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THE FATTY ACIDS IN BEEF OF BULLS

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Abstract

The aim of this work was to evaluate the influence of slaughter weight (500–620 and 630–740 kg) of Charolais bulls on the fatty acid profile in *musculus longissimus thoracis (MLT)*. The bulls were slaughtered at the age of 485–569 days. The average weight gain during fattening was 664 ± 91 g per day. The carcasses (weight ranged from 300 to 395 kg) were classified to the class of meatiness "U" and "R" and the class of fattiness "2". The beef samples (n=83) were excised from carcass at the half cutting level between 8th and 9th rib and analyzed. The highest average proportional ratio was determined in C16:0 that ranged from 22.804 % in bulls at 500–620 kg weight category to 24.797 % at 630–740 kg weight group. The lowest ratio of MUFA was in eicosapentaeonic acid, its content ranged from 0.234 % at the second weight group to 0.587 % at 500–620 kg weight group. The highest MUFA ratio was at C18:1 at amount of 38.857 % with difference ± 2.373 %. The oleic acid ratio in beef rose up linearly according to the higher slaughtering weight ($P < 0.01$). Positive relation was proved between a slaughter weight and C18:3; C20:5 and C22:5 PUFA content. The decrease of eicosapentaeonic and eicosadienoic acid was negative fact due to the essentiality for human health.

Keywords: bull, beef, fatty acid

Introduction

Fat composition, exactly the proportion of each long-chain fatty acid is very often talked over owing to the nutritional importance for people. Unlike plants people can not make polyenic fatty acids n-3 and n-6, although they are essential for life, so they have to be supplied by diet (*Šubrt, 2006*). *Serrano et al., (2005)* evaluated the fatty acid composition of beef steak. The authors present proportions

504.9 mg.100g^{-1} of saturated fatty acid and proportions 263 mg.100g^{1} of unsaturated fatty acid, the ratios of the most important acid n-3 was 23.40 mg.100g^{-1}. *Raes et al. (2003)* compared the beef quality of Belgian Blue and Limousine. The meat samples were packaged in vacuum and stored at 4 °C for 14 days. PUFA proportion in MLL of both breeds was the same (195 mg.100g^{-1}). There was higher quantity of fatty acid n-6 by 40 mg.100g^{-1} in Limousine bulls. The fatty acid n-3 ratio was relatively even in both breeds (25–38 mg.100g^{-1}). The highest CLA proportion (9.63 mg.100g^{-1}) was in Limousine bulls.

Material and methods

The aim of this work was to evaluate the effect of bull slaughter weight on changes of intramuscular fatty acid composition. 83 Charolais bulls were used for evaluation. They were reared in a pasture up to their weaning. The animals were fed by clover-grass silage in winter and then they were grazed from the end of April. The bulls were slaughtered at the age of 485 – 569 days. The average weight gain during fattening was 664 ± 91 g per day. The carcasses (weight ranged from 300 to 395 kg) were classified to the class of meatiness "U" and "R" and the class of fattiness "2". The beef samples were excised from carcass at the half cutting level between 8th and 9th rib and analyzed. Intramuscular fat content was extracted (using diethyl ether as a solvent) in the Soxhlet extractor for 6 hours. The extraction was carried out without acid hydrolysis. The fatty acids methyl ester synthesis was conducted with sodium methylate and subsequently with boron trifluoride in methanol. The FAME was analyzed by a gas chromatograph CHROM 5 with a flame ionization detector (FID). The temperature of the column rose from the initial 100 °C up to 250°C. Nitrogen was used as the carrier gas. Both the injector and the detector (FID) were set at 280°C. 2µl of the sample was injected into the gas chromatograph equipment for each analysis. The analyzed FAME were identified on the basic of elution times and compared with elution times of standard methyl ester of fatty acid. The standard sample of FAME Mix 37 was used for identification. The Cl-105 integrator was used for quantitative evaluations of chromatographic analyses. Fatty acid levels were expressed as the percentage of total fatty acid content.

The results were statistically analysed using the statistical package STATISTICA 9.0, by means of variance analysis: $y_{ij} = \mu + A_i + e_{ij,}$ where A = weight categories (500 – 620 kg and 630 – 740 kg), e = residuum. HSD test was used to determine the statistically significant differences.

Results and discussion

The highest average ratios displayed C16:0, it ranged from 22.804 % in bulls from 500–620 kg weight group up to 24.797 % in bulls from 630–740 kg. *Padre et al., (2007)* presented higher proportion

C16:0. The second highest ratio was found in stearic acid, that ranged from 20.397 % in bulls from 500 – 630 kg weight group up to 21.723 % in bulls 630 – 740 kg. *Bures et al. (2006)* state lower C18:0 content in Simmental bulls compared to the level of this fatty acid in Charolais (*Table 1*).

***Table 1*: Saturated fatty acid composition in beef**

Indicator	Slaughter weight (kg)			
	500–620		630–740	
	n = 38		n = 45	
	LSM	SE	LSM	SE
C12:0	0.080	0.033	0.074	0.016
C14:0	2.552	0.457	2.501	0.406
C16:0	22.804 [a]	2.006	24.797 [b]	1.935
C18:0	20.397 [a]	2.769	21.723 [b]	2.597
C20:0	0.587 [a]	0.171	0.234 [b]	0.094

**a, b = significant difference (P < 0.05)*

Similar results were published by *Laborde et al., (2001)* in Simmental and Angus bulls. Statistically significant differences (P < 0.05) were found between the first and the second weight group in C16:0; C18:0 and C20:0. *Zapletal at al., (2009)* present significant (P < 0.05) difference between Czech Fleckvieh and Montbeliarde in arachidic acid content although this acid ratio was lower compared to our results (0.08 respectively 0.1 %). To the contrary *Scollan et al., (2006)* introduce the fatty acid composition at the level that is comparable to our results. The ratios of monounsaturated fatty acids within Charolais beef are shown in *Table 2*.

***Table 2*: Monounsaturated fatty acid composition in beef**

Indicator	Slaughter weight (kg)			
	500–620		630–740	
	n = 38		n = 45	
	LSM	SE	LSM	SE
C14:1	0.752 [A]	0.342	0.549 [B]	0.252
C16:1	4.820 [A]	0.215	2.896 [B]	0.714
C18:1	36.484 [A]	4.965	41.231 [B]	2.321
C20:1	0.5311 [a]	0.223	0.459 [b]	0.069

**a, b = significant difference (P < 0.05), A, B = highly significant difference (P < 0.01)*

The lowest content of fatty acid with one double bond was expressed at C20:1 (0.531 %, respective 0.459 % to in bulls slaughtered at 630 – 740 kg). The highest ratio in monogenic acid was 38.858 % in the case of C18:1 with a difference ± 2.932 %. Together with the increasing slaughter weight ($P < 0.01$) there was a linear growth of this fatty acid composition in beef. Stearic acid is one of the main FA indicating fat hardness. Increased conversion of stearic acid to oleic acid will raise fat softness because beef lipids enhanced with oleic acid have a lower melting point *(Chung et al., 2006)*. The average palmitic-oleic acid content was at the level of 4.820 ± 0.215 %. Higher ratio (5.6 %) of this fatty acid in oxen slaughtered at 525 kg is presented by *Jiang et al., (2010)*. The important unit makes the fatty acids with 3 to 6 double bonds whereas the most substantial are C18:3, C20:4 and the other "eicosa" acids (C20:3, C20:5, C20:6). The proportion of the polyenic fatty acids from total amount of fatty acid in beef was relatively low. The average C18:3content was 0.473 ± 0.190 % (*Table 3*).

***Table 3*: Polyunsaturated fatty acid composition in beef**

Indicator	Slaughter weight (kg)			
	500–620		630–740	
	n = 38		n = 45	
	LSM	SE	LSM	SE
C18:3	0.301 ^{A}	0.170	0.645 ^{B}	0.109
C20:3	0.102	0.029	0.113	0.054
C20:4	0.434	0.012	0.457	0.007
C20:5	0.207 ^{A}	0.039	0.056 ^{B}	0.017
C20:6	0.094 ^{a}	0.003	0.025 ^{b}	0.009
C22:4	0.080	0.011	0.075	0.020
C22:5	0.117 ^{A}	0.019	0.227 ^{B}	0.085
C22:6	0.118	0.041	0.127	0.040

**a, b = significant difference ($P < 0.05$), A, B = highly significant difference ($P < 0.01$)*

The ratio of this fatty acid demonstrated highly significant difference ($P < 0.01$) between the first and the second weight group of slaughtered bulls. The highest ($P > 0.05$) C20:4 content was determined in intramuscular fat from the second weight group of bulls (0.457 ± 0.007 %) and the lowest (0.434 ± 0.012 %) in the first weight group. Statistically highly significant differences ($P < 0.01$) were found between the first (500 – 620 kg) and the second (630 – 740 kg) weight group of bulls in C20:5 content. There was detected nearly 50% decrease ($P < 0.05$) of C20:6 content in beef between the bulls

slaughtered at the lowest and the highest weight category. Quite regular (0.118; 0.127 %) C22:6 content in both weight groups. Statistically evident ($P < 0.01$) difference was proved at C22:5 content between the first (0.117 %) and the second (0.227 %) weight group. *Marino et al*., (2006) present the ratios of n-3 and n-6 fatty acid in beef of young bulls at the level of 6.72 % which is 1.03% more than at our results (5.69 %). *Enser et al*., (1996) was evaluating fatty acid composition in beef. Their results are comparable to ours, respectively the C20 ratio and C22 PUFA were included in fatty acid profile but their proportions were very low.

Conclusions

The connection between the slaughter weight of bulls and fatty acid composition in intramuscular fat of MLT was proved. The slaughter weight increase brings higher intramuscular fat content with the highest ratios of saturated fatty acids, from these the most numerous being C16:0, C18:0 and C20:0. To speak about monoenic acids, at the same time when oleic acid increase C14:1; C16:1 a C20:1 are decreasing. Positive dependence was established at polyunsaturated fatty acids between the slaughter weight and C18:1; C18:3 and C22:5 content. Negative consequence was the decrease of eicosadienic and eicosapentaeonic fatty acid due to their essentiality for human health.

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