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COMPARISON OF THE CARCASS AND BEEF QUALITY OF THE CZECH FLECKVIEH BULLS WITH GENOTYPE TT AND CT FOR LEPTIN AND BULLS OF GALLOWAY AND CHAROLAIS BREEDS

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Abstract

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The objective of the present study was to compare the quality of the carcass and beef of bulls genotyped for leptin (TT and CT) of the Czech Fleckvieh cattle with Galloway and Charolais bulls. Analysed were 232 bulls. The quality of the carcass body was significantly ($p < 0.05$) the highest in Charolais bulls (78.1% beef, 1.66% fat) as compared with bulls of the Czech Fleckvieh cattle (77.06% beef, 2.52% fat). The percentage of bones in the weight of the carcass body was the same in all breeds (20.49%; 20.28%; 20.24%, respectively). Indicators of the nutritional quality apart from the energetic value of meat of the Galloway and Charolais breeds were not significantly ($p > 0.05$) affected by the breed. In terms of fatty acids significant ($p < 0.01$) differences were discovered in the intramuscular fat of the MLT between the Czech Fleckvieh cattle and both beef breeds in the levels of C16:0; C20:0; C14:1; C16:1; C20:1; C20:2 and rate of the $C14_{index}$. A significant ($p < 0.05$) difference in the level of oleic acid was detected between the meat of the Czech Fleckvieh cattle (37.77 g.100g $^{-1}$) and Charolais (41.23 g.100g^{-1}). From the viewpoint of human health the most favourable rates of fatty acids ($C14_{index} = 22.07$; $C16_{index} = 13.63$; $C18_{index} = 64.19$; AI = 0.67) were seen in the meat of the Czech Fleckvieh cattle. The smallest diameter of muscle fibres (35.61 μm) was detected in the Czech Fleckvieh cattle as compared to the Galloway (37.60 μm) and Charolais (38.01 μm) breeds.

Keywords: bulls, leptin, carcass trait, beef quality, fatty acids

INTRODUCTION

In the Czech Republic a relatively great number of cattle breeds are bred. The dominant breeds are Holstein and Czech Fleckvieh cattle (representing the milked cattle breeds), but relatively substantial and increasing every year are also beef breeds of cattle; the most frequently bred beef breeds are Charolais and Galloway. According to Pabiou *et al.* (2011) the percentage of beef, bones and fat in carcass bodies of bulls is 71%, 19% and 10%, respectively. Chládek *et al.* (2005) reported similar percentages in bulls of the Czech Fleckvieh and Montbéliarde cattle. According to Keane and Allen (1998) and Polách *et al.* (2000) the percentage of beef in carcass bodies of Charolais bulls was 80.13%. Waritthitham *et al.* (2010) assessed the quality of carcass of Charolais and Brahman cattle; they did not prove statistically significant ($p > 0.05$) differences in the percentage of muscle fibres, nonetheless in Charolais bulls they proved ($p < 0.05$) that the total weight of the carcass body the percentage of the round of beef and of the shoulder was higher and the percentage of fat and bones was lower. Sochor *et al.* (2005) compared the quality of beef of bulls of the Czech Fleckvieh cattle with the Charolais, Meat Simmental and Blond d'Aquitaine breeds. The authors did not discover any significant differences in nutritional parameters among the breeds. However, the differences among the breeds in the water-holding capacity and size of the MLT were significant ($p < 0.01$). Serrano *et al.* (2005) stated that the average percentage of proteins in beef was 20.5%. Moloney *et al.* (2011) fed bulls a concentrated feed ration and found that the percentage of proteins in the meat was significantly ($p < 0.05$) higher (23%) than in animals fed grass silage (19%). Zapletal *et al.* (2009) evaluated the amount of intramuscular fat and fatty acids in the meat of the Czech Fleckvieh and Monbéliarde cattle. Although the authors did not prove that the breed had a significant ($p < 0.05$) effect on the content of intramuscular fat, the content of monoenoic and dienoic fatty acids differed ($p < 0.01$). Bartoň *et al.* (2006) presented similar conclusions in terms of the content of intramuscular fat in beef of bulls of the Charolais, Hereford and Meat Simmental breeds. The authors proved that the proportion of polyunsaturated fatty acids was higher in the fat of Charolais and Meat Simmental bulls. Sochor *et al.* (2005) determined that the water-binding capacity of beef of Charolais bulls was 78.3 ± 4.44%. Ruiz de Huidobro *et al.* (2003) published similar values (78.55 ± 3.98%). Huuskonen *et al.* (2010) reported that the colour of meat of bulls fattened in a stable was significantly ($p < 0.05$) lighter than the meat of bulls on pasture. Also Dunne *et al.* (2009) pointed that there is a relation between the method of cattle nutrition and the colour of the fatty tissue in beef. The size of the MLT area according to Moon *et al.* (2006) is 73.59 ± 2.50 cm^2. Sami *et al.* (2004) proved a relation ($p < 0.05$) between the grade class for meatiness based on the seurop system and size of the MLT area.

The objective of the present study was to evaluate the differences in the quality of carcass bodies and meat of bulls of the Czech Fleckvieh (CF), Galloway (Ga) and Charolais (Ch) breeds.

MATERIAL AND METHODS

Data from a group of 232 bulls of the Czech Fleckvieh cattle (n = 82), Galloway breed (n = 72) and Charolais breed (n = 78) were analysed. The experiment included bulls of the Czech Fleckvieh breed cattle genotyped for the leptin gene (CT and TT). Blood samples (2 ml) were collected into tubes with EDTA. Blood was stored at −20 °C. Genomic DNA was isolated from blood using the QIAamp DNA Blood Mini Kit (Qiagen Inc., Valencia, CA, USA). The quality of DNA was verified by agarose gel electrophoresis in 1% gel visualized with ethidium bromide. Genotypes were determined based on molecular genetic analysis of single-nucleotide polymorphism (SNP) in the exon 2 of the leptin gene (transition C → T) (Buchanan *et al.*, 2002). For testing, we used our own methodology. PCR primers were designed based on GenBank U50365 sequence (FW: 5'TCGTTGTTATCCGCATCTGA 3 ', REV: 5'TACCGTGTGTGAGATGTCATTG 3'). The PCR was performed in 12.5 µl volumes containing 25 ng of bovine genomic DNA, 1x HotStarTaq Master Mix (Qiagen) and 0.2 µM of each forward and reverse primer. A PCR thermal profile consisted of pre-denaturation at 95 °C for 2 min; followed by 30 cycles of denaturation at 95 °C for 30 s, annealing temperature 56 °C for 30 s, elongation at 72 °C for 30 s; and final extension at 72 °C for 7 min. The obtained PCR products of 278 bp in size were verified on 3% agarose gel and re-sequenced using the ABI PRISM 3100-Avant Genetic Analyzer. The polymorphic locus (C/T) was located at position 204 of the fragment. Genotypes were determined based on the sequence. During the whole period of fattening the bulls of the Czech Fleckvieh cattle were housed in the fattening house and the feed ration (FR) consisted of maize silage – 60% of the FR (78 g NL, 6.18 MJ NEV), clover-grass silage – 10% of the FR (150.6 g NL, 5.6 MJ NEV), meadow hay – 10% of the FR (102 g NL, 5.1 MJ NEV) and concentrate S-1 – 20% of the FR. Until weaning the beef bulls remained out on pasture together with their mothers. The beef breeds were weaned at the end of the grazing season, after that the bulls were transferred to the fattening house where the composition of the feed ration was the same as for the Czech Fleckvieh bulls.

The bulls were slaughtered in commercial slaughter houses. The carcasses were placed in an ice box for 24 hours (temperature 2–4 °C). Technological dissections of the right half of the carcasses were then performed. Each part of the jointed meat was cut for body tissues – beef (muscles with intramuscular and inter-muscular fat), superficial (separable) fat and bone. The percentage of beef, fat and bone was related to the weight of the right half of the carcass which was being dissected. Basing on the amount of meat and bone the correlation between the two tissues was calculated.

At the level of the 9th to 10th thoracic vertebrae a sample of the *musculus longissimus et thoracis* (MLT) was then taken and used to assess the nutritional and technological parameters of meat quality and profile of fatty acids. The laboratory analyses were based on the Czech norm ČSN 570185 (1963) and methods specified in the work of Komprda *et al.* (2012). Fatty acids were analysed using the gas chromatograph HP4890 with capillary column DB-23 (60 m × 0.25 mm × 0.25 µm). For the measurements we chose a thermal programme from 100 °C * 3 min * 10 °C/min * 170 °C * 0 min

* 4 °C/min * 230 °C * 8 min * 5 °C/min * 250 °C * 15 min, injector temperature 270 °C, temperature of detector 280 °C. Spray was 2 µl. Nitrogen was the carrier gas. A flame ionisation detector (FID) was attached to the exit of the column. The proportions of fatty acids were completed according to Bartoň *et al.* (2010).

Experimental data were assessed using the STATISTICA software, version 10.0 (StatSoft, Inc., Tulsa, Oklahoma, USA) and ANOVA was used for the evaluation of the effect of the breed on the quality of the carcass and beef. The HSD test was used to determine conclusive evidence among the breeds. The correlation between the breed of the bulls and content of fatty acids in the intramuscular fat was assessed by means of covariance analysis where the content of intramuscular fat in the MLT was selected as the covariant.

RESULTS AND DISCUSSION

The CF bulls were slaughtered at an average age of 647 ± 72.88 days and weights ranging between 537 and 689 kg. The slaughter age of Ga bulls was similar (650 ± 66.84 days) but their slaughter weight was 45 kg higher than of the Czech Fleckvieh bulls. Fattening of Ch bulls was completed as the first (610 ± 84.70 days); nonetheless bulls of this breed achieved ($p < 0.01$) the highest slaughter weight (688 ± 113.12 kg). Statistically significant ($p < 0.01$) differences were detected in the weight of the carcass bodies among the breeds and among the individual weights (CF = 332 < Ga = 356 < Ch = 388 kg). Bjelka *et al.* (2011) reported that the carcass weight of Ch bulls slaughtered at the age of 489 ± 20 days was 340 kg. By contrast Kameniecki *et al.* (2009) reported a lower weight (299 ± 13 kg) of the carcass body of bulls of the same breed slaughtered at the age of 518 ± 32 days. Frickh *et al.* (2002) and Papstein *et al.* (1999) discovered that the weight of the carcass of bulls slaughtered at the same age was higher (351.6 kg and 369.8 kg, respectively). The dressing percentage increased linearly among the breeds (CF = 54.94%, Ga = 55.62%, Ch = 56.10 %). A statistically significant ($p < 0.05$) difference was found between the dressing percentage of CF and Ch. Sakowski *et al.* (2001) and Bartoň *et al.* (2006) also reported that the dressing percentage was higher in Ch bulls (Tab. I). The Ch bulls achieved the highest intensity of growth during fattening. The level of the net gains ranged between 544 and 740 g.day^{-1}. The daily gains in the weight of the carcasses of the Ga breed were on average by 51 g lower ($p < 0.05$), i.e. (591 ± 82.73 g.day^{-1}). The growth intensity was the lowest ($p < 0.01$) in CF bulls which reached average net daily gains of 522 g; in this breed a relatively high variability was discovered among the individual bulls (134.70 g.den^{-1}). Bulls of the Ch breed had the highest weight of the right half of the carcass (186.43 ± 31.76 kg). The right half of the carcass of Ga bulls had an insignificantly ($p > 0.05$) lower weight (176.59 ± 30.75 kg). The weight of carcass halves of the Czech Fleckvieh bulls was the lowest (163.21 ± 35.21 kg). A significant ($p < 0.05$) difference was seen between the weight of the right halves of bulls of the CF and Ga breeds and a highly significant ($p < 0.01$) difference in the weight of the right half of the carcasses between the CF and Ch breeds.

Technological dissection showed that the carcass half of the CF bulls had the lowest percentage of beef (77.06 ± 2.29%). The percentage of beef of the carcasses of Ga bulls ($p > 0.05$) was slightly higher (77.79 ± 1.68%). The highest percentage of muscle (78.10 ± 1.90%) was determined in carcasses of Ch bulls. A significant ($p < 0.05$) difference in the proportion of beef in the carcass half was discovered between the Ch and Czech Fleckvieh bulls (Tab. II). Also Keane *et al.* (1990) reported a higher proportion of beef and lower proportion of fat in the carcass of bulls of the Ch breed. A percentage of meat slightly over 80% (80.44–81.68%) in beef breeds of cattle was reported by Polách *et al.* (2000). Among the breeds the proportion of bone was balanced and ranged between 20.24% (Ch) and 21.49 ± 2.35% (CF). Relatively balanced was the variability in the percentage of bone among the breeds (2.02 [Ch] < 2.05 [Ga] < 2.35% [CF]). Identical percentages of beef and bone in the weight of the carcass body were also reported by Pfuhl *et al.* (2007), Zaujec *et al.* (2009) and Filipčík *et al.* (2010). By contrast, significant differences were found in the percentage of separable fat; the right halves of carcasses of the CF breed had the significantly ($p < 0.01$) highest amount of fat (2.52 ± 0.80%).

Similar data on the percentages of beef, bone and fat of the carcasses of the Czech Fleckvieh as against the Montbéliarde cattle were published by Chládek

I: *Slaughtering traits of experimental animals*

Trait	CF (n = 82)		Ga (n = 72)		Ch (n = 78)	
	mean ± s_d		mean ± s_d		mean ± s_d	
Age at slaughter (day)	647	72.88	650	66.84	610	84.70
Final live weight (kg)	591 ^{Aa}	98.35	636 ^{Ab}	102.94	688 ^{B}	113.12
Carcass weight (kg)	332 ^{A}	52.20	356 ^{B}	52.01	388 ^{C}	61.18
Dressing percentage (%)	54.94 ^{a}	1.728	55.62	0.588	56.10^{b}	0.883
Average daily gain (g.day^{-1})	522 ^{A}	134.70	591 ^{Ba}	82.73	642 ^{Bb}	97.68

a, b: means with different superscripts are significantly different at $p < 0.05$, respectively A, B, C: means with different superscripts are significantly different at $p < 0.01$

II: *Carcass traits of bulls*

Trait	CF (n = 82)		Ga (n = 72)		Ch (n = 78)	
	mean ± s_d		mean ± s_d		mean ± s_d	
Weight of right half of carcass (kg)	163.21^{Aa}	35.21	176.59^{b}	30.75	183.43^{B}	31.76
Beef (%)	77.06^{a}	2.29	77.89	1.68	78.10^{b}	1.90
Bones (%)	20.49	2.35	20.28	2.05	20.24	2.02
Fat (%)	2.52^{a}	0.80	1.83	0.73	1.66^{b}	0.69
Beef/bone ratio	3.58	0.45	3.67	0.43	3.75	0.43

a, b: means with different superscripts are significantly different at $p < 0.05$, respectively A, B, C: means with different superscripts are significantly different at $p < 0.01$

III: *Nutritional quality traits of beef*

Trait	CF (n = 82)		Ga (n = 72)		Ch (n = 78)	
	mean ± s_d		mean ± s_d		mean ± s_d	
Dry matter (%)	24.83	1.55	25.59	2.08	25.56	2.22
Intramuscular fat (%)	2.63	1.75	2.65	2.04	2.08	1.35
Total protein (%)	21.45	0.50	21.41	0.67	21.41	0.61
Collagen (g.100 g^{-1})	0.67	0.07	0.57	0.07	0.68	0.08
Ash (%)	1.10	0.04	1.08	0.04	1.09	0.05
Energy value (kJ.kg^{-1})	5991	620.14	6112^{a}	984.01	5635^{b}	756.34

a, b: means with different superscripts are significantly different at $p < 0.05$

et al. (2005). In both beef breeds the percentage of fat was lower (Ga = 1.83 ± 0.73%; Ch = 1.66 ± 0.69%). The carcasses of bulls of the Ch breed were seen to have the most favourable (3.85 ± 0.43) beef/bone ratio. In contrast this ratio was seen as the least favourable in carcasses of the CF cattle (3.76 ± 0.45). Filipčík *et al.* (2008) reported a similar meat/bone ratio in the carcass (3.64 ± 0.06).

The dry matter of beef ranged between 23.33% and 27.29% (Tab. III). The meat of the CF breed had the lowest dry matter content (24.38%). The dry matter content of both beef breeds of cattle was slightly higher and ranged from 25.59% (Ga) to 25.56% (Ch). The percentage of total protein in beef was similar in all the three breeds (CF = 21.45 ± 0.50%; Ga = 21.41 ± 0.67%; Ch = 21.41 ± 0.61%). Similar results in the percentage of protein in beef were published by Sochor *et al.* (2005). Teslík *et al.* (1996) reported that the percentage of protein in the beef of cattle of the CF breed was on average by 2% lower. In terms of the content of collagen proteins the top-quality meat was the meat of Galloway bulls which had the lowest proportion of collagen (0.57 ± 0.07 g.100 g^{-1}). The proportion of collagen protein in the meat of the other breeds was on average by 0.1 g.100 g^{-1} higher implying that the meat of these breeds had a ($p > 0.05$) higher proportion of connective tissue. Šubrt *et al.* (2010) and Tomkins *et al.* (2006) discovered the same insignificant differences in the collagen content among the breeds. Dubost *et al.* (2013) detected a markedly higher proportion of collagen in beef. They proved significant differences in the content of collagen proteins between the beef of Aberdeen Angus (4.69 g.100g^{-1}) and the proportion of collagen in Limousine bulls (3.73 g.100g^{-1}) and the Blond d'Aquitaine breed (3.61 g.100g^{-1}).

The proportion of intramuscular fat in the MLT of the CF and Ga breeds was comparable (2.63% and 2.65%, respectively). In the Ch bulls the proportion of intramuscular fat in the MLT was lower (2.08 ± 1.38%). According to Šubrt *et al.* (1996) the proportion of intramuscular fat in the beef was on average by 0.5% higher. The amount of intramuscular fat is related particularly with the energetic quality of meat which was the highest in the Ga breed (6112 ± 984.01 kJ.kg^{-1}) and slightly lower in the beef of CF bulls (5991 ± 620.14 kJ.kg^{-1}). The lowest energetic value was seen in the meat of Ch bulls (5635 ± 756.34 kJ.kg^{-1}). A statistically significant ($p < 0.05$) difference was found between the energetic quality of beef of 6112 kJ.kg^{-1} (Ga) and 5635 kJ.kg^{-1} (Ch).

Tab. IV shows the evaluations of the effect of the breed of the bulls on the level of fatty acids in the intramuscular fat of beef. In terms of saturated fatty acids the highest were the levels of palmitic acid and stearic acid and between the content of C16:0 in CF bulls (24.13 g.100 g^{-1}) and Ch bulls (27.08 g.100 g^{-1}) there was a statistically significant ($p < 0.01$) difference. Blanco *et al.* (2010) discovered that the content of palmatic acid in the Parda de Montaňa breed (23.22 g.100 g^{-1}) was similar to its content in the beef of CF bulls. The proportion of C18:0 in the intramuscular fat of the above mentioned Spanish breed was on average by 4–5 g.100 g^{-1} lower (17.56 ± 1.105 g.100 g^{-1}) than in the breeds of our present study. The contents of monoenic fatty acids C14:1, C16:1 and C20:1 and dienic fatty acid C20:2 were also found to differ significantly ($p < 0.01$) among the breeds. Likewise Holbert *et al.* (1996) and

Huerta-Leindez *et al.* (1993) reported significant differences among the cattle breeds in the contents of fatty acids. The most important component of fats in terms of healthy nutrition is polyenic unsaturated fatty acids of which there is a relatively small amount in animal fat. The amount of PUFA fatty acids ranged between 5.10 g.100 g^{-1} (Ch) and 6.11 g.100g^{-1} (Ga). According to Scollan *et al.* (2006) the PUFA fatty acid that is essential for ruminants is linolenic acid because more than 50% of the content of fatty acids of fodder consists of C18:3n-3. To this Boufaied *et al.* (2003) added that the resulting content of fatty acids in feed changes according to the method of feed preservation. Šubrt *et al.* (2008) proved significant ($p < 0.01$) differences in the content of fatty acids among the Czech Fleckvieh crosses with beef breeds. The proportion of PUFA in beef of the CF breed was 5.89 g.100 g^{-1} and in this breed the variability was the lowest of all the beef samples (± 1.311 g.100g^{-1}). Dinov *et al.* (2012) reported a markedly higher proportion of PUFA in beef of the Bulgarian Black and White breed (13.30 ± 0.23 g.100g^{-1}). From the point of view of the efficiency of the individual fatty acids for the human organism important is not only the content of the respective fatty acid, but its effective use also depends on the correlation

IV: *Fatty acids composition in intramuscular fat of beef*

Trait	CF (n = 82)		Ga (n = 72)		Ch (n = 78)	
	mean ± s_d		mean ± s_d		mean ± s_d	
C12:0	0.08^{a}	0.028	0.08	0.047	0.02^{b}	0.014
C14: 0	2.49	0.404	2.46	0.456	2.38	0.401
C16:0	24.13^{A}	1.978	24.65	2.057	27.08^{B}	2.120
C18:0	22.22	3.277	21.87	2.470	22.44	3.108
C20:0	0.36^{A}	0.021	0.26^{B}	0.029	0.20^{C}	0.041
C14:1	0.74^{A}	0.059	0.41^{B}	0.011	0.33^{B}	0.051
C16:1	3.82^{A}	0.176	2.97^{B}	0.632	2.78^{B}	0.550
C18:1	39.77^{a}	1.081	40.82	2.722	41.23^{b}	1.114
C20:1	0.48^{A}	0.026	0.34^{B}	0.049	0.35^{B}	0.061
C18:2	3.75	0.915	3.87	0.291	3.36	1.038
C18:3n6	0.16	0.041	0.13	0.043	0.14	0.036
C18:3n3	0.61	0.175	0.69	0.130	0.55	0.212
C20:2	0.29^{A}	0.432	0.09^{B}	0.090	0.03^{B}	0.014
C20:3	0.11	0.070	0.14	0.084	0.12	0.073
C20:4	0.40	0.302	0.53	0.373	0.37	0.310
C20:5	0.10	0.058	0.06	0.040	0.06	0.052
C22:4	0.08	0.056	0.11	0.060	0.07	0.028
C22:5n6	0.04	0.025	0.03	0.034	0.04	0.024
C22:5n3	0.17	0.122	0.22	0.177	0.17	0.105
C22:6	0.13	0.096	0.16	0.121	0.13	0.053
SFA	49.34	2.908	49.33	2.736	50.19	2.872
MUFA	44.78	2.918	44.59	2.992	44.70	3.472
PUFA	5.89	1.311	6.11	1.962	5.10	1.705
UFA	50.67	2.908	50.63	2.736	49.81	2.872
PUFA/SFA	0.12	0.030	0.12	0.043	0.10	0.035
MUFA/SFA	0.91	0.112	0.90	0.109	0.89	0.114
UFA/SFA	1.03	0.122	1.03	0.116	0.99	0.112
$C14_{index}$	22.07^{A}	8.056	14.10^{B}	5.442	12.04^{B}	3.714
$C16_{index}$	13.63^{a}	4.091	10.73^{b}	1.922	9.95^{b}	1.417
$C18_{index}$	64.19	4.913	65.10	3.582	64.77	4.550
AI	0.67	0.076	0.68	0.096	0.70	0.093
PUFA n-3	1.01	0.229	1.15	0.286	0.92	0.343
PUFA n-6	4.36	0.635	4.66	0.068	3.92	0.245
n-6/n-3	4.39	1.241	4.03	1.048	4.36	0.893

a, b: means with different superscripts are significantly different at $p < 0.05$, respectively A, B, C: means with different superscripts are significantly different at $p < 0.01$

V: *Technological quality traits of beef*

Trait	CF (n = 82)		Ga (n = 72)		Ch (n = 78)	
	mean ± s_d		mean ± s_d		mean ± s_d	
Water holding capacity (%)	78.64	5.53	79.19	4.10	78.23	3.17
pH_{48}	5.63	0.36	5.60	0.29	5.55	0.18
Muscle pigments ($mg.g^{-1}$)	3.85	0.93	3.96	0.73	4.04	0.88
Reflectance (%)	5.59	2.05	5.41	1.98	5.38	2.12
MTL area (cm^2)	86.73^a	20.36	87.71	21.17	90.51^b	21.86
Average diameter of muscle fibres (μm)	35.61^{Aa}	4.68	37.60^b	6.89	38.01^B	5.64

a, b: means with different superscripts are significantly different at $p < 0.05$, respectively A, B: means with different superscripts are significantly different at $p < 0.01$

among the individual fatty acids or groups of acids. Significant ($p < 0.01$) differences were discovered in the proportions of fatty acids with 14 carbons ($C14_{index}$) between the CF and both beef breeds of cattle (22.07 versus 14.10 and 12.04 $g.100\ g^{-1}$, respectively).

Considering the sixteen carbon fatty acids ($C16_{index}$) the most favourable ($p < 0.05$) proportion was discovered in the meat of CF bulls (13.63 ± 4.091 $g.100\ g^{-1}$). In cattle of the CF breed Zapletal *et al.* (2009) reported similar values for the "$C16_{index}$" (11.24 ± 0.615 $g.100\ g^{-1}$). Laborde *et al.* (2001) presented similar data for the "$C16_{index}$" in the meat of Simmental and Angus bulls. In the framework of evaluations of the atherogenic index "Al" and the ratio of n-6 and n-3 fatty acids no significant differences among the breeds were detected ($p > 0.05$). Moreno *et al.* (2007) reported a similar ratio between the n-6 and n-3 fatty acids. In contrast to our results Bartoň *et al.* (2010) discovered a higher proportion of PUFA n/3 in the intramuscular fat of Ch bulls than in CF bulls.

The meat of the Ch bulls had the lowest water-holding capacity (78.23 ± 3.17%) and it was slightly higher in the beef of CF bulls (78.64 ± 5.53%). The highest water-holding capacity, but insignificant ($p > 0.05$), was detected in the meat of the Ga bulls. The pH_{48} value ranged within an optimal range between 5.55 and 5.63. Sami *et al.* (2004) did not prove significant ($p > 0.05$) differences in the values of pH_{48} in the beef of the individual cattle breeds either. Two methods were used to assess the colour of the beef – determination of the amount of muscle pigments and by means of reflectance. Even though the bulls of the Ch breed were slaughtered at the youngest age, their meat was the darkest in colour (Tab. V). The proportion of muscle pigments ranged within 4.04 ± 0.88 $mg.g^{-1}$ and is also connected the reflectance value (5.38 ± 2.12%) which was the lowest in dark meat. The content of muscle pigments in the meat of Ga bulls was 3.96 ± 0.73 $mg.g^{-1}$ and the reflectance value was 5.60 ± 1.98%. The meat of CF bulls was the lightest in colour; it contained the lowest amount of muscle pigment (3.85 ± 0.93 $mg.g^{-1}$) and with it was connected the highest reflectance of the light beams (5.59%). Filipčík *et al.* (2009) and Latimori *et al.* (2008) discovered a statistically highly significant ($p < 0.01$) effect of the breed on the colour of beef (content of muscle pigments, reflectance values).

The effect of the breed was also apparent when we evaluated the size of the MTL area. The insignificantly ($p > 0.05$) smallest area of the muscle was measured in the Ga breed (87.71 ± 21.17 cm^2). Virtually identical results were detected in the beef of CF cattle (86.73 ± 20.36 cm^2). In the Chinese Red Cattle Zhou *et al.* (2010) reported the same size of the area of sirloin (88.82 cm^2) and the animals were slaughtered at a considerably higher age (26 months). The largest area of the muscle (90.51 ± 21.86 cm^2) was seen in bulls of the Ch breed. To a certain extent this indicator is based on the strength of muscle fibres and was the highest in samples of muscles from individuals of the Ch breed (38.01 ± 5.64 μm). On the contrary the diameter of the muscle fibre in the meat of CF bulls was the smallest (35.61 ± 4.65 μm). Statistically significant ($p < 0.01$) differences were found in the strength of muscle fibres between the CF and Ch breeds. Significant ($p < 0.05$) differences were found between the diameter of the muscle fibre of the domestic population of Red Spotted cattle and bulls of the Ga breed; i.e. between 35.61 μm and 37.60, respectively. Cicala *et al.* (1998) considered that the main factors affecting the strength of muscle fibres in beef are the slaughter age and weight of the bulls.

CONCLUSION

Evaluations of the quality of the carcass revealed that the proportion of beef was higher and the proportion of fat lower in both beef breeds of cattle than in the Czech Fleckvieh cattle. Statistically significant differences in the nutritional quality of the beef were not detected. The beef of Charolais bulls had the lowest energetic value. In terms of evaluations of the content of fatty acids the lowest content of saturated fatty acids was monitored in the beef of Galloway bulls and Czech Fleckvieh cattle. The intramuscular fat of beef of the Galloway breed had the highest content of polyunsaturated fatty acids. This breed also showed the most favourable PUFA n-6/n-3 ratio. The ratios of the $C14_{index,}$ and $C16_{index}$ were most favourable in the Czech Fleckvieh cattle. In terms of technological traits there were significant differences in the diameters of the muscle fibres; the smallest-size fibres were seen in the MLT of bulls of the Czech Fleckvieh breed. The meat of both beef breeds of cattle consisted of thicker muscle fibres which increased the size of the MLT area.

In conclusion we can say that the Czech Fleckvieh cattle do not rival the quality of the carcasses of intensive beef breeds of cattle which have thicker fleshing. Nonetheless in terms of the nutritional and technological quality the results are comparable and in some cases better than in both beef breeds of cattle.

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