in muscle of pasture finished animals was 10.8 mg/g, while fat in those fed 4 kg/day concentrate was 4.7 mg/g of muscle. Padre et al. (2006) evaluated the CLA concentration in LM of steers finished in a Mombaça pasture system. They found a total CLA concentration of 14.61 mg/g of LM and the CLA *c*-9, *t*-11 concentration was 8.75 mg/g of LM. On this experiment, the animals were kept all the time on a pasture system, which can justify the high value of total CLA in the muscle.

Still in relation of the CLA content, researchers such as Mir et al. (2004) studied animals of different breeds and found 2.7 mg/g fat and 25 mg/100 g muscle (control diet), 12.9 mg/g fat and 134 mg/100 g muscle (sunflower oil enriched feed) for Wagyu breed; 2.8 mg/g fat and 18.0 mg/100 g muscle (control diet), 11.9 mg/g fat and 76 mg/100 g muscle (sunflower oil enriched feed) for Wagyu–Limousin crossbred, while the CLA content in animal tissue varied greatly with finishing season and plant age.

Converting the CLA content to 100 g in muscle reveals that NSG animals still presented larger values of most CLAs, and a higher value of total CLA. The NEL breed present a meat with lower proportion of fat, and a lower concentration of CLA when compared to NSG genetic group.

5. Conclusion

The LD chemical composition and fatty acids profile is influenced by the genetic group. NEL breed presented lower fat deposition and lower SFA proportion when compared to NSG breed.

There are only slight differences in the concentration of CLA in lipids from the genetic groups evaluated, however, the CLA concentration in *Longissimus* muscle of NSG breed was higher then NSI and NEL due to the higher lipid content in the muscle.

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