AN IMPACT OF ANIMAL BREED ON THE COMPOSITION OF FATTY ACIDS IN *MUSCULUS LONGISSIMUS DORSI*

Vigilijus Jukna[1], Česlovas Jukna[1], Galina Garmienė[2], Gintarė Zaborskienė[1,2], Edita Meškinytė-Kaušilienė[1], Jolita Klementavičiūtė[1], Vilma Valaitienė[1], Raimundas Narkevičius[2]
[1]*Laboratory of Meat Characteristics and Quality Assessment, Veterinary Academy*
Lithuanian University of Health Sciences
Tilžės 18, LT-47181 Kaunas, Lithuania, tel. +370 363 414; e-mail: vjukna@lva.lt.
[2]*Food Institute, Kaunas University of Technology*
Taikos Ave. 92, LT-51180 Kaunas LT-3031 Kaunas, e -mail: testlab@lmai.lt

Abstract. The aim of the research was to assess the breed impact on the composition of fatty acids in the *musculus longissimus dorsi* comparing 500-day-old bulls bred under the same conditions. The study investigated the structure of fatty acids in *musculus longissimus dorsi* of the following cattle breeds: Angus, Hereford, Charolaise, Limousin, Lithuanian black and white crossbred with Charolais (LBW x CH), Lithuanian black and white crossbred with Limousines (LBW x LI), Lithuanian black and white crossbred with Simmental (LBW x SI), and the Lithuanian red Limousines hybrids (LR x LI). The breed had the most significant impact on the total amount of monounsaturated and total amount of omega-6 fatty acids ($p<0.05$, $p<0.05$). There were significant differences determined in average values of omega–3 fatty acids ($p<0.05$) depending on breed. A lower ratio of omega-6/ omega-3 fatty acids was observed in pure-bred bulls. The meat of pure-bred bulls contained a slightly larger amount of saturated fatty acids compared to the crossbred bulls. There was a strong correlation between polyunsaturated / saturated fatty acids ratio and the amount of omega – 3, when $r = 0.934$.The amounts of trans-fatty acid isomers were not affected by breed ($p\geq0.05$). The research results revealed that cattle breed affects the composition of fatty acids in the *muscular longissimus dorsi*.
Keywords: fatty acids, bulls, breed, crossbred, pure-bred.

GALVIJŲ VEISLĖS ĮTAKA ILGIAUSIOJO NUGAROS RAUMENS RIEBALŲ RŪGŠČIŲ SUDĖČIAI

Vigilijus Jukna[1], Česlovas Jukna[1], Galina Garmienė[2], Gintarė Zaborskienė[1,2], Edita Meškinytė-Kaušilienė[1], Jolita Klementavičiūtė[1], Vilma Valaitienė[1], Raimundas Narkevičius[2]
[1]*Gyvulių mėsinių savybių ir mėsos kokybės įvertinimo laboratorija, Veterinarijos akademija*
Lietuvos sveikatos mokslų universitetas
Tilžės g. 18, LT-4718 Kaunas; tel. +370 37 363 414; el. paštas: vjukna@lva.lt
[2]*Maisto institutas, Kauno technologijos universitetas, Taikos pr. 92, LT-3031 Kaunas; el. paštas: testlab@lmai.lt*

Santrauka. Šio tyrimo tikslas buvo nustatyti veislės įtaką vienodomis sąlygomis užaugintų 500 dienų buliukų ilgiausiojo nugaros raumens *(M. longissimus dorsi)* riebalų rūgščių sudėčiai. Buvo tirta angusų, herefordų, Šarolė, limuzinų, Lietuvos juodmargių mišrūnų su Šarolė (LJxŠA), Lietuvos juodmargių mišrūnų su limuzinais (LJxLI), Lietuvos juodmargių mišrūnų su simentaliais (LJxSI), Lietuvos žalųjų mišrūnų su limuzinais (LŽxLI) ilgiausiojo nugaros raumens riebalų rūgščių sudėtis. Didžiausią įtaką veislė turėjo mononesočiųjų ir bendram omega-6 riebalų rūgščių kiekiui ($p<0,05$). Taip pat nustatyti žymūs skirtumai tarp atskirų veislių vidutinių omega-3 riebalų rūgščių verčių ($p<0,05$). Mažesnis riebalų rūgščių omega-6 ir omega-3 santykis pastebėtas grynaveislių buliukų raumenyje. Neženkliai didesnis nesočiųjų riebalų rūgščių kiekis buvo grynaveislių galvijų mėsoje palyginti su mišrūnų. Transriebalų rūgščių izomerų kiekiui galvijų veislė įtakos neturėjo ($p\geq0,05$). Nustatyta stipri korealiacija tarp polinesočiųjų rūgščių, sočiųjų rūgščių santykio ir omega-3 kiekio, kai $r= 0,934$. Remiantis tyrimų rezultatais galima teigti, kad galvijų veislė turi įtakos ilgiausiojo nugaros raumens riebalų rūgščių sudėčiai.
Raktažodžiai: riebalų rūgštys, buliukai, veislė, mišrūnai, grynaveisliai.

Introduction. Total intake of saturated fatty acids (SFA), monounsaturated (MUFA) or polyunsaturated fat acids (PUFA) in daily diet not only influence the occurrence and prophylaxis of cardiovascular diseases and cancer but also affect the population mortality rate (Leosdottir, 2005). Considering the concept of healthy nutrition, consumers tent to choose meat containing the minimum amount of fat, and pay attention to their juiciness and colour (Ngapo et al., 2007).

Beef fat has a relatively high ratio of saturated and unsaturated fatty acids, which is a risk factor for development of vascular and coronary diseases (Calder ir Deckelbaum, 2003). It has been determined that beef has lower ratios of saturated fatty acids (Poon et al., 2001). Animal lipids can be a good source of physiologically useful fatty acids (Simopoulos, 2002). Profiles of fatty acids determine organoleptic properties of meat, its taste and juiciness (Calkins and Hodgen, 2007).

Feeding and breed of animals have significant impact on the amount of fat, and composition of muscle tissue

(De Smet et al., 2004). Feeding affects formation of the ten conjugated linoleic acid isomers (Alfaia et al. 2009). Consumers in Western European countries are provided mostly the meat or its products of intensively farmed animals, including ruminants. In the muscular tissue of ruminants, the level of omega-3 and omega-6 fatty acids is usually low, which can have a negative effect on human health (Cordain et al., 2005).

Breed, genotype (Eichhorn et al., 1986; Malau-Aduli et al., 1997; Siebert et al., 1996), sex, and age (Rule et al., 1995) of animals highly affect the chemical composition of beef. The meat of Belgian Blue and Limousine is usually lighter in colour and contains less collagen and intramuscular fat. The fatty acid profiles of these breeds are significantly different compared to the meat of animals from Argentine or Ireland; the ratios of PUFA/SFA and omega-6 and omega-3 are significantly higher in Belgian Blue and Limousin breeds compared to other aforementioned breeds (Raes et al., 2003). The influence of genotype is associated with the myostatin gene mutation that causes muscle hypertrophy (mh). Belgian Asturiana de los Valles breed with double-muscled (mh/mh) character demonstrate higher muscle expression, lower level of fat, higher moisture content of meat, lighter colour, and higher cooking loss compared to the meat of the usual Asturiana de los Valles animals (+/+). The meat composition of heterozygotes (mh / +) is intermediate. Asturiana de la Montana breed demonstrate poorer muscle development, higher level of fat, lower moisture content of meat, and darker colour of meat. According to the profile of fatty acids, the meat of mh/mh animals has lower SFA and MUFA ratio, and higher level of PUFAs and conjugated linoleic acid (CLA) isomers. PUFA/SFA ratio increases when the number of mh alleles increases (characteristic to double-muscled animals), however no significant differences between the ratios of omega-6 and omega-3 were observed in meat of animals of different genotype (Aldai et al. 2006).

In meat fat of dairy and beef cattle, the major saturated fatty acids found are: palmitin (C16:0) (15–18 %), monounsaturated – olein (C18:1) (21–25 %), and polyunsaturated – linol (C18:2) the content of which makes up 10 to 14 percent. Comparing compositions of polyunsaturated acids in dairy and beef cattle, it has been determined that the meat of beef cattle has higher levels of polyunsaturated acids linol (C18:2) and linolen (C18:3): 14 % and 7 % respectively. Thus, based on the qualitative and quantitative composition of fatty acids, the most valuable meat is beef cattle meat (Liutkevičius A. et al., 2009).

Meat quality determines taste characteristics, nutritional value, technological quality, and safety (Wood et al., 1999; Andersen et al., 2005). When assessing the quality of meat, the major attention is paid to separate meat quality indicators, appearance, softness, juiciness, and taste, which in turn are determined by intramuscular fat and fatty acid composition (Aaslyng et al., 2009, Prieto et al., 2010). Consumer's decision on what beef to buy is determined by variety of health and organoleptic properties, which includes colour, softness, juiciness, flavour, and taste (Verbeke & Viaene, 1999).

The aim of our research was to determine the impact of breed on the composition of fatty acid in the *musculus longissimus dorsi* of cattle raised in Lithuania under the same conditions.

Materials and methods. The composition of fatty acids in the intramuscular fat of *M. longissimus dorsi* of 500-days old Angus, Hereford, Charolaise, Limousin, Lithuanian black and white crossbred with Charolais (LBW x CH), Lithuanian black and white crossbred with Limousines (LBW x LI), Lithuanian black and white crossbred with Simmental (LBW x SI), and the Lithuanian red Limousines hybrids (LR x LI) grown under the same conditions in the station of control fattening of young bulls was researched at the Institute of Food of Kaunas University of Technology. The samples for the research were taken from the area near the last two ribs. 8 samples were taken from each breed and crossbred group (64 samples in total), and 2 of each group of samples were prepared for chromatographic analysis (128 samples in total).

The amount of fatty acids was determined by the method of gas chromatography using flame ionization detector. For the analysis of fat acids, the samples were prepared according to the standard LST EN ISO 12966-2:2011[1]. Fatty acids were methylated using ahydrous KOH methanol solution. Chromatographic analysis of fatty acids methyl esters was performed using gas chromatograph Shimadzu GC - 17A, using BPX – 70, 120 m column following the methodology established in LST EN ISO 15304:2003/AC: 2005[2].

[1]**LST EN ISO 12966-2:2011** Animal and vegetable fats and oils - Gas chromatography of fatty acid methyl esters - Part 2: Preparation of methyl esters of fatty acids (ISO 12966-2:2011).

[2]**LST EN ISO 15304:2003/AC:2005** *(LST EN ISO 15304:2003/AC:2005)* Animal and vegetable fats and oils – Determination of the content of trans fatty acid isomers of vegetable fats and oils - Gas chromatographic method (ISO 15304:2002/Cor.1:2003).

Analytical conditions:

- Column temperature: 60ºC 2 min, 20ºC/min to 230ºC, maintaining the temp. for 45 min.
- evaporator temperature 250ºC,
- flame ionization detector temperature 270ºC,
- gas-carrier: nitrogen.

For identification of fatty acids, Supelco 37 Component FAME Mix was used; the fatty acids tetradecen (C14:2) and hexadecen (C16:2) were identified by means of interpolation, and conjugated linoleic acid isomers were identified applying the commercial standard of Matreya Inc. (Pleasant Gap, PA, USA).

For data analysis, the software Microsoft Corporation Excell 2007 was used for calculating and presenting in the article the average values in percentages of the total fatty acids (TFA), standard deviations (±STDEV), the level of reliability (p) for average amounts of fatty acids in beef cattle meat (comparing purebred and crossbred groups) using unpaired t-test, correlation and their coefficients r.

Abbreviations of fatty acids used in the work are:

butyric - C4:0, caproic - C6:0, caprylic acid methyl ester C8:0, capric C10:0, lauric - C12:0, myristic - C14:0, tetradecanoic (C14:2), myristoleic - C14:1, pentadecanoic C15:0, palmitic - C16:0, palmitoleic - C16:1, exadecenoic (C16:2), heptadecanoic acid C17:0, cis-10-heptadecenoic C17:1, stearic - C18:0, elaidic - C18:1n9t, oleic - C18:1n9c, linolelaidic - C18:2n6t, linoleic - C18:2n 6c, γ-linoleic - C18:3n 6, α-linoleic C18:3n3, together cis-9, trans 11 C18:2 and trans-11 cis-12 C18:2 – conjugated linoleic acids (CLA), arachidic - C20:0, cis-11,14-eicosenoic - C20:2, cis-11,14,17- eicosadienoic – C20:3n3, arachidonic C20:4n6, cis 5,8,11,14,17-eicosapentaenoic – C20:5n3, behenic - C22:0; cis-7,10,13,16- docosadienoic C22:4n6, cis-7,10,13,16,19-docosadienoic C22:5n3, cis-4,7,10,13,16,19-docosahexaenoate – C22:6n3; lignoceric- C24:0.

Research results

The average amounts of the main fatty acids found in the *longissimus* muscle fat are presented in Table 1.

Table 1. **Average amounts of fatty acids in meat of various cattle breeds, expressed in percentages of TFA**

Fatty acids	Cattle Breed							
	Angus	Hereford,	Charolaise	Limousine	LJ x ŠA	LJ x LI	LJ x SI	LŽ x LI
C10:0	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.1±0.04
C11:0	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00
C12:0	0.63±0.29*	0.73±0.16	0.28±0.15	0.30±0.21	0.20±0.10	0.13±0.06*	0.17±0.06	0.40±0.10
C13:0	0.20±0.15	0.53±0.32	0.44±0.31	0.73±0.14	0.20±0.13*	1.67±0.35*	0.16±0.12*	0.2±0.08*
C14:0	4.20±0.25	4.17±0.31	4.03±0.31	4.33±0.75*	3.60±0.00*	4.30±0.20	3.50±0.26*	4.10±0.10
C15:0	1.40±0.67*	1.25±0.75	1.19±0.32	1.20±0.30	1.00±0.53	0.9±0.12	1.03±0.13	0.45±0.08*
C16:0	19.57±1.40*	19.97±1.90	20.53±0.69	20.45±0.77	19.40±0.14*	21.67±0.31*	20.37±0.59	20.40±0.26
C17:0	0.47±0.24	0.30±0.08*	0.38±0.21	0.67±0.20	0.20±0.06*	0.37±0.15	1.90±0.32	1.93±0.23*
C18:0	15.53±0.86*	16.13±1.88	17.82±0.82	15.55±3.07*	18.05±0.07*	16.93±0.70	16.27±1.53	16.00±1.73
C20:0	0.53±0.12	0.63±0.40	0.32±0.04	0.33±0.10	0.40±0.14	0.33±0.06	0.53±0.32	0.37±0.06
C22:0	0.00±0.00	0.17±0.10	0.00±0.00	0.13±0.05	0.00±0.00	0.00±0.00	0.20±0.12	0.13±0.03

Differences between average values between the columns are reliable when *p<0.05; ±STDEV – standard deviation, n=16.

The table above presenting the average amounts of saturated fatty acids shows that saturated fatty acid C10:0 was found only in the meat of LŽ x LI crossbred animals. The largest amounts of the saturated fatty acid C12:0 was found in Angus cattle meat, while the least amount was found in Lithuanian black and white crossbred with Limousines meat; the difference was significant and made up 0.5 percent (p<0.05). The largest amounts of saturated fatty acid C13:0 was found in Lithuanian black and white crossbred with Limousines meat, while the least amount was found in Lithuanian black and white crossbred with Simmental cattle meat; the difference was 1.51 percent (p<0.05). The largest amounts of the saturated fatty acid C15:0 was found in Angus cattle meat, while the least amounts were found in Lithuanian red crossbred with Limousines meat; the difference made up 0.95 percent (p>0.05). Significant differences in the amounts of the saturated fatty acid C16:0 were observed in the meat of Angus, Lithuanian black and white crossbred with Charolaise, and Lithuanian black and white crossbred with Limousine cattle (p<0.05). The largest amounts of the fatty acid C17:0 were found in Lithuanian red crossbred with Limousines meat, while the least amounts were found in Lithuanian black and white crossbred with Charolaise meat as well as in Hereford cattle meat; the differences were statistically reliable (p<0.05). The largest amounts of C18:0 were found in Lithuanian black and white crossbred with Charolaise meat, and the least amounts were found in Angus cattle meat; the difference made up 2.52 percent and was reliable (p<0.05). The differences in the amounts of the fatty acid C20:0 were not significant in different cattle meat.

Table 2. **Average amounts of monounsaturated fatty acids in various cattle meat, in percentages of the TFA**

Fatty Acids	Cattle Breed							
	Angus	Hereford,	Charolaise	Limousine	LJ x ŠA	LJ x LI	LJ x SI	LŽ x LI
C:14:1	5.10±0.15**	0.75±0.32	0.84±0.41	0.93±0.36*	0.20±0.12**	0.30±0.19*	3.65±1.31*	0.47±0.20
C:15:1	0.90±0.38	0.43±0.10*	0.76±0.13	0.97±0.21*	0.55±0.27	0.99±0.03*	0.90±0.17*	0.60±0.26
C:16:1	3.40±1.42	3.20±0.41**	3.30±0.52*	3.97±0.21	4.00±1.53	5.86±0.99**	5.43±1.01*	5.00±0.87
C:17:1	1.00±0.05	0.97±0.32	0.99±0.32	0.67±0.08*	1.10±0.54	1.68±0.61*	1.37±0.30	1.10±0.27
C:18:1	27.96±5.01**	29.90±3.32*	28.93±1.32*	27.30±1.87**	30.65±1.06*	28.97±0.21*	31.43±1.98**	28.36±1.09*
C20:1	0.20±0.01*	0.00±0.00*	0.62±0.10	0.63±0.21*	0.25±0.19	0.60±0.08	0.54±0.06	0.50±0.04
C:22:1	0.20±0.01	0.23±0.08	0.00±0.00*	0.80±0.21*	0.25±0.03	0.00±0.00*	0.30±0.02	0.27±0.18
C:24:1	0.00±0.00	0.00±0.00	0.05±0.01	0.00±0.00	0.01±0.00	0.03±0.00	0.00±0.00	0.00±0.00

Differences between average values between the columns are reliable when *p<0.05; ±STDEV – standard deviation, n=16.

The amounts of monounsaturated fatty acids are presented in Table 2. After examining the amounts of fatty acids in various cattle meat it was determined that the largest amounts of the fatty acid C14:1 were found in Angus cattle meat, while the least amounts were found in Lithuanian black and white crossbred with Charolaise cattle meat; the difference made up 4.9 percent ($p<0.01$).

The largest amounts of the monounsaturated fatty acids C15:1 and C16:1 RR were found in Lithuanian black and white crossbred with Limousine cattle meat, while the least amounts were found in Hereford cattle meat; the difference made up 0.56 percent ($p<0.05$), and 2.66 percent ($p<0.01$). The largest amounts of the main monounsaturated fatty acids C18:1 were found in Lithuanian black and white crossbred with Simmental cattle meat, while the least amounts were found in Limousine cattle bread; the difference was 4.13 percent ($p<0.01$). Small amounts of monounsaturated fatty acids C24:1 were found in Sharolaise meat, Lithuanian black and white crossbred with Limousine cattle meat, and Lithuanian black and white crossbred with Sharolaise cattle meat; this acid was not found in other cattle meat examined.

Average amounts of polyunsaturated fatty acids in different cattle meat are presented in Table 3 below.

Table 3. **Average amounts of polyunsaturated fatty acids in various cattle meat, in percentages of the TFA**

Fatty Acids	Cattle Breed							
	Angus	Hereford,	Charolaise	Limousine	LJ x ŠA	LJ x LI	LJ x SI	LŽ x LI
C:14:2	0.46±0.12*	1.30±0.08	1.33±0.21	1.37±0.09	1.20±0.08	1.40±0.42	0.43±0.06	1.47±0.07*
C:16:2n6	1.87±0.23	1.83±0.09	1.35±0.06*	2.13±0.13*	1.90±0.35*	1.90±0.08	1.97±0.07*	1.83±0.09
C:18:2n6	4.17±0.34*	4.76±0.78*	4.07±0.71*	3.97±0.43*	4.68±1.09*	3.98±0.98*	4.02±0.89*	4.00±1.06*
C:18:3n6	0.83±0.08*	0.87±0.06	1.05±0.04	0.87±0.03	1.20±0.21*	0.70±0.27*	0.80±0.29*	1.17±0.09*
C:18:3n3	1.10±0.13*	0.87±0.12	0.87±0.15	0.90±0.45	1.05±0.07*	0.53±0.29*	0.67±0.15*	1.0±0.10*
C:20:2n6	0.16±0.06	0.05±0.01	0.31±0.04	0.19±0.08	0.28±0.10	0.17±0.07	0.21±0.15	0.16±0.01
C:20:3n3	0.00±0.00	0.13±0.12	0.13±0.120	0.07±0.10	0.00±0.00	0.00±0.00	0.03±0.06	0.00±0.00
C:20:4n6	0.00±0.00	0.12±0.01	0.00±0.00	0.06±0.01	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00
C:20:5n3	0.00±0.00	0.00±0.00	0.00±0.00	0.06±0.01	0.00±0.00	0.00±0.00	0.00±0.00	0.05±0.01
C:22:2n6	0.10±0.01	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00
C:22:4n6	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00
C:22:5n3	0.03±0.06	0.00±0.00	0.00±0.00	0.00±0.00	0.05±0.07	0.00±0.00	0.03±0.06	0.00±0.00
C:22:6n3	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.03±0.01	0.00±0.00	0.00±0.00

Differences between average values between the columns are reliable when $*p<0.05$; ±STDEV – standard deviation, n=16.

The data presented in Table 3 show that the amounts of separate polyunsaturated fatty acids in different cattle meat were not significantly different. The highest difference of C14:2 fatty acid was observed when comparing Lithuanian red crossbred with Limousine cattle meat and Angus cattle meat ($p<0.05$), while the highest differences in the amounts of C16:2n6 were observed in Charolaise and Limousine cattle meat ($p<0.05$). Significant differences in the amounts of the main polyunsaturated linoleic acid C18:2n6 were observed in all the samples of the examined cattle meat ($p<0.05$).

Table 4 presents the average amounts of trans fatty acid isomers in different cattle meat. The largest amount of the trans-fatty acid isomers C18: 1 was found in the Limousine cattle meat, while the smallest amount was found in the Angus cattle meat; the difference was 0.57 percent ($p<0.05$). The largest amounts of trans fatty acid isomers C18:2 were found in the samples of Lithuanian black and white crossbred with Simmental cattle meat, while the least amounts were found in Hereford cattle meat. The amounts of conjugated fatty acids (CFA) were rather small in the samples of different cattle meat; no significant differences were observed between the amounts of CFA in the *M. longissimus dorsi* of different cattle breeds; no significant differences were found between the amounts of CFA in the *M. longissimus dorsi* of different cattle breeds.

Table 4. **Average amounts of trans fatty acid isomers in different cattle meat, in percentages of the TFA**

Fatty Acids	Cattle Breed							
	Angus	Hereford,	Charolaise	Limousine	LJ x ŠA	LJ x LI	LJ x SI	LŽ x LI
C:18:1 trans	3.43±0.21*	4.23±0.32	3.83±0.37	4.70±0.56*	4.00±0.48	3.87±0.43	3.90±0.32	4.63±0.54*
C:18:2 trans	1.67±0.81	1.58±0.05*	1.63±0.08	2.03±0.12*	1.65±0.13*	1.90±0.34	2.60±0.21*	1.86±0.24
KLR	0.77±0.17	0.97±0.08	1.28±0.41	1.20±0.21	0.90±0.09	1.00±0.05	1.20±0.07	1.00±0.10

Differences between average values between the columns are reliable when $*p<0.05$; ±STDEV – standard deviation, n=16.

Average amounts of omega – 3 fatty acids in different cattle meat are presented in Table 5. The amounts of omega – 3 fatty acids vary in different cattle meat. The largest amounts of α-linoleic acid C:18:3n3 were found in Angus cattle meat, and the least amounts were found in Lithuanian black and white crossbred with Limousine cattle meat; the difference was 0.57 percent (p<0.05). The differences between the amounts of other omega – 3 fatty acids in different cattle meat were not significant.

Table 5. **Average amounts of omega – 3 fatty acids in different cattle meat, in percentages of the TFA**

Fatty Acids	Cattle Breed							
	Angus	Hereford,	Charolaise	Limousine	LJ x ŠA	LJ x LI	LJ x SI	LŽ x LI
C:18:3n3	1.10±0.13*	0.87±0.12	0.87±0.15	0.90±0.45	1.05±0.07*	0.53±0.29*	0.67±0.15*	1.0±0.10*
C:20:3n3	0.10±0.03	0.12±0.02	0.16±0.04	0.09±0.01	0.15±0.03	0.09±0.02	0.06±0.01	0.04±0.01
C:22:5n3	0.03±0.06	0.00±0.00	0.00±0.00	0.00±0.00	0.05±0.07	0.00±0.00	0.03±0.06	0.00±0.00
C:22:6n3	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.03±0.01	0.00±0.00	0.00±0.00

Differences between average values between the columns are reliable when *p<0.05; ±STDEV – standard deviation, n=16.

Average amounts of saturated fatty acids in the *M. longissimus dorsi* of different cattle animals were slightly larger in pure-bred cattle meat compared to crossbred cattle with p≥0.05, however significant differences between average amounts of saturated fatty acids were found in Angus, Lithuanian black and white crossbred with Charolaise cattle meat compared to Charolaise and Limousin meat with p<0.05 (Table 6). Average amounts of monounsaturated fatty acids in all the samples were significantly different (p<0.05), however, no significant differences were observed between the amounts of monounsaturated fatty acids in pure-bred and crossbred cattle meat (p≥0.05). Average amounts of polyunsaturated fatty acids in the samples of the examined cattle breeds were significantly different in Angus, Hereford, Lithuanian black and white crossbred with Simmental and Limousine cattle meat with p<0.05. No significant differences were found when comparing the ratios of the fatty acids omega 6 and omega 3 in pure-bred and cross-bred breeds (p≥0.05). The lowest ratio of omega 6 and omega 3 was found in Angus and Limousine meat. The lowest ratio of polyunsaturated fatty acids and saturated fatty acids was found in Lithuanian black and white crossbred with Limousine meat, while the highest ratio was found in Angus, and Lithuanian red crossbred with Limousine cattle meat.

Table 6. **Average amounts of fatty acids of the major groups, in percentages of the TFA, ratios of omega 6 and omega 3, ratios of polyunsaturated and saturated fatty acids in the meat of various cattle breeds**

Fatty Acids	Angus	Hereford,	Charolaise	Limousine	LJ x ŠA	LJ x LI	LJ x SI	LŽ x LI
Saturated	43.33±0.98*	44.7±0.46	45.42±1.69*	46.17±0.62*	43.45±0.21*	45.17±1.33	43.5±1.74	44.67±2.00
Monounsaturated	38.27±0.12*	35.63±0.79*	37.13±2.35*	36.32±3.38*	37.5±1.84*	37.57±2.32*	39.0±1.21*	34.7±1.35*
Polyunsaturated	10.23±0.65*	10.4±0.47*	9.32±0.79	9.67±1.01	10.2±0.42	8.27±0.42*	8.13±0.72*	10.73±1.01
Trans isomers	7.0±1.15	7.93±0.67	6.4±0.90	5.98±1.16	6.55±1.06	6.8±0.95	7.7±1.15	7.5±0.46
Omega 3	1.17±0.67*	1.0±0.20*	0.98±0.17*	1.07±0.50*	1.1±0.00*	0.73±0.06*	0.77±0.06*	1.23±0.25*
Omega 6	4.97±0.90	5.63±1.36*	5.12±0.58	5.17±0.78	5.8±0.71*	4.33±0.31	3.97±0.93*	6.2±0.82*
Omega 6 / omega 3	4.25	5.63	5.22	4.83	5.27	5.93	5.16	5.04
Polyunsaturated / saturated	0.24	0.23	0.21	0.21	0.23	0.18	0.19	0.24

Differences between average values between the columns are reliable when *p<0.05; ±STDEV – standard deviation, n=16.

When analysing the research data, a strong correlation was determined between the ratio of polyunsaturated fatty acids and saturated fatty acids, and the amount of omega – 3, when r= 0.934; negative correlation was determined between the ratio of polyunsaturated fatty acids and saturated fatty acids, and the ratio of omega – 6 and omega -3 (r=-0.534). There was a negative correlation observed between the amounts of saturated fatty acids and monounsaturated fatty acids (r=-0.518), and between the amounts of monounsaturated fatty acids and the ratio of polyunsaturated fatty acids and saturated fatty acids (r=-0.476).

Similar amounts of saturated and monosaturated fatty acids in the *M. longissimus dorsi* were also observed by other authors that were examining the content of fatty acids in the meat of bovine animals (Raes et al., 2003; Realini et al., 2004). Over the past few years, numerous studies were carried out to improve the content of fatty acids in the meat of bovine animals: the aim was to increase the amounts of conjugated linoleic acids, omega

- 3 long chain polyunsaturated fatty acids and vaccenic acid, and reduce the ratio of omega - 6 and omega – 3 as well as the ratio of polyunsaturated and saturated fatty acids (Raes et al., 2004; Givens et al., 2006; Schmid et al., 2006; Scollan et al., 2006). Comparing different breeds of cattle it is apparent that the largest amounts of polyunsaturated fatty acids were found in the meat of Lithuanian red crossbred with Limousine breed cattle, while the smallest amounts were found in the meat of Lithuanian red and Simmental crossbred cattle, the difference was 2.60 percent. Comparing the ratios of polyunsaturated acids omega -6 and omega 3 in *M. longissimus dorsi* of animals from different breeds with the data obtained by Kraft et al., (2008), it turned out that the ratio of omega -6 and omega 3 in Limousine meat in our case was 4.83 and 1.7 times smaller, while in Angus breed cattle meat, this ratio was 4.25, which was 2 times larger. According to Kraft et al. (2008), the lowest ratio of polyunsaturated and saturated fatty acids was observed in the *M. longissimus dorsi* of free gazing animals – 0.12 in Angus breed animals, while the largest ratio was observed in intensively farmed Limousines – 0.34. Our research showed that in the meat of farmed Limousines, this ratio, similarly as in the case of Sharolaise, was 0.21, which is lower compared to the data found by Kraft et al. Thus, after comparing the obtained data we can see that the majority of fatty acid indicators depend not only on the breed but also on the feeding, farming method and intensity.

Findings:

1. Cattle breed affects the content of fatty acids in the *M. longissimus dorsi* of bovine animals. The greatest influence of cattle breed was seen on the amounts of monounsaturated fatty acids, especially oleic, omega-3, α-linolenic, and polyunsaturated fatty acids, especially linoleic; the differences were reliable with $p<0.05$.
2. In the meat of purebred cattle, the ratio of polyunsaturated acids and saturated acids was slightly higher compared to cross-bred animals as well as the amounts of polyunsaturated fatty acids and omega–3, while the ratio of omega 6 and omega 3 was lower ($p\geq0.05$).
3. Cattle breed did not affect the amounts of trans-fatty acid isomers ($p\geq0.05$). The amounts of conjugated linoleic acid isomers were rather small in muscles of animals of different breeds; no significant differences were observed in the amounts of CLA in the *M. longissimus dorsi* of bovine animals of different breeds.
4. The differences of polyunsaturated α-linolenic acid and omega-6 polyunsaturated fatty acids affected health indicators of *M. longissimus dorsi*: the ratio of polyunsaturated and saturated fatty acids as well the ratio of omega-6 and omega-3. As strong correlation was determined between the ratio of polyunsaturated fatty acids and saturated fatty acids and the amount of omega – 3 fatty acid when r= 0.934; and negative correlation was observed between the ratio of polyunsaturated fatty acids and the ratio of omega – 6 and omega -3 fatty acids (r=-0.534).
5. There was a negative correlation observed between the amounts of saturated fatty acids and monounsaturated fatty acids (r=-0.518), and between the amounts of monounsaturated fatty acids and the ratio of polyunsaturated fatty acids and saturated fatty acids (r=-0.476)

List of References

1. Aaslyng M. D. Trends in meat consumption and the need for fresh meat and meat products of improved quality. 2009. In J. P. Kerry, & D. Ledward (Eds.). Improving the sensory and nutritional quality of fresh meat. Cambridge: Woodhead Publishing.

2. Aldai N., Murray B. E., Olivan M., Martınez A., Troy D. J, Osoro K., Najera A. I. The influence of breed and mh-genotype on carcass conformation, meat physico-chemical characteristics, and the fatty acid profile of muscle from yearling bulls. Meat Science. 2006. 72. P. 486–495.

3. Alfaia C. P. M., Alves S. P., Martins S. I. V., Costa A. S. H., Fontes C. M. G. A., Lemos J. P. C., Bessa R. J. B., Prates J. A. M. Effect of the feeding system on intramuscular fatty acids and conjugated linoleic acid isomers of beef cattle, with emphasis on their nutritional value and discriminatory ability. Food Chemistry,.2009. 114. P. 939–946.

4. Andersen H. J., Oksbjerg N., Young Jette F., Therkildsen M. Feeding and meat quality – a future approach. Meat science. 2005. 70. P. 543–554.

5. Calder P. C., Deckelbaum R. J., Fat as a physiological regulator: the news gets better. Current Opinion in Clinical Nutrition & Metabolic Care. 2003. 6. P. 127–131.

6. Calkins C. R., Hodgen J. M. A fresh look at meat flavor. Meat Science. 2007. 77. P. 63–80.

7. Cordain L., Eaton S. B., Sebastian A., Mann N., Lindeberg S.,Watkins B. A., ir kt.. Origins and evolution of the Western diet: health implications for the 21st century. American Journal of Clinical Nutrition. 2005. 81(2). P. 341–354.

8. De Smet S., Matthys C., Bilau M., Van Camp J., Warnants N., Raes K., ir kt. Effects of fatty acid composition of animal products on adolescent fatty acid intake in Belgium. In ICoMST 50th International congress of meat science and technology. 2004. August 2004, Helsinki, Finland. P. 8–13.

9. Eichhorn, J. M., Coleman, L. J., Wakayama, E. J., Blomquist, G. J.,Bailey, C. M., & Jenkins, T. G. Effects of breed type and restricted versus ad libitum feeding on fatty acid composition and cholesterol content of muscle and adipose tissue from mature bovine females. Journal of Animal Science. 1986. 63. P. 781–794.

10. Givens D.; Kliem K. E.; Gibbs R. A. The role of meat as a source of n-3 polyunsaturated fatty acids in

the human diet. Meat Sci. 2006. 74. P. 209–218.

11. Kraft J., Kramer J. K. G., , Schoene F., Chambers J. R., Jahreis G. Extensive Analysis of Long Chain Polyunsaturated Fatty Acids, CLA, trans -18:1 Isomers, and Plasmalogenic Lipids in Different Retail Beef types. J. Agric. Food Chem. 2008. 56(12). P. 4775–4782.

12. Leosdottir M.;, Nilsson P.M.; Nilsson J.A.; Mansson H.; Berglund, G. Dietary fat intake and early mortality patterns – data from The Malmo Diet and Cancer Study. J. Intern. Med. 2005. 258(2). P. 153–165.

13. Liutkevičius A., Speičienė V., Mieželienė A., Alenčikienė G., Zaborskienė G. Įprastomis sąlygomis užaugintų mėsinių, pieninių bei ekologiškai užaugintų pieninių galvijų mėsos kokybė. Maisto chemija ir technologija. 2009. 43(2). P. 47–56.

14. Malau-Aduli A. E. O., Siebert B. D., Bottema C. D. K., ir Pitchford W. S. A comparison of the fatty acid composition of triacylgly- cerols in adipose tissue from Limousin and Jersey cattle. Australian Journal of Agricultural Research. 1997. 48. P. 715–722.

15. Ngapo T. M., Martin J. F., & Dransfield E. International preferences for pork appearance: 1. Consumer choices. Food Quality and Preference. 2007. 18. P. 26−36.

16. Poon P. W. B., Durance, T., Kitts D. D. Composition and retention of lipid nutrients in cooked ground beef relative to heat-transfer rates. Food Chemistry. 2001, 74, P. 485–491.

17. Prieto N., Navajas E. A., Richardson R. I., Ross D. W., Hyslop J. J., Simma G., Roehe R. Predicting beef cuts composition, fatty acids and meat quality characteristics by spiral computed tomography. Meat Science. 2010. 86. P. 770–779.

18. Raes K., Balcaen A., Dirinck P., De Winne A., Claeys E., Demeyer D., De Smet S.. Meat quality, fatty acid composition and flavour analysis in Belgian retail beef. Meat Science. 2003. 65. P. 1237–1246.

19. Raes, K.; De Smet, S.; Demeyer, D. Effect of dietary fatty acids on incorporation of long chain polyunsaturated fatty acids and conjugated linoleic acid in lamb, beef and pork meat: a review. Anim. Feed Sci. Technol.,2004. 113. P. 199–221.

20. Realini C. E., Duckett S. K., Brito G. W., Rizza M. D., De Mattos D. Effect of pasture vs. Concentrate feeding with or without antioxidants on carcass characteristics, fatty acid composition, and quality of Uruguayan beef . Meat Science,.2004. 66. P. 567–577.

21. Rule D. C., Smith S. B., Romans J. R. Fatty acid composition of muscle and adipose tissue of meat animals. In S. B. Smith & D. R. Smith, Biology of fat in meat animals (p. 144–165). Current Advances series of the American Society of Animal Science. 1995. Champaign, III.

22. Schmid A.; Collomb M.; Sieber R.; Bee G. Conjugated linoleic acid in meat and meat products: a review.Meat Sci.,2006. 73. P. 29–41.

23. Scollan N.; Hocquette J. F.; Nuernberg K.; Dannenberger D.; Richardson I.; Moloney A. Innovations in beef production systems that enhance the nutritional and health value of beef lipids and their relationship with meat quality. Meat Sci., 2006. 74. P. 17–33.

24. Siebert B. D., Deland M. P., & Pitchford W. S. Breed differences in the fatty acid composition of subcutaneous and intramuscular lipid of early and late maturing, grain-finished cattle. Australian Journal of Agricultural Research. 1996. 47. P. 943–952.

25. Simopoulos A. P., The importance of the ratio of omega-6/omega-3 essential fatty acids. Biomedicine and Pharmacotherapy. 2002. 56, P. 365–379.

26. Verbeke W., & Viaene J. Beliefs, attitude and behaviour towards fresh meat consumption in Belgium: empirical evidence from a consumer survey. Food, Quality and Preference. 1999. 10. P. 437–445.

27. Wood J. D., Enser M., Fisher A. V., Nute G. R., Richardson R. J. and Sheard P. R. Manipulating meat quality and composition. Proceedings of the Nutrition Society. 1999. 58. P. 363–370.

Received 8 August 2012
Accepted 2 October 2013