Meat quality and fatty acid profile of the musculus longissimus lumborum in Czech Fleckvieh, Charolais and Charolais × Czech Fleckvieh bulls fed different types of silages

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ABSTRACT: The effects of breed and diet containing different types of silages on meat quality parameters and fatty acid profile of *m. longissimus lumborum* (*MLL*) were evaluated in a total of 30 Czech Fleckvieh (CF), Charolais (CH) and Charolais × Czech Fleckvieh (CH × CF) bulls. The animals were fed two mixed diets: MS (based on maize silage) and LCS (based on legume-cereal mixture silage and lucerne silages) with different concentrations of dietary energy and fatty acids. The *MLL* from CH bulls had the lowest content of dry matter ($P < 0.01$), less protein ($P < 0.01$) and lighter meat ($P < 0.01$) compared to the CF. The extensive LCS diet reduced dry matter ($P < 0.01$) and intramuscular fat ($P < 0.01$) and increased the content of hydroxyproline ($P < 0.05$). The CH bulls exhibited higher PUFA n-3 ($P < 0.05$) and lower MUFA ($P < 0.05$) compared to the CF, with the CH × CF being intermediate. The LCS diet enhanced the proportions of PUFA ($P < 0.05$) and PUFA n-3 ($P < 0.001$) and reduced MUFA ($P < 0.001$). In conclusion, both breed and diet affected the meat quality and fatty acid profile of the intramuscular fat of the bulls. The replacement of maize silage with the legume-cereal mixture and lucerne silages in the diet reduced the concentration of intramuscular fat and improved its fatty acid profile from the human nutrition perspective.

Keywords: beef; meat quality; fatty acids; breed; diet composition

Beef quality including the fatty acid composition has recently received increasing attention. Consumers expect to be provided with food of high sensory and nutritional quality. Nutritional guidelines have been developed recommending that the total fat, SFA, polyunsaturated fatty acids (PUFA) n-6 series, PUFA n-3 series, and *trans* fatty acids consumed should contribute to < 30%, < 10%, 5–8%, 1–2%, and < 1% of the total energy intake, respectively (WHO, 2003). Health concerns have been directed at the fat content and fatty acid composition of beef, particularly due to the high content of saturated fatty acids (SFA) which are believed to be associated with certain human diseases (Hocquette et al., 2005).

The fatty acid composition of beef is influenced by a number of factors including diet, breed, genotype, age and gender. Differences between cattle breeds have been reported for Simmental and Red Angus steers (Laborde et al., 2001), Belgian Blue, Limousin and Aberdeen Angus bulls (Cuvelier et al., 2006), and for bulls with a different double muscling genotype (Aldai et al., 2008).

Different feeding strategies are applied to increase the content of PUFA n-3 and to improve the PUFA n-6/PUFA n-3 ratio in beef intramuscular

Supported by the Ministry of Agriculture of the Czech Republic (Project No. MZE 0002701404).

fat. Apart from feeding oilseeds rich in PUFA, they involve grazing or feeding conserved forage with a high concentration of linolenic acid (French et al., 2000; Lourenço et al., 2008).

The objective of this study was to determine the differences in the meat quality and fatty acid profile of intramuscular fat in Czech Fleckvieh, Charolais and Charolais × Czech Fleckvieh bulls fed diets consisting of different types of silages.

MATERIAL AND METHODS

Experimental design

A detailed description of the experimental design, animal management, ingredient and chemical composition of the diets used, and post-slaughter measurements was reported previously (Bartoň et al., 2007a). In brief, a total of thirty-four Czech Fleckvieh (CF – a Simmental-type dual-purpose breed), Charolais (CH) and Charolais × Czech Fleckvieh (CH × CF) bulls with an average live weight of 284 kg were initially included in the experiment. The bulls from each breed group were assigned according to live weight and age to one of the two similar dietary groups: MS (a more intensive diet based on maize silage) and LCS (a more extensive diet based on legume-cereal mixture silage and lucerne silage). The target slaughter live weight was set at 600 kg. Three CH × CF and one CF bulls were prematurely withdrawn from the experiment due to injuries and severe lameness.

The animals were slaughtered in the experimental abattoir of the Institute of Animal Science following standard procedures, and the carcasses were stored at approximately +2°C for 24 h. A section of the *musculus longissimus lumborum* (*MLL*) between the 9th and 11th ribs was removed from the right side of each carcass and transported to the laboratory.

Meat quality measurements

The measurements of pH were performed 24 h after slaughter using an InoLab pH 730 pH meter (WTW, Weilheim, Germany). Meat colour (*L**, lightness; *a**, redness; *b**, yellowness) was measured at three places on the *MLL* using a portable spectrophotometer (CM-2500d, Minolta, Japan). Drip loss during the storage period 24 to 48 h after slaughter was determined as described by Honikel (1998).

The muscle samples for chemical and fatty acid analyses were removed of subcutaneous fat, homogenised in a food blender, and frozen at –20°C until analysis. The dry matter content was determined by oven drying at 105°C to a constant weight. The dried samples were pulverised (GRINDOMIX GM 200, Retsch, Germany) and analysed for crude protein using the Kjeltec 2400 Analyser unit (FOSS Tecator AB, Höganäs, Sweden) and for crude fat by extraction with petroleum ether in the Soxtec Avanti 2055 apparatus (FOSS Tecator AB, Höganäs, Sweden). The hydroxyproline content was determined by acid hydrolysis in accordance with Diemair (1963).

The FA composition of feeds and muscles was determined after the extraction of total lipids in accordance with Folch et al. (1957) Alkaline transmethylation of FA was performed in accordance with ISO 5509 (2001). Gas chromatography of FA methyl esters was performed using the HP 6890 gas chromatograph (Agilent Technologies, Inc.) with a programmed 60 m DB-23 capillary column (150 to 230°C). FA were identified on the basis of retention times corresponding to standards. The standards used were PUFA 1, PUFA 2, PUFA 3, and 37 Component FAME Mix (Supelco, Bellefonte, PA, USA). CLA isomers *trans*-10, *cis*-12 and *cis*-9, *trans*-11 were identified on the basis of retention times.

Calculations and statistical analysis

The indices of fatty acid desaturation were calculated in accordance with the following equations (adapted from Mele et al., 2007):

C14 index = C14:1 *cis*-9/(C14:0 + C14:1 *cis*-9) × 100

C16 index = C16:1 *cis*-9/(C16:0 + C16:1 *cis*-9) × 100

C18 index = C18:1 *cis*-9/(C18:0 + C18:1 *cis*-9) × 100

CLA index = CLA *cis*-9, *trans*-11/(CLA *cis*-9, *trans*-11 + C18:1 *trans*-11)

Total index = (C14:1 *cis*-9 + C16:1 *cis*-9 + C18:1 *cis*-9 + CLA *cis*-9, *trans*-11)/(C14:1 *cis*-9 + C16:1 *cis*-9 + C18:1 *cis*-9 + CLA *cis*-9, *trans*-11 + C14:0 + C16:0 + C18:0 + C18:1 *trans*-11) × 100

The index of atherogenicity (AI) was calculated in accordance with Chilliard and Ferlay (2004):

AI = (C12:0 + 4 × C14:0 + C16:0)/MUFA + PUFA

Statistical analyses were performed using the GLM procedure of SAS (SAS, 2001). The initial statistical model involved the fixed effects of breed group and diet and the interaction of breed group × diet. As no significant interactions were detected (the probability of their significance was lower than 0.05), they were removed from the final model. Differences between breed group means were tested by Tukey's method (level of significance set at 5%). The data in the tables are presented as the main effect least-squares means (LSM) with their respective standard errors (SEM) and significance levels.

Table 1. Ingredient, chemical and fatty acid composition of the diets

	Diet	
	MS[d]	LCS[e]
Ingredient (g/kg)		
Wheat grain	121	144
Soybean meal	39	–
Maize silage	755	–
Legume-cereal mixture silage	–	432
Lucerne silage	–	318
Lucerne hay	66	72
Wheat straw	–	23
Limestone	6	–
Mineral-vitamin mixture	12	10
Chemical composition		
Dry matter (DM; g/kg fresh weight)	469	540
Crude protein (g/kg DM)	141	138
PDIN[a] (g/kg DM)	93	85
PDIE[b] (g/kg DM)	92	85
NEF[c] (MJ/kg DM)	7.73	6.75
Crude fibre (g/kg DM)	165	270
Crude fat (g/kg DM)	28	19
Fatty acid profile (g/100 g fatty acids)		
C14:0	0.49	0.83
C16:0	15.97	18.54
C18:0	5.59	6.54
C18:1 n-9	21.72	8.60
C18:2 n-6	47.42	23.43
C18:3 n-3	4.91	28.09

[a]protein digested in the small intestine supplied by rumen-undegraded protein and microbial protein from rumen-degraded protein (Sommer et al., 1994)
[b]protein digested in the small intestine supplied by rumen-undegraded protein and microbial protein from rumen-fermented organic matter (Sommer et al., 1994)
[c]net energy of fattening (Sommer et al., 1994)
[d]MS = maize silage based diet
[e]LCS = legume-cereal mixture silage and lucerne silage based diet

RESULTS

The average ingredient, chemical, and fatty acid composition of the diets is given in Table 1. The MS diet had a higher concentration of energy, protein and crude fat and a lower concentration of crude fibre compared to the LCS diet. The MS also contained more C18:1n-9 and C18:2n-6, whereas the proportion of C18:3n-3 was lower compared to the LCS. The proportion of total PUFA (C18:2n-6 + C18:3n-3) was approximately the same in both diets.

The chemical analysis of the *MLL* (Table 2) revealed several significant differences between breeds as well as diet groups. The CH samples had the lowest content of dry matter ($P < 0.01$). The protein content was higher in the CF than in the CH ($P < 0.05$), with the CH × CF being intermediate. The CH animals had lighter *MLL* (higher *L**) compared to the CF ($P < 0.05$). The extensive diet (LCS) reduced dry matter ($P < 0.01$) and intramuscular fat ($P < 0.01$) contents, and increased the content of hydroxyproline ($P < 0.05$) compared to the intensive maize silage-based diet.

The profile of individual FA in *MLL* (g/100 g FA determined) is shown in Table 3. Only major and nutritionally important FA, representing more than 96% of the total FA, are reported. The proportion of C16:1n-7 was lower in the CH than in the CH × CF ($P < 0.05$), and C18:1n-9 was lower in the CH than in the CF ($P < 0.05$). The CH bulls deposited higher proportions of C18:3n-3 than CF ($P < 0.05$) and higher proportions of CLA*c9*, *t11* ($P < 0.05$). The animals fed LCS had a lower proportion of C18:1n-9 ($P < 0.001$), whereas the proportions of all PUFA n-3 were increased – C18:3n-3 ($P < 0.001$), C20:5n-3 ($P < 0.01$), C22:5n-3 ($P < 0.01$), and C22:6n-3 ($P < 0.05$).

The sums of FA (g/100 g FA determined) and some FA ratios important from the human nutrition perspective are presented in Table 4. The CH bulls exhibited higher PUFA n-3 ($P < 0.05$) and lower MUFA ($P < 0.05$), MUFA/SFA ($P < 0.05$), and PUFA n-6/PUFA n-3 ($P < 0.01$) compared to the CF, with the CH × CF being intermediate. The differences in MUFA resulted in lower C16, C18, and total desaturase indices in the CH compared to the CF samples ($P < 0.05$). The LCS diet enhanced the proportions of PUFA ($P < 0.05$) and PUFA n-3 ($P < 0.001$) and reduced MUFA ($P < 0.001$), MUFA/SFA ($P < 0.01$), C16 index ($P < 0.05$), C18 index ($P < 0.01$), and the total desaturase index ($P < 0.01$).

Table 2. Chemical composition and physical properties of *m. longissimus lumborum*

	Breed (B)						Diet (D)				*P*-value	
	CF[d] (*n* = 11)		CH × CF[e] (*n* = 7)		CH[f] (*n* = 12)		MS[g] (*n* = 15)		LCS[h] (*n* = 15)		B	D
	LSM	SEM	LSM	SEM	LSM	SEM	LSM	SEM	LSM	SEM		
Dry matter (g/kg)	244.7[a]	1.5	243.4[a]	1.9	236.5[b]	1.5	244.8	1.3	238.3	1.3	0.002	0.002
Protein (g/kg)	211.8[a]	1.3	210.2[ab]	1.7	206.2[b]	1.3	209.4	1.2	209.4	1.2	0.019	0.995
Intramuscular fat (g/kg)	14.0	1.1	12.8	1.3	10.8	1.0	14.7	0.9	10.4	0.9	0.108	0.002
Hydroxyproline (g/kg)	0.59	0.02	0.60	0.03	0.63	0.02	0.57	0.02	0.64	0.02	0.574	0.045
pH_{24}	5.82	0.09	5.58	0.12	5.74	0.09	5.77	0.08	5.66	0.09	0.298	0.382
Colour lightness (*L**)	36.6[a]	1.7	41.0[ab]	2.1	43.9[b]	1.6	39.8	1.5	41.3	1.5	0.016	0.467
redness (*a**)	13.4	0.9	13.2	1.2	11.8	0.9	13.0	0.8	12.6	0.8	0.430	0.697
yellowness (*b**)	12.3	0.9	13.5	1.2	14.4	0.9	13.9	0.8	12.9	0.8	0.298	0.386
Drip loss (%)	1.75	0.37	2.58	0.46	2.23	0.35	1.72	0.32	2.65	0.32	0.363	0.047

[a,b,c]means (B) within a row with different superscripts differ significantly ($P < 0.05$)
[d]CF = Czech Fleckvieh
[e]CH × CF = Charolais × Czech Fleckvieh
[f]CH = Charolais
[g]MS = maize silage based diet
[h]LCS = legume-cereal mixture silage and lucerne silage based diet

Table 3. Fatty acid profile of *m. longissimus lumborum* (g/100 g FA determined)

	Breed (B)						Diet (D)				*P*-value	
	CF[c] (*n* = 11)		CH × CF[d] (*n* = 7)		CH[e] (*n* = 12)		MS[f] (*n* = 15)		LCS[g] (*n* = 15)		B	D
	LSM	SEM	LSM	SEM	LSM	SEM	LSM	SEM	LSM	SEM		
C14:0	2.15	0.14	2.51	0.17	2.31	0.13	2.32	0.12	2.32	0.12	0.274	0.983
C16:0	27.02	0.65	27.51	0.81	27.28	0.62	26.97	0.56	27.57	0.57	0.892	0.451
C18:0	19.44	0.57	19.59	0.71	20.75	0.54	19.53	0.49	20.33	0.50	0.219	0.255
C14:1n-5	0.24	0.03	0.26	0.03	0.23	0.03	0.23	0.02	0.26	0.02	0.744	0.325
C16:1n-7	2.20[ab]	0.11	2.35[a]	0.14	1.88[b]	0.11	2.25	0.10	2.03	0.10	0.030	0.113
C18:1n-9	35.51[a]	0.83	34.01[ab]	1.04	32.03[b]	0.80	35.88	0.72	31.82	0.73	0.020	< 0.001
C18:1n-7	1.37	0.05	1.42	0.06	1.32	0.05	1.39	0.04	1.35	0.04	0.480	0.553
C18:1n-11*t*	1.07	0.13	0.87	0.16	1.06	0.12	1.00	0.11	1.00	0.11	0.562	0.995
C18:2n-6	4.76	0.43	5.13	0.54	5.52	0.41	4.79	0.37	5.49	0.38	0.458	0.192
C20:3n-6	0.28	0.03	0.30	0.04	0.29	0.03	0.27	0.03	0.31	0.03	0.959	0.402
C20:4n-6	0.93	0.12	1.06	0.16	1.16	0.12	0.95	0.11	1.15	0.11	0.425	0.185
C22:4n-6	0.17	0.02	0.10	0.02	0.14	0.02	0.16	0.02	0.12	0.02	0.089	0.123
C18:3n-3	0.78[a]	0.13	0.96[ab]	0.17	1.29[b]	0.13	0.63	0.11	1.39	0.12	0.032	< 0.001
C20:5n-3	0.19	0.04	0.23	0.05	0.32	0.04	0.17	0.04	0.32	0.04	0.105	0.005
C22:5n-3	0.46	0.08	0.52	0.09	0.72	0.07	0.41	0.07	0.72	0.07	0.054	0.002
C22:6n-3	0.03	0.01	0.03	0.01	0.04	0.01	0.02	0.01	0.04	0.01	0.182	0.010
CLA *c9, t11*	0.24[ab]	0.02	0.20[a]	0.03	0.30[b]	0.02	0.22	0.02	0.26	0.02	0.019	0.128
CLA *t10, c12*	0.05	0.02	0.03	0.02	0.05	0.02	0.04	0.02	0.04	0.02	0.780	0.746

[a,b]means (B) within a row with different superscripts differ significantly ($P < 0.05$)
[c]CF = Czech Fleckvieh
[d]CH × CF = Charolais × Czech Fleckvieh
[e]CH = Charolais
[f]MS = maize silage based diet
[g]LCS = legume-cereal mixture silage and lucerne silage based diet

DISCUSSION

As reported previously (Bartoň et al., 2007a), the bulls from different breed groups were slaughtered at similar age and final live weight and did not differ in daily live weight gain. The MS animals grew more rapidly and reached the target slaughter weight at the lower average age.

Small, nevertheless significant, differences in several meat quality traits were found between the investigated breeds and the diet groups. The lower dry matter content of *MLL* samples in the CH bulls in comparison with bulls of the other beef breeds was also reported in our previous study (Bureš et al., 2006). On the contrary, no differences in dry matter and protein content between Fleckvieh and Fleckvieh × Charolais bulls and heifers were observed by Velik et al. (2008).

Higher feeding intensity is often associated with an increased degree of fatness (Vestergaard et al., 2000; Sami et al., 2004). This is in good agreement with our results, when the lower energy concentration in the LCS diet resulted in a reduced intramuscular fat content in the *MLL* of LCS animals. Thénard et al. (2006) reported higher total collagen (hydroxyproline × 7.5) values in the *MLL* of Montbeliard steers under extensive feeding management. The authors explained this difference by

Table 4. Sums of FA (g/100 g FA determined) and nutritionally important ratios

	Breed (B)						Diet (D)				*P*-value	
	CF (*n* = 11)		CH × CF (*n* = 7)		CH (*n* = 12)		MS (*n* = 15)		LCS (*n* = 15)		B	D
	LSM	SEM	LSM	SEM	LSM	SEM	LSM	SEM	LSM	SEM		
SFA[i]	48.61	0.85	49.61	1.07	50.34	0.81	48.82	0.73	50.22	0.75	0.354	0.188
MUFA[j]	40.39[a]	0.84	38.90[ab]	1.06	36.52[b]	0.81	40.75	0.73	36.46	0.74	0.010	< 0.001
PUFA[k]	7.60	0.71	8.33	0.89	9.47	0.68	7.40	0.61	9.54	0.62	0.176	0.019
PUFA n-6[l]	6.15	0.57	6.59	0.71	7.11	0.54	6.16	0.49	7.07	0.50	0.480	0.200
PUFA n-3[m]	1.46[a]	0.22	1.74[ab]	0.28	2.37[b]	0.21	1.23	0.19	2.47	0.19	0.019	< 0.001
PUFA/SFA	0.16	0.02	0.17	0.02	0.19	0.02	0.15	0.01	0.19	0.01	0.301	0.074
MUFA/SFA	0.84[a]	0.03	0.79[ab]	0.04	0.73[b]	0.03	0.84	0.03	0.73	0.03	0.040	0.004
PUFA n-6/PUFA n-3	5.12[a]	0.36	4.35[ab]	0.46	3.35[b]	0.35	5.27	0.31	3.28	0.32	0.007	< 0.001
C14 index	9.80	0.88	9.69	1.10	8.93	0.84	8.96	0.75	9.98	0.77	0.743	0.345
C16 index	7.54[a]	0.30	7.81[a]	0.38	6.44[b]	0.29	7.70	0.26	6.82	0.27	0.012	0.024
C18 index	64.40[a]	0.99	63.39[ab]	1.24	60.73[b]	0.95	64.67	0.85	61.01	0.87	0.036	0.005
CLA index	19.52	2.48	20.18	3.12	24.03	2.37	18.49	2.14	24.00	2.18	0.391	0.079
Total desaturase index	43.38[a]	0.88	42.15[ab]	1.10	40.15[b]	0.84	43.63	0.76	40.16	0.77	0.048	0.003
Atherogenic index	2.51	0.10	2.61	0.13	2.66	0.10	2.51	0.09	2.68	0.09	0.578	0.219

[a,b]means (B) within a row with different superscripts differ significantly ($P < 0.05$)
[d]CF = Czech Fleckvieh
[e]CH × CF = Charolais × Czech Fleckvieh
[f]CH = Charolais
[g]MS = maize silage based diet
[h]LCS = legume-cereal mixture silage and lucerne silage based diet
[i]SFA = C14:0 + C16:0 + C18:0
[j]MUFA = C14:1n-5 + C16:1n-7 + C18:1n-9 + C18:1n-7 + C18:1n-11*t*
[k]PUFA = PUFA n-3 + PUFA n-6
[l]PUFA n-6 = C18:2n-6 + C20:3n-6 + C20:4n-6 + C22:4n-6
[m]PUFA n-3 = C18:3n-3 + C20:5n-3 + C22:5n-3 + C22:6n-3

the age of animals, which may also be the case in our study as the LCS bulls were, on average, 54 days older at slaughter than the MS animals.

Meat colour is one of the main parameters influencing consumer buying decisions and is affected by a number of different factors (reviewed by Mancini and Hunt, 2005). The lighter meat produced by the CH bulls in our study confirms the results of earlier breed comparisons (Chambaz et al., 2003; Pfuhl et al., 2007). The difference may be explained by different haem iron content in the muscle (Chambaz et al., 2003).

The meat from animals finished on pasture is usually darker than meat from those finished on concentrates (Priolo et al., 2001). In our study, the replacement of maize silage with legume-cereal mixture and lucerne silages had no significant effect on meat colour and pH_{24}. Similarly, in studies by Sami et al. (2006) and Keady et al. (2007), meat colour was not altered by feeding different types of silages.

Higher drip loss values observed in the LCS group were probably related to the differences, although not significant, in pH_{24}. Accelerated pH decline is associated with the development of low water-holding capacity and high drip loss (Huff-Lonergan and Lonergan, 2005).

Compared to the other breed groups, the *MLL* of the CH bulls contained less C16:1n-7 and C18:1n-9, and consequently MUFA, C16, C18, and total desaturase indices. This is in agreement with the results of our previous studies, in which we compared CH and Limousin heifers (Bartoň et al., 2007b) and CH

and Simmental bulls (Bartoň et al., 2008). It was suggested that the differences were due to different activity of Δ^9-desaturase, which is the enzyme responsible for catalyzing the conversion of SFA to Δ^9 MUFA (Yang et al., 1999). Δ^9-desaturase is also involved in the endogenous synthesis of CLA*c9*, *t11* from vaccenic acid (C18:n-11*t*) in bovine adipose tissues. In our study, however, the high concentration of CLA*c9*, *t11* in the CH bulls was associated with a low total desaturation index. Similarly, Shen et al. (2007) observed no relationship between the Δ^9-desaturase index and different accumulation rates of CLA*c9*, *t11* in different tissues. The difference between the CH and CH × CF groups in the CLA*c9*, *t11* concentration in the present study may be explained by a higher substrate (C18:n-11*t*) availability in the CH. Linear positive correlations between these two FA were found previously (Enser et al., 1999; Shen et al., 2007).

Breed differences in the FA profile of muscle lipids are often strongly affected by the content of intramuscular fat due to differences in the FA composition of the major muscle lipid fractions and the relative contribution of these fractions to total lipids (reviewed by De Smet et al., 2004). In our study, the breed groups did not statistically differ in intramuscular (marbling, neutral) fat content, and therefore, when intramuscular fat was included in the model as a covariate, breed differences in MUFA and PUFA were only slightly reduced. Similarly, genetic differences rather than differences in intramuscular fat content were suggested as causing the differences in FA composition of crossbred cattle (Graham et al., 2006).

The intramuscular PUFA n-6/PUFA n-3 ratio is influenced by feeding factors to a greater extent than by genetics (reviewed by Raes et al., 2004). In this study, however, the CF bulls had less C18:3n-3, PUFA n-3 and a higher PUFA n-6/PUFA n-3 ratio compared to the CH. Like in our study, a lower concentration of PUFA n-3 and a higher PUFA n-6/PUFA n-3 ratio were found in total muscle lipids of Simmental as compared to Red Angus steers (Laborde et al., 2001).

Green leafy plants contain high concentrations of C18:3n-3 due to their ability to biosynthesise *de novo* this FA. Forages thus represent one of the main sources of C18:3n-3 in ruminant diets (Dewhurst et al., 2003; Clapham et al., 2005). In our study, replacing maize silage with legume-cereal mixture and lucerne silages considerably increased the dietary intake of C18:3n-3.

Feeding diets of different FA composition to bulls resulted in different FA patterns of intramuscular fat. While the dietary treatment had no effect on total SFA, the concentrations of MUFA (especially C18:1n-9) were higher and those of PUFA were lower in the MS animals. This can be partially explained by the difference in intramuscular fat content between the two groups. A positive relationship between C18:1n-9 and the amount of marbling fat was found (Kazala et al., 2006), which is in good agreement with our results. The increased concentration of intramuscular fat is associated with a relatively reduced proportion of PUFA-rich phospholipids and a relatively increased proportion of triacylglycerols. This dilution effect is a likely reason for the lower proportion of PUFA in muscles with a higher intramuscular fat content (Sami et al., 2006).

Despite the biohydrogenation of C18:3n-3 in the rumen, the concentration of this FA was 2.2 times higher in the intramuscular fat of the LCS animals. The proportion of PUFA in phospholipids is controlled by the system of desaturases and elongases responsible for the conversion of essential C18:2n-6 and C18:3n-3 to long-chain PUFA (Raes et al., 2004). As reported by Nuernberg et al. (2002) and as shown in our study, the high availability of C18:3n-3 in the diet resulted in an enhanced absorption of this FA and its conversion to C20:5n-3, C22:5n-3, and C22:6n-3. Long-chain PUFA are beneficial to human health due to their anti-atherogenic, antithrombotic, and anti-inflammatory effects. Meat represents one of their important dietary sources (Givens et al., 2006). The PUFA n-6/PUFA n-3 ratio is considered as a risk factor in cancers and coronary heart diseases and should be lower than 4 (Webb and O'Neill, 2008). This ratio was significantly lower in the LCS bulls and well below the recommended maximum.

In conclusion, both breed and diet affected the meat quality and fatty acid profile of the intramuscular fat of bulls. The CH animals produced lighter meat with lower proportions of dry matter and protein. Their *MLL* contained lower concentrations of MUFA and higher concentrations of PUFA n-3 and CLA*c9*, *t11* compared to the CF bulls. The replacement of maize silage with legume-cereal mixture and lucerne silages in the diet reduced the concentration of intramuscular fat and improved its fatty acid profile from the perspective of human nutrition by increasing the concentration of long-chain PUFA n-3.

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Received: 2009–06–03
Accepted after corrections: 2010–04–25

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