EFFECT OF THE BODY WEIGHT ON CHEMICAL AND FATTY ACIDS COMPOSITION OF THE *LONGISSIMUS* MUSCLE FROM YOUNG BULLS

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Abstract – The *Longissimus* muscle (LM) from young bulls (½ Angus vs. ½ Nellore) slaughtered at light, medium and heavy body weights (BW) were used to investigate the chemical and fatty acids (FA) composition. The bulls were distributed in a completely randomized design by a factorial scheme 3 x 3 and data analyzed by ANOVA using the GLM procedure. Twenty-one young bulls (243 ± 11.7 kg, 12 ± 2 month old) were allocated in individual pens and distributed into three experimental diets (n = 7): E0.0, diet without addition of the blend of EO; E3.5, 437 mg/kg of dry matter (DM) of the blend of EO; and E7.0, 875 mg/kg of DM of the blend of EO; for 4 months (sugar cane bagasse pellets, ground corn, soybean meal, limestone, yeast, mineral salt were used as-fed). The young bulls (16 months ± 2) were slaughtered at light, 386 ± 12.9 kg; medium, 443 ± 13.6 kg; and heavy, 500 ± 28.6 kg BW. LM from bulls slaughtered at medium BW had higher values of crude protein, polyunsaturated FA (FUFA), omega-6, PUFA:SFA (saturated FA) ratio than bulls light BW. Therefore, bulls slaughtered with medium BW improves chemical and FA composition in the LM.

Key Words - sugar cane pellets, Longissimus dorsi, fatty acid composition..

I. INTRODUCTION

Beef has an excellent nutritional quality because it contains proteins of high biological value, vitamins (especially B-complex), a high mineral content (especially iron), and essential fatty acids (especially α-linoleic, eicosapentaenoic and docosapentaenoic) [1]. However, beef is considered one of the factors that may lead to the development of obesity, hypertension and human cardiovascular diseases [2]. There has been an increased interest in recent years to manipulate the chemical and fatty acids composition of meat. On the other hand, the chemical and fat acids composition is not an item required by beef market. Nowadays, beef market in Brazil requires carcass with good conformation and minimum 3 to 6 mm fat thickness [1]. In last years, essential oils extracted from plants [3] are being used as feed additive in livestock production to improve feed efficiency [4] and meat products as antimicrobial [5] or antioxidant agents [6]. The synergism between compounds from essential oils can possibility an increased on antimicrobial [7] and antioxidant activities [8], which have largest potential to improve carcass grade and meat quality from bulls finished in a feedlot. The aim of this study was to investigate the effect of final body weight (light; medium; and heavy) on chemical and fatty acids composition of the *Longissimus thoracis* muscle from crossbred bulls fed with blend of essential oils.

II. MATERIALS AND METHODS

Twenty-one 12 month-old crossbred (½ Angus vs. ½ Nellore) young bulls, average weight of 243.2 ± 11.7 kg, were randomly assigned to one of three finishing diets (n = seven young bulls per treatment). The three experimental treatments were: E0.0, diet without addition of the blend of essential oils (EO); E3.5, diet with 437 mg/kg of dry matter (DM) of the blend of EO; and E7.0, diet with 875 mg/kg of DM of the blend of EO. The blend of EO used consisted of seven plants extracts: oregano (*Origanum vulgare*), garlic

(*Allium sativum*), lemon (*Citrus limonium*), rosemary (*Rosmarinus officinalis*), thyme (*Thymus vulgaris*), eucalyptus (*Eucalyptus saligna*) and sweet orange (*Citrus aurantium*), registered as Mixoil® (Animal Wellness Products – Oakland – Nebraska – USA). The blend of EO had powdery texture; and it added to the concentrate each two weeks in a commercial mixer where diets were prepared during the experimental period. The young bulls were finished with their respective diets under intensive conditions (90:10; concentrate:forage). The concentrate consisted of corn grain (819 g/kg of dry matter, DM), soybean meal (65.2 g/kg of DM), Limestone (4.6 g/kg of DM), yeast (0.5 g/kg of DM), mineral salt (4.1 g/kg of DM) and urea (6.2 g/kg of DM). Sugar-cane pellets were used as-forage (100 g/kg of DM). The basal diet was formulated for a 1.5 kg/day average daily gain. All diets were isoenergetic and isonitrogenous. The total diet consisted of 125 g/kg of DM of crude protein, 22 g/kg of DM of either extract, 303 g/kg of DM of neutral detergent fiber, 14.8 g/kg of DM of acid detergent fiber and 708 g/kg of DM of nutrient digestible total. The mineral salts consisted of (g/kg of DM) 150 Ca, 88.0 P, 0.08 Co, 1.45 Cu, 10.0 S, 1.0 Fe, 0.88 F, 0.06 I, 10.0 Mg, 1.10 Mn, 0.02 Se, 120 Na and 3.40 Zn. The bulls were finished for 4 months and slaughtered when they reached an average of 386 kg BW (light), 443 kg BW (medium), and 500 kg BW (heavy). The young bulls (16 month-old ±2) were slaughtered by ethical procedures in a commercial slaughterhouse 20 km from Experimental Farm (Maringá, PR) according to Brazilian practices. After slaughter, the carcasses were labelled and chilled for 24 h at 4°C. After chilling, the carcass were weighed and the right side of the carcass was used to determine the quantitative and qualitative characteristics. *Longissimus* muscle (LM) samples were taken by complete cross-section between the 12th to the 13th ribs and were immediately frozen at -20^{o}C for later analysis. The chemical composition (moisture, ash, crude protein, total lipids and collagen) were performed using FoodScan near-infrared (NIR) spectrophotometer from (FOSS NIRSystems, Inc., USA). Total lipids were extracted using a method with a chloroform/methanol mixture [9]. Fatty acid methyl esters (FAME) were prepared by triacylglycerol methylation according to ISO-R-5509 [10]. Then, the esters were extracted with 2 mL of n-heptane and stored at -18°C for later chromatographic analysis. Methyl ester was separated by gas chromatography using a Thermo 3300 gas chromatograph fitted with a flame ionisation detector (FID) and a CP-7420 fused-silica capillary column (100 m x 0.25 mm i.d. x 0.25 µm of cyanopropyl, SELECT FAME). The operation parameters were as follows: detector temperature 240^{o}C, injection port temperature 230^{o}C, column temperature 165^{o}C for 18 min, programmed to increase at 4^{o}Cmin-1 up to 235^{o}C, with a final holding time of 14.5 min, hydrogen carrier gas at 1.2 mL min-1, nitrogen make up gas at 30 mL min-1, and split injection at a 1:80 ratio. For identification, the retention times of the fatty acids were compared to those of standard methyl esters (Sigma, St. Louis, MO). Retention times and peak area percentages were automatically computed with Chronquest 5.0 software. The fatty acid compositions of the LM were expressed as a percentage. The bulls were distributed in a complete randomized design by a factorial scheme 3 x 3, comprising three treatments (E0.0, E3.5, and E7.0), and three different BW (light, medium, and heavy). All data under study were tested for normality. The data were analyzed by the ANOVA, using GLM procedure (SAS, 2002) according to the following model: $Yijk = \mu + \alpha i + \beta j + (\alpha\beta)ij + Eijk$; where Yijk = observation of the animal undergoing treatment i, slaughter BW j, and repetition k; μ = constant overall; αi = effect of the treatment, i = 1, 2, 3; βj = effect of the slaughter BW, j = 1, 2, 3; $(\alpha\beta)ij$ = interaction treatment x slaughter BW, and Eijk = random error associated with each observation Yij and repetition k. Differences between group means were assessed by using the Tukey's test ($P \leq 0.05$).

III. RESULTS AND DISCUSSION

The experimental design allowed the examination of the effects of final BW on chemical and fatty acids composition in the LM. The young bulls (16 month-old ± 2) were slaughtered at light, 386 ± 12.9 kg BW; medium, 443 ± 13.6 kg BW; and heavy 500 ± 28.1 kg BW. The moisture, ash, total lipids and collagen were

similar ($P > 0.05$) for bulls slaughter at light, medium and heavy BW (Table 1). The bulls slaughtered at medium and heavy BW had higher values of crude protein in the LM ($P \leq 0.05$) than bulls slaughtered at light BW (Table 1). In this study, the mean cold carcass weight were 206 ± 8.05 , 241 ± 9.59 and 272 ± 18.0 kg, respectively light, medium and heavy BW. The bulls slaughtered at light BW were still growing and did not achieved carcass weight required by beef market in Brazil (carcass between 225 to 250 kg) [1]. The carcass weight below of the required by beef market can influence the physical characteristics and chemical composition of the carcass [11], which results in industry economic losses and a low-meat quality. The values of crude protein found in the LM is due lower carcass weight from bulls slaughtered at light BW.

Table 1 Effect of the body weight from crossbred bulls fed with a blend of essential oils on chemical composition in the *Longissimus* muscle

Item	Slaughter body weight*			SEM[4]	P^5
	Light[1]	Medium[2]	Heavy[3]		
Moisture, %	74.6	73.9	73.3	0.40	0.11
Ash, %	1.60	1.46	1.49	0.07	0.58
Crude protein, %	22.1[b]	23.1[a]	23.3[a]	0.22	0.01
Total lipids, %	2.79	2.88	2.91	0.32	0.76
Collagen, mg g^{-1}	1.48	1.35	1.37	0.05	0.24

[1]386 kg *BW; [2]443 kg *BW; [3]500 kg *BW; [4]Standard deviation; [5]Probability, n = seven bulls per treatment; a, b: different superscripts represent significant differences ($P \leq 0.05$).

According to the animals´ physiological growth, bone and muscle tissue is deposited before the adipose tissue [2]. Therefore, when bulls were slaughtered at light BW, the muscle tissue was being deposited, which resulted in low protein values in the LM. The saturated fatty acids (SFA), monounsaturated fatty acids (MUFA), omega-3 (*n*-3) and *n*-6:*n*-3 ratio were similar ($P > 0.05$) for bulls slaughter at light, medium and heavy weight (Table 2). While, polyunsaturated fatty acids (PUFA), omega-6 (*n*-6) and PUFA:SFA ratio were higher ($P \leq 0.05$) for bulls slaughtered at medium BW (Table 2). The PUFA from the diet are extensively transformed in the rumen by action of microbial enzymes [12]. The use of ionophores and natural additives in the diet can decrease the lipolysis and increase PUFA deposition in the LM [13]. The intramuscular adipose tissue in the LM comprised triacylglycerol's and phospholipids [2]. The phospholipids contains higher amount PUFA than SFA and MUFA, which are little influenced by species, breed, nutrition or age [2].

Table 2 Effect of the body weight from crossbred bulls fed with a blend of essential oils on fatty acids composition in the *Longissimus* muscle

Item	Slaughter body weight*			SEM[4]	P^5
	Light[1]	Medium[2]	Heavy[3]		
SFA[6]	49.3	46.5	46.2	1.17	0.19
MUFA[7]	46.8	45.9	48.7	1.27	0.28
PUFA[8]	4.20[b]	8.03[a]	5.32[ab]	1.04	0.04
n-6, omega-6	3.51[b]	6.90[a]	4.64[ab]	0.93	0.05
n-3, omega-3	0.25	0.32	0.26	0.03	0.22
PUFA:SFA	0.08[b]	0.17[a]	0.11[ab]	0.02	0.05
n-6:*n*-3	13.9	21.2	17.2	2.63	0.15

[1]386 kg *BW; [2]443 kg *BW; [3]500 kg *BW; [4]Standard deviation; [5]Probability, n = seven bulls per treatment; [6]Saturated fatty acids; [7]Monounsaturated fatty acids; [8]Polyunsaturated fatty acids; a, b: different superscripts represent significant differences ($P \leq 0.05$).

The PUFA into phospholipids are controlled by a complex enzymatic system (desaturases and elongases enzymes) [2]. The triacylglycerol contains highest values of SFA, MUFA and lower PUFA values, which is dependent on the fat deposition. Thus, the largest manipulation of the FA occurs on triacylglycerol's [2], which can be influenced by fat level, genetic group and diet. However, in this study the amounts of total lipids in the LM were similar for bulls slaughtered at light, medium and heavy BW. Likewise, a previous study [14] did not found any difference in total lipids in the LM from bulls finished at 3.4 or 4.8 mm of fat thickness. However these authors report an increase on *n*-6/*n*-3 ratio in the LM from bulls slaughtered at 4.8 mm of fat thickness. In this study, the PUFA values found in the LM for bulls slaughtered at medium BW can be explained by increase in *n*-6 FA, which are considered PUFA's (18:2 *n*-6 – linoleic, 18:3 *n*-6 – *γ*-linolenic and 20:4 *n*-6 – arachidonic FA). Likewise, the *n*-6 values influenced the values of PUFA:SFA ratio in the LM for bulls slaughtered at medium BW. Previous studies reported that the increase in fat level in the LM occurs from

beginning birth to slaughter, which can change fatty acid proportions [2].

IV. CONCLUSION

The results of this study showed that young bulls slaughtered at medium body weight achieve the carcass weight required by beef market in Brazil and contains higher values crude protein, polyunsaturated fatty acids, *n*-6 and PUFA/SFA ratio in the *Longissimus* muscle, which is interesting for human nutrition.

ACKNOWLEDGEMENTS

The current project was supported by the São Paulo Research Foundation, SP (process 2012/18873-8); Araucaria Foundation, PR (process 2010/113); Brazilian Council for Research and Technological Development, CNPq; and Vet Science Nutraceuticals Ltda. (Maringá, Paraná, Brazil). Trade names or commercial products in this publication are mentioned solely for the purpose of providing specific information and do not imply recommendations by the Department of Animal Science, State University of Maringá, Maringá, Paraná, Brazil.

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