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Haruyoshi Ito, Roberto; Nunes do Prado, Ivanor; Vergílio Visentainer, Jesuí; do Prado, Rodolpho Martin; Fugita, Carlos Alberto; de Oliveira Pires, Maria Carla
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Carcass characteristics, chemical and fatty acid composition of *Longissimus* muscle of Purunã bulls slaughtered at 18 or 24 months of age

Roberto Haruyoshi Ito[1], Ivanor Nunes do Prado[2*], Jesuí Vergílio Visentainer[3], Rodolpho Martin do Prado[1], Carlos Alberto Fugita[1] and Maria Carla de Oliveira Pires[1]

*[1]Departamento de Zootecnia, Universidade Estadual de Maringá, Maringá, Paraná, Brazil. [2]Programa de Pós-graduação em Zootecnia, Centro de Ciências Agrárias, Universidade Estadual de Maringá, Av. Colombo, 5790, 87020-900, Maringá, Paraná, Brazil. [3]Departamento de Química, Universidade Estadual de Maringá, Maringá, Paraná, Brazil. *Author for correspondence. E-mail: inprado@uem.br*

ABSTRACT. This study was carried out to evaluate carcass characteristics, chemical and fatty acid composition of the *Longissimus* muscle of 78 Purunã bulls (39 bulls/treatment) slaughtered at 18 or 24 months old. The experimental design was completely randomized. The bulls were distributed into two systems: 1) Finished in feedlot 13 to 18 months old (T18), or 2) Finished in feedlot from 21 to 24 months old (T24). The diet, roughage:concentrate ratio of 52:48 (dry matter basis), contained 12% crude protein and 72% total digestible nutrients. The T18 system showed lower ($p < 0.05$) conformation (12.46 *vs.* 13.41 points), higher ($p < 0.05$) subcutaneous fat thickness (3.82 *vs.* 3.11 mm), lower ($p < 0.05$) *Longissimus* area (66.17 *vs.* 70.87 cm^2), lower ($p < 0.05$) muscle percentage (60.64 *vs.* 64.26%) and higher ($p < 0.05$) fat percentage (23.56 *vs.* 20.00%). Moisture (73.27%), ash (1.05%), crude protein percentages (22.56%) and total cholesterol content (36.47 mg/100 g of muscle) were similar ($p < 0.05$) between both slaughter ages. The total lipid percentage was higher ($p < 0.05$) for the T18 system (1.61 *vs.* 1.33%). *Longissimus* muscle fatty acid composition was not influenced ($p < 0.05$), with exception of C18:1 *n*-9 and C18:3 *n*-3, which were lower ($p < 0.05$) for the T18 system. Saturated fatty acids, monounsaturated fatty acids, polyunsaturated fatty acids, *n*-6, *n*-3 percentage and PUFA/SFA and *n*-6/*n*-3 ratio did not change ($p < 0.05$) according to slaughter age.

Key words: beef cattle, *Bos taurus vs. Bos indicus*, meat quality, slaughter age.

RESUMO. Características de carcaça, composição química e em ácidos graxos do músculo *Longissimus* de bovinos Purunã abatidos aos 18 ou 24 meses. Este trabalho teve como objetivo avaliar as características da carcaça e composição química do músculo *Longissimus* de 78 bovinos Purunã (39/tratamento) abatidos no sistema super precoce (SUP) e precoce (PRE). Os bovinos foram distribuídos em dois sistemas: 1. Terminação em confinamento dos 13 aos 18 meses de idade (SUP) ou 2. Terminação em confinamento dos 21 aos 24 meses de idade (PRE). Os animais receberam uma dieta com 12% de proteína bruta e 72% de NDT com proporção volumoso:concentrado de 52:48. Animais do sistema SUP apresentaram menor ($p < 0,05$) conformação (12,46 *vs.* 13,41 pontos), maior ($p < 0,05$) espessura de gordura de cobertura (3,82 *vs.* 3,11 mm), menor ($p < 0,05$) área do *Longissimus* (66,17 *vs.* 70,87 cm^2), menor ($p < 0,05$) percentagem de músculo (60,64 *vs.* 64,26%) e maior ($p < 0,05$) percentagem de gordura (23,56 *vs.* 20,00%). A percentagem de umidade (73,27%), cinzas (1,05%), proteína bruta (22,56%) e teor de colesterol total (36,47 mg 100 g^{-1} de músculo) foi similar ($p < 0,05$) entre o peso de abate. A maior ($p < 0,05$) percentagem de lipídeos totais foi para o SUP (1,61 *vs.* 1,33%). A composição de ácidos graxos não foi influenciada ($p < 0,05$) pelo sistema de terminação, com exceção da percentagem dos ácidos graxos C18:1 *n*-9 e C18:3 *n*-3 que foram menores ($p < 0.05$) para o PRE. As percentagens de ácidos graxos monoinsaturados, poliinsaturados, n-6, n-3 e as razões de AGPI/AGS e n-6/n-3 não foram alteradas ($p < 0,05$) pela idade de abate.

Palavras-chave: bovino de corte, *Bos taurus vs. Bos indicus*, qualidade da carne, idade de abate.

Introduction

Beef has excellent nutritional quality because it contains proteins with high biological value, is rich in vitamin content (especially B-complex), and is associated with high mineral content (especially iron), in high bioavailability form (SAUCIER, 1999).

Beef contains all the amino acids in nearly ideal levels as required by humans (PENSEL, 1998). However, beef is considered one of the factors that may lead to the development of human cardiovascular

disease, obesity, hypertension and cancer, especially due to the presence of saturated fat and cholesterol. Low presence of fat contents (less than 5% relative to muscle) (MOREIRA et al., 2003; PRADO et al., 2008a, b, c, and d) and low cholesterol contents (less than 50 mg 100 g^{-1} in the muscle) have been observed in beef chemical analyses, ranging from one third to one half of the daily recommended cholesterol intake (ARICETTI et al., 2008; MAGGIONI et al., 2009, 2010; PRADO et al., 2009a, b, and c; ROTTA et al., 2009a, and b).

The decrease in slaughter age has been studied to improve carcass characteristics and meat quality (VAZ et al., 2002). However, for slaughter bulls with the weight required by slaughterhouses, feed strategies are necessary for daily weight gain from 16 to 24 months of age. To achieve a daily weight gain of 1.20 kg, the feedlot is an alternative that provides daily weight gain around 1.30 kg (PRADO et al., 2008c). The young bull's production, also denominated younger bulls is an object of study. Research studies (RESTLE et al., 1999; COSTA et al., 2002) demonstrated that bulls finished at 12-14 months are more efficient during finishing than bulls finished at 24 months. There are no great differences for carcass characteristics between these two categories when slaughtered at similar weight; however, carcass dressing for younger bulls is greater (COSTA et al., 2002).

Beef normally has a low PUFA/SFA ratio compared with pork because of the biohydrogenation of unsaturated fatty acids in rumen (TAMMINGA; DOREAU, 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 greatly, depending on genetic and feeding factors and should thus not be generalized (WEBB, 2006).

The state of Paraná, located in southern Brazil, features a milder climate as compared to other regions of the country. Consequently, researchers have been conducting studies since the 1980 on the crossbreeding between Zebu and European breeds, with the objective of increasing production (PEROTTO et al., 2000) and meat quality of bulls (MOREIRA et al., 2003; PADRE et al., 2006, 2007; DUCATTI et al., 2009). After several stages of crossbreeding, an ideal crossbreeding ratio was found as the best adapted for the region. Initially, Nellore specimens were crossbred with Charolaise, Angus, Caracu and Canchim cattle (PEROTTO et al., 2000), giving rise to a breed denominated Purunã. Purunã bulls are very well adapted to subtropical and tropical regions, and show good weight gain potential.

The objective of this work was to evaluate the carcass characteristics, chemical and fatty acid composition of the *Longissimus* muscle of Purunã bulls slaughtered at 18 or 24 months of age.

Material and methods

The committee of Animal Production at the State University of Maringá approved this study (CIOMS/OMS, 1985), which was carried out at the Experimental Station at the Agronomic Institute of Paraná – Iapar, in the city of Ponta Grossa, Paraná State, southern Brazil.

Seventy-eight Purunã bulls were allotted in two treatments: 1) Finishing from 13 to 18 months old (T18 – feeding in collective feedlot and after feedlot finishing), and 2) Finishing from 21 to 24 months old (T24 – feeding in pasture and after feedlot finishing). The experimental design used was randomized with 39 repetitions for T18 and T24 treatments, respectively.

The bulls from system T18 were weaned at 80 days old and remained in Hermartria (*Hemarthria altissima*) pastures with supplementation based on 1.5 kg $animal^{-1}$ day^{-1} of the mixture (25% soybean meal + 73% corn grain + 2% mineral salt). After 6 months (spring and summer) the bulls remained in Hermartria pastures without supplementation. The bulls were finished in feedlot during 150 days in individual covered stalls, with an area of 8 m^2, provided with concrete floor, feeder for roughage, concentrate and mineral salt, and water regulated by an automatic buoy system. Average initial live weight was 284.43 kg.

The bulls from system T24 were weaned at 90 days old and remained in Hermartria (*Hermarthria altissima*) pastures with supplementation based on 1.5 kg $animal^{-1}$ day^{-1} of the mixture (25% of soybean meal + 73% of corn grain + 2% of mineral salt) during 8 months. Afterwards, during 6 months (spring and summer) the bulls remained in Hermartria pastures without supplementation. The bulls were finished in feedlot during 90 days in individual covered stalls, with an area of 8 m^2, provided with concrete floor, with feeder for roughage, concentrate and mineral salt, and water regulated by an automatic buoy system. Average initial live weight was 306.90 kg.

The bulls were weighted at the beginning of the experiment at 8h. After the initial weighing the bulls were weighting every 28 days, according to a fasting of solids for 16 hours, obtained by the total withdrawal of food at 16h of the previous day.

The bulls received a diet with 12% crude protein and 72% total digestible nutrients. The roughage used was corn silage and concentrate (composed of 25% soybean meal, 73% corn grain and 2% mineral salt). The roughage:concentrate ratio was 52:48. Diet formulation and quantity supplied were provided for 1.4 kg day^{-1} gain, as recommended by NRC (2000). The chemical composition of the feed is presented in Table 1 and fatty acid composition is presented in Table 2.

Table 1. Chemical composition of feed (%/DM).

Composition	Feed (% /DM)	
	Concentrate	Corn Silage
Dry Matter	88.0	32.3
Crude Protein	18.7	6.16
Ether extract	7.04	3.05
Ashes	3.10	4.60
Neutral fiber detergent	19.5	58.6
Acid fiber detergent	6.69	27.6

Table 2. Fatty acids composition of experimental diets (% of relative area).

Fatty acids	% of relative area
14:0	0.55
16:0	14.6
16:1 *n*-7	0.20
17:0	0.51
18:0	2.23
18:1 *n*-9	30.6
18:1 *n*-7	1.31
18:2 *n*-6	44.6
18:3 *n*-6	0.48
18:3 *n*-3	3.98
20:4 *n*-6	0.22
22:6 *n*-3	0.81

Carcass characteristics

The animals were slaughtered at a commercial slaughterhouse 90 km away from the Ponta Grossa Research Farm, according to industrial practices in Brazil. Following slaughter, the carcasses were identified and chilled for 24h at 4°C. After chilling, the right part of the carcass was used to determine the quantitative characteristics. Twenty-four hours later, *Longissimus* muscle 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. After slaughter, the following characteristics were determined on the carcass:

Hot carcass weight (HCW): HCW was determined after the slaughter and before the carcass was chilled.

Hot carcass dressing (HCD): The percentage of individual animal dressing was defined as the hot carcass weight divided by the live weight 14 hours before slaughter.

Carcass conformation (COF): Müller's (1980) point scale was used to determine carcass conformation. On this scale, the highest value indicates the best conformation. The carcass conformation was reported as superior, very good, good, regular, poor or inferior; ratings may also be reported as plus, mid and minus.

Fat thickness (FAT): Fat thickness was determined with a caliper averaging three points between the 12th and the 13th ribs on the *Longissimus* muscle (LM).

Longissimus muscle area (LMA): The *Longissimus* area was measured with a tracing made on the right side of carcass; a cross-sectional cut between the 12th and 13th ribs exposed the *Longissimus* muscle. Next, a compensating planimeter, an instrument that measures the area of irregularly shaped objects, was used to determine the area.

Color (COL): Muscle color was analyzed after the carcass had been chilled for 24 hours. Coloration was evaluated according to a point scale (MÜLLER, 1980) 30 minutes after a cross-section was made on the *Longissimus* muscle between the 12th and 13th ribs.

Marbling (MAR): Intramuscular fat was measured in the LM between the 12th and 13th ribs according to the Müller (1980) scores.

Percentage of carcass muscle (MUS), fat (FAT) and bone (BON): muscle, fat and bone were physically separated from the *Longissimus* section, which corresponds to the 10th, 11th and 12th ribs, and individually weighed according to Hankins and Howe (1946). The data were regressed to equations by Müller (1980) – the model converts data to values corresponding to the 9th, 10th, and 11th ribs as follows:

$$MUS = 6.292 + 0.910\ X1$$
$$FAT = 1.526 + 0.913\ X2$$
$$BON = 2.117 + 0.860\ X3$$

in which:

X1, X2 and X3 represents muscle, fat and bone percentages.

The values corresponding to the 9th, 10th and 11th ribs were regressed to equations following the methods of Hankins and Howe (1946) to find the muscle (MUS), fat (FAT) and bone (BON) percentages.

$$MUS = 15.56 + 0.81\ M;$$
$$FAT = 3.06 + 0.82\ F;$$
$$BON = 4.30 + 0.61\ B.$$

in which:

M, F and B are the muscle, fat and bone estimates from the equations by Müller (1980).

Chemical composition

Twenty-four hours after slaughter, 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 -20ºC for later analysis.

Laboratory analyses of the meat were carried out two months after sampling. The samples were unfrozen at room temperature (20ºC), grounded (cracker mill), homogenized, and analyzed in triplicate. *Longissimus* moisture and ash percentage were determined according to AOAC (1995) Crude protein percentage was obtained by the Kjeldahl method. Total lipids were determined by the Bligh and Dyer (1959) method using a chloroform/methanol mixture.

Cholesterol quantification

Cholesterol analysis was carried out by the method modified by Rowe et al. (1999). A 60% (w v^{-1}) solution of potassium hydroxide was added to the samples in quantities equivalent to 2 mL h^{-1} of sample under 1h reflux. The residue was dissolved again in 2 mL hexane containing 0.2 mg mL^{-1} 5-α cholestane internal standard (IS) (Sigma, USA). 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). The injector, column and detector temperatures were 260, 280 and 280ºC, respectively. Ultra-pure gas fluxes (White Martins) were used in the following quantities: 1.5 mL $min.^{-1}$ H_2 as carrier gas, 30 mL $min.^{-1}$ N_2 as make-up gas, 300 mL $min.^{-1}$ as synthetic gas and 30 mL $min.^{-1}$ N_2 for the flame. 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^{-1}, all containing 0.20 mg mL^{-1} 5α-cholestane (Sigma, USA); the solutions were then 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}.

Analysis of fatty acid methyl esters

Fatty acid methyl esters (FAME) were prepared by triacylglycerol methylation, according to the ISO (1978) method. 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 165ºC for 18 min., 180ºC (30ºC $min.^{-1}$) for 22 min. and 240ºC (15ºC $min.^{-1}$) for 30 min., with 45-psi pressure. The injector and detector were kept at 220ºC and 245ºC, 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), 30 mL $min.^{-1}$ for H_2 and 300 mL $min.^{-1}$ the synthetic flame gas. Sample injection split mode was 1/80. Fatty acids were identified by comparing the relative retention times of the samples' FAME peaks with fatty acids methyl esters standards from Sigma (USA). The samples were spiked with the standard. The peak areas were determined with Star software (Varian). The data were expressed as percentages of the normalized area of fatty acids. The peak areas were determined by Data Station Advanced DataApex Clarity Litr. Software (v.2.4.1.9.1, 2003), and the identification of total cholesterol was effectuated by comparison with Sigma (USA).

Statistic analysis

The statistic analysis was interpreted by analysis of variance analyzed by SAS (2000) program as the model:

$Yij = \mu + Ti + eij$ being:

Yij "j" animal observation subjected to treatment "i";

μ - general constant;

Ti – treatment effect i; i = 1, 2;

eij – random error associated with each observation.

Results and discussion

There was no difference ($p > 0.05$) between the systems for final live weight (FLW), hot carcass weight, hot carcass dressing, color, marbling and bone percentage (Table 3). The average final live weight (467.1 kg) and hot carcass weight (250.7 kg) observed in this work follow the Brazilian pattern for male slaughter, which corresponds to 450 kg final live weight. Carcass weight is an important characteristic, because it is directly associated to the animal commercial value as slaughterhouse pay the producer according to animal carcass weight. Prado et al. (2008a) evaluated the carcass characteristics, chemical and fatty acids composition of the *Longissimus* muscle of young bulls Purunã 1st generation, Purunã 2nd generation and ½ Purunã *vs.* ½ Canchim finished and slaughtered at average age of 22 months and observed values of 496, 472 and

449 kg of final live weight and 249.9, 228.8 and 241.9 kg for hot carcass weight, respectively. The values of carcass dressing were 50.4, 48.5 and 53.7%, respectively.

Table 3. Carcass characteristics of Purunã bulls slaughtered at 18 or 24 months old.

Parameters	Production system		Mean	SE[1]
	T18	T24		
Slaughter age, months	18	24		
Initial live weight, kg	284.4	306.9	295.7	6.39
Final live weight, kg	465.1	469.0	467.1	4.96
Hot carcass weigth, kg	249.0	252.5	250.7	3.15
Hot carcass dressing, %	53.5	53.8	53.7	0.37
Conformation, points	12.5b	13.4a	12.9	0.17
Fat tchickness, mm	3.82a	3.11b	3.46	0.14
Longissimus muscle area, cm^2	66.2b	70.9a	68.5	0.88
Longissimus muscle area 100 kg^{-1} carcass, cm^2	26.7b	28.3a	27.5	0.38
Color, points	3.50	3.33	3.42	0.08
Marbling, points	5.02	4.74	4.88	0.20
Muscle, %	60.6b	64.3a	62.5	0.45
Bone, %	15.8	15.7	15.8	0.15
Fat, %	23.6a	20.0b	21.8	0.47

Means in the same line with different letters are different by Tukey test ($p < 0.05$). [1]Stardart errors.

A difference was observed ($p < 0.05$) for conformation between production systems, with a greater value for the bulls from treatment T24 (13.4 points) in comparison to treatment T18 (12.5 points). This shows that bulls slaughtered at 24 months old have an increase in muscle development compared to the animals slaughtered at 18 months old, especially by the fact that they increased *Longissimus* muscle area (70.9, T24 *vs.* 66.2 cm^2, T18), *Longissimus* muscle area/100 (28.3, T24 *vs.* 26.7 cm^2/100, T18), muscle percentage (64.3, T24 *vs.* 60.6%, T18) and decreased of fat percentage (20.0, T24 *vs.* 23.6%, T18).

Fat thickness was greater ($p < 0.05$) for bulls from system T18 (3.82 mm) in comparison with T24 bulls (3.11 mm). This result is directly involved with carcass fat percentage, which was 23.6% for system T18 *vs.* 20.0% of carcass fat percentage for system T24. The higher carcass fat percentage for bulls slaughtered at 18 months occurred due the longer period in the feedlots (150 days), which promoted an alteration in the weight gain of animals, accumulating more fat, as can be observed by the higher fat percentage (23.6, T18 *vs.* 20.0%, T24) in the carcasses of these bulls compared with bulls slaughtered at 24 months old (90 days). The value for fat thickness observed in this study is the minimum limit of the required values by slaughterhouses (3 mm). Costa et al. (2002) reported that carcass fat thickness should be between 3 and 6 mm, because values lower than 3 mm are detrimental to the carcass by not protecting the external muscles from cold darkening, while values greater than 6 mm represent a loss for the producer, because the excess fat is eliminated during the cleaning process in the slaughterhouse. The lower fat thickness observed may have occurred because bulls may not have reached adequate maturity for the breed composition that formed the Purunã (consisting of 25% each Aberdeen Angus, Canchim, Caracu and Charolais), in which Caracu and Charolais deposit fat later than Aberdeen Angus. The final weight was set to 460 kg; the bulls did not show an adequate finishing had they been slaughtered with a higher live weight.

Igarasi et al. (2008) evaluated the meat quality, carcass characteristics and parameters of ½ Red Angus *vs.* ½ Nellore bulls fed with sorghum or corn silage and slaughtered at 14 months old. The authors did not observe difference for carcass dressing, *Longissimus* muscle area and fat thickness, with greater average values of 54.0%, 74.2 cm^2 and 4.85 mm, respectively. The carcass finishing of these animals was adequate to the precocity transmitted by the Red Angus, by the longer feedlot period (172 days) and final live weight of 519 kg.

Similar results regarding muscle and fat percentage were observed by Pacheco et al. (2005), who evaluated the physical carcass composition and meat quality of young bulls slaughtered at 15 and 23 months old. The authors observed that animals slaughtered at 23 months old presented greater muscle percentage (66.5 *vs.* 60.3%) and lower fat percentage (18.6 *vs.* 24.8%) compared to animals slaughtered at 15 months old, while bone percentage was similar.

According to Berg and Buterfield (1976), between the tissues that compose the carcass, the muscle is the most important, because it is the most sought after by the consumer. Therefore, the carcass must present a maximum quantity of muscle, a minimum of bone, and fat quantity that varies according to consumer preference.

Therefore, the variables of carcass characteristics evaluated in this experiment have similar values to those already studied by several authors (PACHECO et al., 2005; BIANCHINI et al., 2007; IGARASI et al., 2008; PRADO et al., 2008a).

There was no difference ($p < 0.05$) between systems for the variables of: moisture, ash, crude protein and total cholesterol (Table 4).

The values for moisture, ash and crude protein were similar even when different diets were used, as observed by Prado et al. (2008b), who evaluated the effect of soybean oil and linseed on the chemical and fatty acids composition on the *Longissimus* muscle of bulls (½ Simenthal *vs.* ½ Nellore) finished in feedlot and observed average values of 74.6, 1.03 and 20.2%, respectively. Similar results were observed by Padre

et al. (2006), who evaluated the chemical and fatty acids composition of *Longissimus* muscle of bulls finished in pasture and with values of 73.0, 0.97 and 20.9, respectively.

Table 4. Chemical composition of *Longissimus* muscle of Purunã bulls slaughtered at 18 or 24 months old.

Chemical composition	Production system		Means	SE[1]
	T18	T24		
Moisture, %	73.4	73.5	73.3	0.11
Ash, %	1.00	1.10	1.02	0.01
Crude protein, %	22.7	22.7	22.6	0.09
Total lipids, %	1.61a	1.33b	1.45	0.04
Total cholesterol, mg 100 g^{-1} muscle	36.5	36.4	36.5	0.13

Means in the same line with different letters are different by Tukey test ($p < 0.05$). [1]Stardart errors.

The values of total lipids were higher ($p < 0.05$) for system T18 (1.60 *vs.* 1.34%) compared to system T24. These results are directly linked to the higher carcass fat percentage of the animals slaughtered at 14 months old and to the longer feedlot time (150 days) until the animals reached the final live weight (460 kg) compared to the animals slaughtered at 22 months old (90 days), which promoted an alteration in weight gain.

Similar results were observed by Pacheco et al. (2005), who observed a higher lipid percentage (1.76%) for bulls slaughtered at 15 months old compared to animals slaughtered at 23 months old (1.01%).

The authors reported that this result is justified by the longer period in feedlot of the animals slaughtered at 15 months (143 days) compared to the animals slaughtered at 23 months (35 days), which promoted an alteration in weight gain composition.

The level of cholesterol did not show any difference ($p > 0.05$) between systems. However, the average value observed in this study (36.5 mg 100 g^{-1} of muscle) is lower than the value observed by Prado et al. (2008c) which evaluated the carcass characteristics and meat chemical composition of Purunã, ½ Purunã *vs.* ½ British, and ½ Charolais *vs.* ½ Caracu genetic groups finished in pasture systems.

No difference was observed ($p > 0.05$) for most of the analyzed fatty acids, with the exception of 18:1 *n*-9, 18:1 *n*-7 and 18:3 *n*-3 (Table 5).

Saturated fatty acids (SFA) represent approximately 50% of the total analyzed fatty acids composition of *Longissimus* muscle of Purunã bulls.

However, some SFAs are considered hypercholesterolemic: 12:0, 14:0 and 16:0. The values for 14:0 and 16:0 observed in this study were 2.48 and 29.6%, respectively.

Table 5. Fatty acids composition of *Longissimus* muscle of Purunã bulls slaughtered at 18 or 24 months old.

Fatty acids	Production system		Means	SE[1]
	T18	T24		
14:0	2.46	2.49	2.48	0.06
14:1 *n*-7	0.36	0.36	0.36	0.01
15:0	0.27	0.24	0.26	0.01
15:1 *n*-9	0.16	0.16	0.16	0.01
16:0	29.5	29.7	29.6	0.27
16:1 *n*-9	0.20	0.19	0.20	0.00
16:1 *n*-7	2.95	2.85	2.90	0.09
16:1 *n*-5	0.38	0.39	0.38	0.01
17:0	0.60	0.65	0.63	0.02
17:1 *n*-9	0.40	0.44	0.42	0.01
18:0	16.6	16.6	16.6	0.21
18:1 *t*-11	0.52	0.57	0.55	0.02
18:1 *n*-9	35.9a	35.1b	35.5	0.21
18:1 *n*-7	1.01b	1.11a	1.06	0.02
18:2 *n*-6 (LA)	5.80	6.09	5.94	0.21
18:3 *n*-6	0.10	0.10	0.10	0.00
18:3 *n*-3 (LNA)	0.23b	0.33a	0.28	0.02
CLA 18:2 *c*-9,*t*-11	0.18	0.16	0.17	0.08
22:0	0.03	0.03	0.03	0.00
20:4 *n*-6	1.67	1.80	1.73	0.08
20:5 *n*-3 (EPA)	0.14	0.17	0.16	0.01
22:5 *n*-3	0.36	0.38	0.37	0.02
22:6 *n*-3 (DHA)	0.10	0.10	0.10	0.00

Means in the same line with different letters are different by Tukey test ($p < 0.05$). [1]Stardart errors.

The majority of analyzed fatty acids of the *Longissimus* muscle of Purunã bulls slaughtered at 14 and 22 months old were: 16:0 (29.6%), 18:0 (16.6%) and 18:1 *n*-9 (35.5%).

The increase in 18:0 fatty acid occurred because of the high levels of polyunsaturated fatty acids in the diets (PUFA – higher or equal to two double links) which leads to an increase in these fatty acids on the meat.

However, in ruminants, PUFA are hydrogenised when they pass by the rumen to form principally 18:0 and 18:1 fatty acids (TAMMINGA; DOREAU, 1991). Therefore, an increase in PUFA from the diet does not lead to an increase of these fatty acids on meat.

The 18:1 *n*-9 fatty acid (oleic acid) was higher ($p < 0.05$) for system T18 (35.94 *vs.* 35.1%) compared to system T24. This fatty acid may come, in part, by the presence of the fatty acids from the diet (30.6%) and PUFA hydrogenation when they pass by the rumen, and forms especially the 18:0 and 18:1 fatty acids (TAMMINGA; DOREAU, 1991).

The *n*-3 fatty acids were higher ($p < 0.05$) for system T24 (0.33 *vs.* 0.23%). This can be justified by the higher percentages of PUFA, especially from the 18:3 *n*-3 fatty acid found in tropical forages (FRENCH et al., 2000), and according to Padre et al. (2006) who used ½ Nellore *vs.* ½ Aberdeen Angus steers and young bulls finished in pasture system. The chemical and fatty acids composition of the forage used in this work, *Panicum maximum*, had 30.5% SFA, 25.0% monounsaturated fatty acids (MUFA) and 44.6% PUFA (16.7% *n*-6 fatty acids

and 27.9% *n*-3 fatty acids). Thus, the higher *n*-3 fatty acid value found for 22-month-olds can be due to the pasture.

CLA did not show any difference ($p > 0.05$) between the two systems. This fatty acid is formed by a precursor, the 18:1 *t*-11 fatty acid (trans-vaccenic acid), which is an intermediate fatty acid in the biohydrogenetation process of the 18:2 *n*-6 fatty acid in the rumen, and this fatty acid can be transformed into CLA (18:2 *c*-9, *t*-11) by the delta-9-desaturase enzyme in the tissue of ruminants after being absorbed (GRIINARI et al., 2000).

There was no difference ($p > 0.05$) for SFA, MUFA, PUFA, *n*-6, *n*-3, PUFA:SFA and *n*-6:*n*-3 between the systems (Table 6).

Table 6. Sum and ratios of fatty acids of *Longissimus* muscle of Purunã bulls slaughtered at 14 or 22 months old.

Sum and ratios	Production system		Means	SE[1]
	T18	T24		
SFA[2]	49.5	49.7	49.6	0.27
MUFA[3]	41.9	41.1	41.5	0.22
PUFA[4]	8.60	9.13	8.86	0.30
n-6	7.57	7.98	7.78	0.28
n-3	0.84	0.98	0.91	0.04
PUFA:SFA	0.18	0.18	0.18	0.01
n-6:*n*-3	9.39	8.69	9.04	0.44

Means in the same line with different letters are different by Tukey test ($p < 0.05$). [1]Stardart errors; [2]Saturated fatty acids; [3]Monounsaturated fatty acids; [4]Polyunsaturated fatty acids.

SFA (49.61%) and MUFA (41.52%) were similar by the values from Prado et al. (2008a).

PUFA:SFA and *n*-6:*n*-3 were 0.18 and 9.04, respectively. According to English Department of Health (HMSO, 1994), the recommended ratio of PUFA:SFA should be 4:1. *n*-6:*n*-3 is influenced by the composition of fatty acids in the diet. This can occur by the higher percentage of PUFA, especially the 18:3 *n*-3 fatty acids present in tropical forages (FRENCH et al., 2000). The inclusion of *n*-3 fatty acids sources in animal diet increases the total content of *n*-3, especially with a decrease in intramuscular deposition of the *n*-6 fatty acid. The finishing in pasture can decrease *n*-6:*n*-3 in bulls for values lower than 2, while in concentrate-fed ruminants, this ratio is around 6 to 10 (RAES et al., 2004).

Conclusion

Purunã animals slaughtered at 18 and 24 months old at 460 kg presented fat thickness close to 3 mm. More studies are necessary to determinate the suitable Purunã slaughter weight in order to achieve 6 mm of fat thickness. Carcasses of Purunã slaughtered at 24 months old are more desirable because of the higher ratio of commercially valuable muscle.

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