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Carcass Characteristics and Chemical Composition of the *Longissimus* Muscle of Nellore, Caracu and Holstein-friesian Bulls Finished in a Feedlot

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ABSTRACT : This work was carried out to study the carcass characteristics, the chemical composition and the fatty acid profile in *Longissimus* muscle (LM) of bull breeds Nellore, NEL (11), Caracu, CAR (12) and Holstein-Friesian, HFR (12) finished in a feedlot. The bulls were fed twice a day with corn silage, cotton meal, cracked corn, urea, limestone and mineral salt. NEL and CAR bulls had similar ($p>0.05$) final weight and hot carcass weight. However, NEL and CAR bulls had higher ($p<0.05$) final weight and hot carcass weight than HFR bulls. Carcass hot dressing, carcass conformation, cushion thickness, *Longissimus* muscle area and texture were similar ($p>0.05$) among NEL, CAR and HFR bulls. NEL and HFR bulls had higher ($p<0.05$) carcass length in comparison to the CAR breed. Nellore breed had higher ($p<0.05$) leg length in comparison to CAR and HFR breeds. Leg length was similar ($p>0.05$) between CAR and HFR breeds. Thickness fat, color and marbling score were lower ($p<0.05$) in NEL breed in comparison to CAR and HFR breeds. LM of NEL bulls had higher ($p<0.05$) meat moisture content in comparison to CAR and HFR bulls. In contrast, lipid content was lower ($p<0.10$) in HFR bulls. LM ash and crude protein contents were similar ($p>0.05$) among breeds. Saturated fatty acids (SFA) were higher ($p<0.10$) in HFR animals. Monounsaturated fatty acids (MUFA), polyunsaturated fatty acids (PUFA), *n*-6, *n*-3 and PUFA/SFA ratio were similar ($p>0.05$) among the different breeds. *N*-6/*n*-3 ratio was higher ($p<0.05$) in CAR animals. (**Key Words :** Beef, Breed, Carcass, Chemical Composition, *Longissimus* Muscle)

INTRODUCTION

Brazil has the biggest commercial cattle herd in the world, with approximately 159 million animals and a production of approximately 8.2 millions tons of carcass each year (Anualpec, 2007). Brazil has the great potential to become the highest bovine meat producer and exporter, but, to achieve such position, it is extremely important to control the quality of the commercialized product.

Beef has an excellent nutritional quality because it has proteins of high biological value, it is rich in vitamin contents, especially B-complex, and it is associated to a high mineral content, especially iron, in high bioavailability form (Saucier, 1999). Beef contains all the 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. Low presence fat contents (less than 5% relative to muscle, Moreira et al., 2003; Prado et al., 2008a;b;c;d) and low cholesterol contents (less than 50 mg/100 g in the muscle) have been observed in beef chemical analyses, ranging from one third to one half of the daily recommended cholesterol intake (Greghi et al., 2003; Padre et al., 2006; Macedo et al., 2007; Padre et al., 2007; Aricetti et al., 2008; Kazama et al., 2008; Prado et al., 2008a;b;c;d; Maggioni et al., 2009).

Breed of cattle is one of the most important factors for fat deposition and composition that needs to be understood because of its genetic transmission. However, the detailed mechanisms of the variation, and whether or how they can

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Table 1. Scale of points for carcass conformation

Conformation	Minus	Mid	Plus	Conformation	Minus	Mid	Plus
Inferior	1	2	3	Good	10	11	12
Poor	4	5	6	Very good	13	14	15
Regular	7	8	9	Superior	16	17	18

Source: Müller (1980).

be manipulated are not clearly known. British breeds are well-known for their highly marbled meat while the Zebu and Holstein-Friesian breeds contains less fat and more connective tissue (Moreira et al., 2003). In the warm region of the Brazil, adapted breeds of cattle are primarily limited to *Bos indicus* cattle bred with Brazilian Nellore.

Caracu is a tropically adopted, criollo beef breed to Brazil. Few studies have investigated the meat characteristics of Caracu but focused more on reproductive and performance (Perotto et al., 2000; Gesualdi Jr et al., 2006). Marbling and fatty acid composition of Caracu cattle, especially as compared to other pure breeds and crossbreeding remain few studied. Caracu is a breed with European origin (Bos taurus Taurus, Aquitaine) and it was brought by the initial colonizers.

Beef normally has a low PUFA/SFA ratio compared with pork because of the biohydrogenation of unsaturated fatty acids in rumen (Tamminga et al., 1991). Enser et al. (1996) found that for steaks and chops the mean P/S ratio is 0.11 and 0.58 for beef and pork respectively and is more favorable for pork. However, these mean values may vary largely depending on genetic and feeding factors and should thus not be generalized (Webb, 2006).

This work was carried out to study the carcass characteristics, the chemical composition and the fatty acid profile in *Longissimus* muscle (LM) of bulls breeds Nellore (11), Caracu (12) and Holstein-Friesian (12) finished in feedlot.

MATERIAL AND METHODS

Animal management and sampling

The State University of Maringa animal care and use committee approved the use of animals in this study (CIOMS/OMS, 1985).

This study was carried out at Experimental Farm of Agronomic Institute of Paraná, south Brazil. Thirty five (11 Nellore, 12 Caracu and 12 Holstein-Friesian) bulls with an initial average of 22 months old were used. The meat analyzes were carried out at Chemical Laboratory of State University of Maringa.

After weaning (8 mo old), each breed was kept in a fenced pasture Braquiaria gras (*Brachiaria decumbens* Stapf) until 18 mo old when they were fed in feedlot. The animals were kept in an exclusive pasture system together from 8 to 18 months old. After 18 months on pasture, they were divided in three breeds groups: NEL, CAR and HFR. The animals were kept separate in individual pen (5 m^2 each animal) for 4 months. The animals were fed twice a day. They were given access to a diet formulated to meet requirements for fattening beef cattle (NRC, 1996). The diet consisted of 50% silage corn, 20% cracked corn, 13% cotton meal, 15% corn germen, 1.0% urea, 0.5% limestone, and 0.5% mineral salt. The animals were weighed in the beginning of feed-lot and each 28 days, and on the day before slaughter after 12-h fasting.

Carcass characteristics

The animals were slaughtered at a commercial slaughterhouse 90 km away from the Experimental Farm of Agronomic Institute of Paraná with the same age (22 months), according to industrial practice in Brazil. After slaughter, the carcass were identified and cooled for 24 h at 4°C. The animals were selected for slaughtered by body weight, according to Brazilian market.

Hot carcass weight (HCW) : It was determined before cooling.

Carcass dressing (CAD) : For an individual animal is defined as hot carcass weight divided by live weight.

Carcass conformation (CAC) : It was evaluated by Müller's point scale (Müller, 1980) in which the highest value indicates the best conformation. The carcass conformation were reported as superior, very good, good, regular, poor, and inferior; ratings may also be reported as plus, mid, and minus. The carcass length was evaluated by measurements taken from the border of the pubis bone until the anterior side of the first rib (Table 1).

Carcass length (CAL) : It is the distance since the anterior board of bone of pubis into the previous side of first rib, measure with a ribbon or a tape line.

Leg length (LEL) : It was evaluated using a wood compass with metallic edges that measures the distance from the anterior border of the pubis bone to a middle point at the tarsus bone.

Cushion thickness (CUT) : It was taken by a wood compass with metallic edges that measures the distance between the lateral face and the median at the superior part of the cushion. The cushion is flat muscle (*Biceps femoris*).

Fat thickness (FAT) : It was taken by a caliper averaging three points between the 12^{th} and the 13^{th} rib but over the LM.

Longissimus muscle area (LMA) : *Longissimus* area was

Table 2. Scale of points for meat texture and color evaluation

Meat texture	Points	Meat colour	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).

measured by a tracing made on the right side of carcass, where is made a transversal cut between the 12ª and 13ª ribs, exposing the *Longissimus* muscle. After this, a compensating planimeter, which is an instrument that measures area of irregularly shaped objects, was used to determine the area.

Color (COL) : Muscle color after 24 h carcass cooling was analyzed. Coloration was evaluated according to a point scale (Table 2) 30 min after a transversal section was made on the *Longissimus* between the 12th and 13th ribs.

Texture (TEX) : Texture was determined through the size of the fascicle (muscle "grain" size) and evaluated subjectively with a point scale (Table 2).

Marbling (MAR) : Intramuscular fat was measured in *LM* between the 12th and 13th ribs according to the scores in Table 3.

After 24 h LM samples (300 g) 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 -20°C for later analysis.

Chemical composition

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

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

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

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 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, all containing 0.20 mg/ml 5-α 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 (Rowe et al., 1999; Milinsk et al., 2005).

Analysis of fatty acid methyl esters

The fatty acids 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) for 22 min, and 240°C (15°C/min) for 30 min, with 45-psi pressure. The injector and detector were kept at 220°C and 245°C, respectively. The gas fluxes (White Martins) used was: 1.4 ml/min 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 the relative retention times of FAME peaks of the samples with fatty acids methyl esters standards from Sigma (USA) by spiking samples with standard. The peak areas were determined by

Table 3. Scale of points for marbling grade evaluation

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

Source: Müller (1980).

Table 4. Means (±SE) showing the effect of breed on carcass characteristics of bulls finished in a feedlot

Parameters	Breed of bull			Effect (p value)
	NEL[1]	CAR[2]	HFR[3]	
Final weight (kg)	536±16.2[a]	514±15.5[a]	448±13.5[b]	0.05
Hot carcass weight (kg)	276±9.76[a]	272±9.62[a]	237±8.38[b]	0.10
Carcass dressing (%)	51.5±1.01	52.8±1.04	53.2±1.04	NS
Conformation (points)	10.6±0.68	12.9±0.83	12.0±0.77	NS
Leg length (cm)	79.5±0.92[a]	70.3±0.81[b]	77.6±0.89[a]	0.01
Carcass length (cm)	147±1.37[a]	132±1.23[b]	131±1.21[b]	0.01
Cushion thickness (cm)	24.6±0.53	26.0±0.56	25.3±0.54	NS
Fat thickness (mm, mean of 3 values)	1.63±0.20[b]	2.88±0.35[a]	2.32±0.29[ab]	0.05
Longissimus area (cm^2)	59.9±1.51	63.5±1.60	59.3±1.50	NS
Color (points; low values = darker)	2.50±0.13[b]	3.75±0.20[a]	4.27±0.23[a]	0.01
Texture (points; low values = coarser)	4.38±0.15	4.13±0.14	4.09±0.14	NS
Marbling (points; low values = less marbling)	3.00±0.26[b]	5.63±0.50[a]	4.00±0.38[ab]	0.01

[1] Nellore. [2] Caracu. [3] Holtein-Friesian. NS = No significant difference among means.
Means with different letters, in the same line, are different by Tukey test.

Star software (Varian). The data were expressed as percentages of the normalized area of total fatty acids.

Experiment design and statistical analysis

The experimental design consisted of 3 treatments: 11 NEL, 12 CAR and 12 HFR bulls. The data were submitted to an analysis of variance, and the averages (when different) were compared using the Tukey test at 10, 5 and 1% significance levels, using SAS statistical software (2000).

RESULTS AND DISCUSSION

Carcass characteristics

Table 4 shows the carcass characteristics of NEL, CAR and HFR bulls finished in feedlot. NEL and CAR bulls had similar ($p>0.05$) final weight (FWE) and hot carcass weight (HCW), which were greater ($p<0.05$) than the FWE and HCW of HFR bulls. The higher FWE and HCW observed to NEL and CAR breeds is due the higher average day gain during of the life (Perotto et al., 2000). The higher FWE observed to NEL and CAR breeds is due their ability to production of meat. In the other hand, animals HFR have higher ability to production of milk, as they have lower average daily gain.

Carcass dressing (CAD), carcass conformation (CAC), cushion thickness (CUT), *Longissimus* area (LMA) and texture (TEX) were similar ($p>0.05$) for all three breeds (Table 4). The CAD of all breeds was near 52.0%. This carcass dressing may be considered low. Abrahão et al. (2005) observed carcass dressing more than 54.8% in bulls finished in feedlot.

NEL and HFR breeds were longer ($p<0.05$) leg length (LEL) in comparison to that CAR breed, but the LEL was similar ($p>0.05$) between NEL and HFR breeds (Table 3). The lower leg length for CAR breed is due the selection work that animals were submitted for many years (selection for major muscle and fatty deposition in the body).

NEL breed was higher ($p<0.01$) carcass length (CAL) in comparison to that of CAR and HFR breeds. CAL was similar ($p>0.01$) between CAR and HFR breeds. The zebu breeds has major development of the carcass than the British and Caracu breeds, because the Zebus breeds had a selection for the animals may walk along in the tropical region looking for pasture.

On the contrary, fat thickness (FAT), color (COL) and marbling (MAR) score were lower ($p<0.05$) in NEL breed in comparison to that CAR and HFR breeds. Zebu breed was known for low fat deposition. The Nellore's muscle is considered leaner than others breeds because this animal has less marbling (Moreira et al., 2003) so presents less risk to human (Saucier, 1999). The result of marbling score can be due fat deposition.

Table 5. Means (±SE) showing the effect of breed on chemical composition in *Longissimus* muscle of bulls finished in a feedlot

Parameters	Breed of bull			Effect (p value)
	NEL[1]	CAR[2]	HFR[3]	
Moisture (%)	75.1±0.38[a]	73.4±0.40[b]	73.2±0.37[b]	0.05
Ash (%)	1.07±0.02	1.08±0.02	1.03±0.02	NS
Crude protein (%)	24.0±0.51	24.9±0.53	24.5±0.52	NS
Total lipids (%)	1.83±0.21[b]	2.55±0.29[a]	1.05±0.12[c]	0.10
Total cholesterol[4]	44.1±2.55[ab]	34.1±1.98[b]	55.3±3.20[a]	0.01

[1] Nellore. [2] Caracu. [3] Holstein-Friesian. [4] mg/100 g of muscle.
NS = No significant difference among means. Means with different letters, in the same line, are different by Tukey test.

Table 6. Means (±SE) showing the effect of breed on fatty acids profile (% of total of fatty acids) of *Longissimus* muscle of bulls finished in a feedlot

Fatty acids	Breed of bull			Effect (p value)
	NEL[1]	CAR[2]	HFR[3]	
C 14:0 Miristic acid	1.94±0.16[a]	2.16±0.18[a]	1.28±0.11[b]	0.05
C 14:1 *n*-7	0.27±0.02[a]	0.25±0.02[a]	0.13±0.01[b]	0.01
C 16:0 Palmitic acid	24.2±0.77	25.7±0.81	25.1±0.80	NS
C 16:1 *n*-7 Palmitoleic acid	1.88±0.16	2.39±0.20	1.81±0.15	NS
C 17:0 anti-isso	0.27±0.01[b]	0.18±0.01[c]	0.36±0.02[a]	0.01
C17:0 iso	0.58±0.03	0.50±0.03	0.55±0.03	NS
C 17:0 Margaric acid	0.98±0.07[a]	0.58±0.04[b]	0.70±0.05[b]	0.05
C 17:1 *n*-7 Heptadecenoic acid	0.68±0.03[a]	0.52±0.02[b]	0.53±0.02[b]	0.01
C 18:0 Estearic acid	21.5±0.98	19.4±0.89	20.2±0.92	NS
C 18:1 *n*-9 Oleic acid	35.2±0 96	37.5±1.02	35.9±0.97	NS
C 18:1*n*-7 Cis-vaccenic acid	3.13±0.08[a]	2.23±0.05[b]	3.61±0.09[a]	0.01
C 18:1 *t*-11 Trans vaccenic acid	1.43±0.09[a]	0.61±0.04[c]	1.05±0.07[b]	0.01
C 18:2 *n*-6 Linoleic acid	6.36±0.66	5.66±0.59	7.86±0.82	NS
C 18:3 *n*-6 Linolenic acid	0.16±0.02	0.13±0.01	0.19±0.02	NS
C 18:2 *c*-9 *t*-11 CLA	0.28±0.05[a]	0.21±0.02[b]	0.26±0.02[a]	0.10
C 18:3 *n*-3 α-Linolenic acid	0.38±0.05[a]	0.18±0.02[b]	0.30±0.04[ab]	0.01
C 20:4 *n*-6 Arachidonic acid	1.51±0.17[b]	1.47±0.16[b]	2.43±0.27[a]	0.05
C 20:5 *n*- 3 Eicosapentanoic acid - EPA	0.23±0.05	0.14±0.03	0.15±0.03	NS
C 22:0 Behenic acid	0.36±0.05	0.29±0.04	0.41±0.06	NS
C 22: 5 *n*- 3 Docosapentaenoic acid - DPA	0.33±0.06[a]	0.15±0.03[b]	0.20±0.03[ab]	0.05
C 22:6 *n*- 3 Docosahexaenoic acid - DHA	0.56±0.02[a]	0.51±0.02[a]	0.11±0.01[b]	0.01

[1] Nellore. [2] Caracu. [3] Holstein-Friesian.
NS = No significant difference among means. Means with different letters, in the same line, are different by Tukey test.

Chemical composition

Table 5 shows the chemical composition results of *Longissimus* muscle (LM) of NEL, CAR and HFR bulls. NEL bulls LM had higher ($p<0.05$) moisture contents in comparison to that of CAR and HFR bulls, but the moisture contents between CAR and HFR was similar ($p>0.05$). Meat moisture content is inversely related to its lipid content because the fat has low water content.

The ash content and crude protein content were similar ($p>0.05$) among breeds. The protein and ashes contents change very little in *Longissimus* muscle of cattle finished in feedlot (Greghi et al., 2003; Abrahão et al., 2005).

Total lipids was higher ($p<0.10$) in CAR breed in comparison to HFR breed and NEL breed (Table 5). Total lipids were lower ($p<0.10$) in HFR breed.

The animals HFR show low lipids contents because this animals did not select to fat deposition (Greghi et al., 2003). In the other hand, animals as NEL and CAR that were selected for meat production show the high muscle and fat deposition (Abrahão et al., 2005).

LM cholesterol content was lower ($p<0.01$) in CAR breed (34.1 mg/100 g muscle) to that HFR breed (55.3 mg/100 g muscle). LM cholesterol content in NEL (44.1 mg/100 g muscle) was similar ($p>0.01$) in comparison to that CAR and HFR. These values can be considered low in comparison to cholesterol levels cited in literature (Greghi et al., 2003; Moreira et al., 2003; Padre et al., 2006).

The variations observed among treatments can be explained by the age (22 months old).

However, the cholesterol content observed was 44.5 mg/100 g of muscle less than 50.0 mg/100 g of muscle have been reported in literature as been badly for human health (Saucier, 1999).

Fatty acid profile

The proportion of fatty acids in LM intramuscular fat is shown in Table 6. On the contrary observed in pork (Enser et al., 1996) the fatty acid composition in cattle change little in function with the diet (Greghi et al., 2003; Abrahão et al., 2005; Padre et al., 2007; Aricetti et al., 2008; Macedo et al., 2008; Prado et al., 2008a;b;c;d). Fatty acids diversity in cattle is partly explained by the biohidrogenation that occurs in the rumen (Tamminga et al., 1991).

The palmitic acid (C 16:0), palmitoleic acid (C 16:1 *n*-7), iso (C 17:0 iso), estearic acid (C 18:0), oleic acid (C 18:1 *n*-9), linoleic acid (C 18:2 *n*-6), linolenic acid (C 18:3 *n*-6), eicosapentanoic acid (C 20:5 *n*-3) and behenic acid (C 22:0) content were similar ($p>0.05$) among breeds.

The miristic acid (C 14:0), (C 14:1 *n*-7) and docosahexaenoic acid (C 22:6 *n*-3) content were higher ($p<0.05$) in the NEL and CAR breeds. On the contrary, the arachidonic acid (C 20:4 *n*-6) was lower ($p<0.05$) in the

Table 7. Means (±SE) showing the effect of breed on saturated fatty acids, monounsaturated fatty acids, polyunsaturated fatty acids, *n*-6, *n* 3, PUFA/SFA and *n*-6/*n*-3 ratio of *Longissimus* muscle of bulls finished in a feedlot

Parameters	Breed of bull			Effect (p value)
	NEL[1]	CAR[2]	HFR[3]	
Saturated fatty acids	45.9±0.96[b]	48.9±1.03[ab]	49.4±1.04[a]	0.10
Monounsaturated fatty acids	41.2±1.14	39.8±1.10	40.0±1.10	NS
Polyunsaturated fatty acids	8.41±1.01	11.8±1.42	10.8±1.30	NS
n-6	10.5±1.14	8.63±0.94	8.95±0.98	NS
n-3	1.28±0.15	1.34±0.15	1.35±0.15	NS
PUFA/SFA	0.26±0.03	0.18±0.02	0.22±0.03	NS
n-6/*n*-3	6.74±0.57[b]	8.60±0.73[a]	5.90±0.50[b]	0.05

[1] Nellore. [2] Caracu. [3] Holstein-Friesian. [4] Variation coefficient.
NS = No significant difference among means. Means with different letters, in the same line, are different by Tukey test.

NEL and CAR breeds. The margaric acid (C 17:0), heptadecenoic acid (C 17:1 *n*-7), trans vaccenic acid (C 18:1 *t*-11), α-linolenic acid (C 18:3 *n*-3) and docosapentaenoic acid (C 22:5 *n*-3) were higher ($p<0.05$) in NEL breed.

The anti-iso (C 17:0) and cis-vaccenic acid (C 18:1 *n*-7) content was higher ($p<0.01$) in NEL and HFR breeds. This fatty acid is an important intermediate produced by microorganisms in the rumen. After it is absorption, this acid can be transformed into CLA (C 18:2 *c*-9, *t*-11-rumenic acid) in the tissue of ruminants (Bauman et al., 1999). The CLA content was higher ($p<0.10$) in NEL and HFR breeds.

As ruminant diets contain low fat concentration, the majority the adipose tissue is synthesized from lipogenisis. Fatty acids are elongated up to C 18:0 and are converted into C 18:1 by desaturation (Rule et al., 1997). As the adipose tissue increases, the deposition of C 18:1 content increases also and of C 18:0 content is reduced.

Oleic acid increases human HDL-cholesterol (High Density Lipoprotein) and decreases LDL-cholesterol (Low Density Lipoprotein) concentrations in blood (Katan et al., 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).

Saturated fatty acids (SFA) content was similar ($p<0.10$) in CAR and in HFR breeds. However, SFA content was lower ($p<0.10$) in NEL to than HFR breed (Table 7).

Monounsaturated fatty acids (MUFA), polyunsaturated fatty acids (PUFA), *n*-6, *n*-3 and the PUFA/SFA ratio were similar ($p>0.05$) among breeds.

Although the animal diet contained high levels of PUFA, the meat presents high values of SFA due to biohydrogenation in the rumen. PUFA/SFA 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).

The *n*-6/*n*-3 ratio was higher ($p<0.05$) in CAR breed in comparison the NEL and HFR breeds. Nevertheless, did not have difference ($p>0.05$) between NEL and HFR. The *n*-6/*n*-3 ratio must be 4 to 10. In this manner, all the breeds showed very great ratio for quality food to human health.

IMPLICATIONS

The animal's genetic status has influence on carcass characteristics, chemical composition and fatty acid profile. However, the carcass characteristics change show magnitude little to meat quality.

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REFERENCES

Abrahão, J. J. S., I. N. Prado, D. Perotto and J. L. Moletta. 2005. Effect of replacing corn by increasing levels of cassava starch by-products on carcass characteristics and meat for young bulls. Braz. J. Anim. Sci. 34:1640-1650.

Anualpec, 2007. Anuário da Pecuária Brasileira. São Paulo: Institute FNP, 2007. p. 368.

Aricetti, J. A., P. P. Rotta, R. M. Prado, D. Perotto, J. L. Moletta, M. Matsushita and I. N. Prado. 2008. Carcass characteristics, chemical composition and fatty acid profile of *Longissimus* muscle of bulls and steers finished in a pasture system. Asian-Aust. J. Anim. Sci. 21:1441-1448.

Bauman, D. E., L. H. Baumgard, B. A. Corl and J. M. Griinari. 1999. Biosynthesis of conjugated linoleic acid in ruminant. Proceedings of the American Society of Animal Science www.asas.org/JAS/symposia/proceedings/0937.pdf

Bligh, E. G. and W. J. Dyer. 1959. A rapid method of total lipid extraction and purification. Can. J. Bioch. Phys. 37:911-917.

CIOMS/OMS. 1985. Council for International Organizations of Medical Services. WHO Distribuition and sales service, 1211 Geneva 27, Switzerland, International Guiding Principles for Biomedical Research Involving Animals.

Cunnif, P. A. 1998. Official Methods of Analysis of AOAC International (6th ed.). Arlington: Association of Official

Analytical Chemists.

Enser, M., K. Hallett, B. Hewitt, G. A. F. Fursey and J. D. Wood. 1996. Fatty acid content and composition of English beef, lamb and pork at retail. Meat Sci. 42:443-456.

Gesualdi, Jr. A., A. C. Queiroz, F. D. Resende, G. F. Alleoni, A. G. Razook, L. A. Figueiredo, C. L. S. Gesualdi and E. Detmann. 2006. Production and bioeconomic efficiency of Nellore and Caracu bulls selected to weight gain and fed *ad libitum* or restricted. Braz. J. Anim. Sci. 35:576-583.

Greghi, M. E., F. C. Vieira, N. Ruiz, J. V. Visentainer, I. N. Prado and N. E. Souza. 2003. Effects of slaughter weight on the muscle fatty acids compositions of subcutaneous and intramuscular lipids of Dutch steers. An. Assoc. Bras. Quim. 52:129-133.

Hu, F. B. 2001. The balance between ω-6 ans ω-3 fatty acids and the risk of coronary heart disease. Nutr. 17:741-742.

ISO (International Organization for Standardization). 1978. Animal and vegetable fats and oils-Preparation of metyl esters of fatty acids. ISO 5509, 01-06.

Katan, M. B., P. L. Zock and R. P. Mensink. 1994. Effects of fats and fatty acid on blood lipids in humans: on review. Amer. J. Clin. Nutr. 60 (Suppl. 1):1017-1022.

Kazama, R., L. M. Zeoula, I. N. Prado, D. C. Silva, T. Ducatti and M. Matsushita. 2008. Quantitative and qualitative carcass characteristics of heifers fed different energy sources on a cottonseed hulls and soybean hulls based diet. Braz. J. Anim. Sci. 37:350-357.

Kwiterovich, P. O. 1997. The effect of dietary fat, antioxidants, and prooxidants on blood lipids, lipoproteins, and athecosclerosis. J. Amer. Diet. Assoc. 97 (Suppl.):31-41.

Macedo, L. M., I. M. Prado, T. Ducatti, J. M. Prado, M. Matsushita and I. N. Prado. 2007. Performance, carcass characteristics and chemical composition of no pregnant or pregnant heifers finished in feedlot. Acta Scient. Anim. Sci. 29:425-432.

Macedo, L. M., I. M. Prado, J. M. Prado, P. P. Rotta, R. M. Prado, N. E. Souza and I. N. Prado. 2008. Chemical composition and fatty acids profile of five carcass cuts of crossbred heifers finished in feedlot. Semina 29:599-610.

Maggioni, D., J. A. Marques, D. Perotto, P. P. Rotta, T. Ducatti, M. Matsushita, R. R. Silva and I. N. Prado. 2009. Bermuda grass hay or sorghum silage with or without yeast addition on performance and carcass characteristics of crossbred young bulls finished in feedlot. Asian-Aust. J. Anim. Sci. 22:206-215.

Milinsk, M. C., R. G. Padre, C. Hayasgi, C. C. Oliveira, J. V. Visentainer and N. E. Souza. 2005. Effects of feed protein and lipid contents on fatty acid profile of snail (*Helix aspersa maxima*) meat. J. Food Compos. Anal. 19:212-216.

Moreira, F. B., N. E. Souza, M. Matsushita, I. N. Prado and W. G. Nascimento. 2003. Evaluation of carcass characteristics and meat chemical composition of *Bos indicus*×*Bos taurus* crossbred steers finished in pasture systems. Braz. Arch. Biol. Techn. 46: 609-616.

Müller, L. 1980. Normas para avaliação de carcaças e concurso de carcaças de novilhos. Santa Maria: Universidade Federal de Santa Maria, p. 31.

NRC. 1996. Nutrient requirements of beef cattle. 7th ed. Nat. Acad. Press, Washington, DC.

Padre, R. G., J. A. Aricetti, F. B. Moreira, I. Y. Mizubuti, I. N. Prado, J. V. Visentainer, N. E. Souza and M. Matsushita. 2006. Fatty acid profile, and cheminal composition of *Longissimus* muscle of bovine steers and bulls finished in pasture system. Meat Sci. 74:242-248.

Padre, R. G., J. A. Aricetti, S. T. M. Gomes, R. H. T. B. Goes, F. B. Moreira, I. N. Prado, J. V. Visentainer, N. E. Souza and M. Matsushita. 2007. Analysis of fatty acids in *Longissimus* muscle of steers of different genetic breeds finished in pasture systems. Livest. Sci. 110:57-63.

Pensel, N. 1998. The future of meat in human diets. Nutr. Abstr. Rev. (Series A) 68:1-4.

Perotto, D., J. L. Moletta, J. E. P. Oliveira and C. Lesskiu. 2000. Feed intake and feed:gain ratio of Charolais, Caracu and reciprocal crossbred males in finished in feedlot. Braz. J. Anim. Sci. 29:108-116.

Prado, I. N., R. H. Ito, J. M. Prado, I. M. Prado, P. P. Rotta, M. Matsushita, J. V. Visentainer and R. R. Silva. 2008a. The influece of dietary soyabean and linseed on the chemical composition and fatty acid profile of the *Longissimus* muscle of feedlot-finished bulls. J. Anim. Feed Sci. 17:307-317.

Prado, I. N., R. M. Prado, P. P. Rotta, J. V. Visentainer, J. L. Moletta and D. Perotto. 2008b. Carcass characteristics and chemical composition of the *Longissimus* muscle of crossbred bulls (*Bos taurus indicus* vs. *Bos taurus taurus*) finished in feedlot. J. Anim. Feed Sci. 17:295-306.

Prado, I. N., P. P. Rotta, R. M. Prado, J. V. Visentainer, J. L. Moletta and D. Perotto. 2008c. Carcass characteristics and chemical composition of the Longissimus muscle of Purunã and 1/2 Purunna vs. 1/2 Canchin bulls. Asian-Aust. J. Anim. Sci. 21:1296-1302.

Prado, I. N., J. A. Aricetti, P. P. Rotta, R. M. Prado, D. Perotto, J. V. Visentainer and M. Matsushita. 2008d. Carcass characteristics, chemical composition and fatty acid profile of the Longissimus muscle of bulls (*Bos Taurus indicus* vs. *Bos Taurus Taurus*) finished in pasture systems. Asian-Aust. J. Anim. Sci. 21:1449-1457.

Rowe, A., F. A. F. Macedo, J. V. Visentainer, N. E. Souza and M. Matsushita. 1999. Muscle composition and fatty acid profile in lambs fattened in dry-lot or pasture. Meat Sci. 51:283-288.

Rule, D. C., M. D. Macneil and R. E. Short. 1997. Influence of sire growth potential, time on feed, and growing-finishing strategy on cholesterol and fatty acids of ground carcass and *Longissimus* muscle of beef steers. J. Anim. Sci. 75:1525-1533.

SAS Institute. 2000. SAS/STAT®. User's guide: statistics, version 8.1. 4. ed., v.2, Cary: SAS Institute.

Saucier, L. 1999. Meat safety: challenges for the future. Nutr. Abstr. Rev. (Series A), 69:705-708.

Webb, E. C. 2006. Manipulating beef quality through feeding. South Afr. J. Food Sci. Nutr. 7:1-24.