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The effect of genotype on the chemical and fatty acid composition of the *Quadriceps femoris* muscle in extensively fattened lambs

DAVID ZAPLETAL[1], JAN KUCHTÍK[2] and IGOR DOBEŠ[2]

[1]Faculty of Veterinary Hygiene and Ecology, University of Veterinary and Pharmaceutical Sciences Brno, Czech Republic,
[2]Faculty of Agronomy, Mendel University in Brno, Czech Republic

Abstract

The aim of the experiment was to define the effect of a Suffolk-sired genotype on the chemical composition and fatty acid profile of the *Quadriceps femoris* muscle in fattened lambs reared under organic farming conditions. Three different genotypes of Suffolk-sired crossbreds were included in the experiment: F1 Suffolk-Charollais (SF 50 CH 50, n=10), F11 Suffolk-Charollais (SF 75 CH 25, n=10) and F1 Suffolk-Improved Walachian (SF 50 IW 50, n=10). The genotype did not have any effect on age at slaughter, average daily gain or carcass dressing percentages. However, the SF 75 CH 25 lambs displayed a lower live weight at slaughter ($P<0.05$), lower cold carcass weight ($P<0.05$) and lower protein content in muscle ($P<0.05$) than both of the other genotypes. They also had a lower content of kidney fat compared to the SF 50 CH 50 ($P<0.01$). The F11 Suffolk-Charollais lambs showed a higher proportion of C12:0 ($P<0.01$), C14:0 ($P<0.01$) and C16:0 ($P<0.05$) than the other two genotypes. A higher proportion of C18:0 was found in the SF 50 CH 50 lambs ($P<0.05$). The total content of saturated fatty acids (SFA) was higher in the SF 75 CH 25 crossbreds ($P<0.05$). The genotype also affected the content of C16:1 having its highest presence in the SF 75 CH 25 lambs while the lowest presence was found in the SF 50 CH 50 lambs ($P<0.01$). Between these two genotypes there were also found different proportions of C18:1 having its higher presence in SF 50 CH 50 lambs ($P<0.05$). Moreover, the IW type lambs had a lower SFA proportion and lower values of atherogenic and thrombogenic indexes and a higher polyunsaturated/saturated fatty acid (P/S) ratio in their meat than lambs of the CH genotypes ($P<0.05$). As for crossing between the Suffolk and Charollais breeds, a favourable fatty acids profile of meat was observed in the F1 crossbred as compared to the F11 crossbred.

Keywords: sheep, meat, fatty acids, Suffolk-sired crossbreds, organic farming

Zusammenfassung

Der Einfluss des Genotyps auf die chemische und Fettsäurezusammensetzung des *Musculus quadriceps femoris* (Oberschenkelmuskels) bei extensiv gemästeten Lämmern

Das Ziel des Experimentes war, den Effekt eines von Suffolk-Vatertieren hervorgebrachten Genotyps auf die chemische Zusammensetzung und das Fettsäureprofil des *Musculus*

quadriceps femoris in den gemästeten Lämmern zu definieren, die unter Bedingungen der ökologischen Landwirtschaft aufgezogen wurden. Drei verschiedene Genotypen von Suffolk-Vatertier-Kreuzungen waren an dem Experiment beteiligt: F1 Suffolk-Charollais (SF 50 CH 50, n=10), F11 Suffolk-Charollais (SF 75 CH 25, n=10) und F1 Suffolk – Walachen Schaf (SF 50 WS 50, n=10). Der Genotyp hatte keinen Einfluß auf das Schlachtalter, die täglichen Zunahmen oder auf die Schlachtausbeute. Jedoch zeigten die SF 75 CH 25 Lämmer ein niedrigeres Lebendgewicht am Schlachttag ($P<0.05$), niedrigere Ausschlachtung ($P<0.05$) und niedrigeren Proteingehalt im Muskel ($P<0.05$) als die beiden anderen Genotypen. Auch hatten sie einen geringeren Anteil an Nierenfett im Vergleich zu den SF 50 CH 50 ($P<0.01$). Die F11 Suffolk-Charollais-Lämmer zeigten einen höheren Anteil C12:0 ($P<0.01$), C14:0 ($P<0.01$) und C16:0 ($P<0.05$) als die beiden anderen Genotypen. Ein höherer Anteil C18:0 wurde in den SF 50 CH 50 Lämmern gefunden ($P<0.05$). Der Gesamtinhalt von SFA war bei den SF 75 CH 25 Kreuzungen höher ($P<0.05$). Der Genotyp beeinflusste auch den Inhalt in C16:1 ($P<0.01$) und C18:1 ($P<0.05$). Außerdem hatten die WS Lämmer einen niedrigeren SFA-Anteil und niedrigere Werte bei den Atherogenen und Thrombogenen Indizes und ein höheres P/S Verhältnis in ihrem Fleisch als Lämmer der CH-Genotypen ($P<0.05$). Was die Kreuzung zwischen den Suffolk- und Charollaisherkünften betrifft, wurde ein vorteilhafteres Fettsäureprofil des Fleisches bei den F1-Kreuzungen im Vergleich mit den F11-Kreuzungen beobachtet.

Schlüsselwörter: Schaf, Lämmer, Fettsäuren, Suffolk-Vatertier-Kreuzungen, ökologische Landwirtschaft

Introduction

The Suffolk (SF) and Charollais (CH) breeds are among the most important breeds of sheep reared in the Czech Republic. A national report on sheep performance recording states that in 2007 the SF purebreds made up the largest segment of the sheep population and CH purebreds were the third largest. On the other hand, the original Improved Walachian (IW) sheep, a very important breed in the Slovak Republic, is currently a minor breed in the Czech Republic. The stocks of this triple-purpose breed are located mainly in its place of origin – Walachian region – while one part of its population is milked and the other part is designated for meat production.

As for the meat production of IW sheep, they are most frequently crossed with meat type rams, mainly with Suffolk sires. In the Czech Republic, the Suffolk sheep are reared in all production regions, either as purebreds, or as a sire breed crossed with dual and multipurpose breeds in order to improve the growth rate and carcass value (mainly the meatiness) of lambs. In contrast, the CH sheep are reared in more favourable climatic conditions (at altitudes up to 500 m) and usually as purebreds. However, recently, the CH breed has begun spreading to sub-mountainous (in our case) and mountainous regions. Generally, it can be stated that newborn CH lambs are typically less woolly (particularly in the distal part of body), which, in unfavourable climatic conditions such as low temperatures, long-term rainfall, and snow even in early May, can lead to a decreased performance, algidity or even death. Taking into account the above stated facts, many farms in sub-mountainous and mountainous regions have started to cross CH ewes with Suffolk sires in order to grading up to SF breed.

Recently, the profile of fatty acids in the human diet has received increased attention due to their impact on human health. Lamb fat deposition and composition of fatty acids (FA) can be influenced by many factors including breed, gender, age/body weight, fatness, depot site, environmental conditions, diet and rearing management (NÜRNBERG *et al.* 1998, NÜRNBERG *et al.* 2001, SZUMACHER-STRABEL *et al.* 2001, GRUSZECKI *et al.* 2004). Also, the significant effects of cross-breeding on the FA composition of lamb meat have been confirmed by SNOWDER and DUCKETT (2003), SALVATORI *et al.* (2004) and BORYS *et al.* (2007). There are only a few studies evaluating the nutritional quality of lamb meat fattened under organic farming conditions (CIFUNI *et al.* 2003, NÜRNBERG *et al.* 2006, ANGOOD *et al.* 2008), and there is no information about the FA composition of meat in IW type lambs.

The aim of this study was to define the effect of the Suffolk-sired genotype on the chemical composition and fatty acid profile of the *Quadriceps femoris* muscle in fattened lambs reared in organic farming conditions.

Material and methods

The experiment was carried out at an organic sheep farm in Růžďka located in northern Moravia in the Czech Republic (pastures are situated at the altitude of 365 to 738 m above sea level with an average annual temperature of 7.0 °C and precipitation of 880 mm). The animals used in the experiment were 30 single male lambs descended from three-year old ewes. Three different genotypes of Suffolk-sired crossbreds were included in the experiment: F1 Suffolk-Charollais (SF 50 CH 50, n=10), F11 Suffolk-Charollais (SF 75 CH 25, n=10), and F1 Suffolk-Improved Walachian (SF 50 IW 50, n=10). All lambs were born indoors during the second half of January, 2007. During the period from their birth until the end of April, all of the lambs were reared indoors with their mothers. The daily feeding ration of the lambs consisted of the mother's milk (*ad libitum*), meadow hay (*ad libitum*) and organic mineral lick (*ad libitum*). The lambs were weaned during the last ten days of April. From May until slaughter, all of the lambs were grazed in an extensive permanent pasture under organic conditions. The daily feeding ration for the weaned lambs consisted of grass (*ad libitum*), meadow hay (*ad libitum*) and organic mineral lick (*ad libitum*). During the experiment, all of the lambs were reared in one flock under identical conditions without any discernible differences in nutrition or management.

The SF 75 CH 25 lambs were slaughtered at an average age of 150 days and at a live weight of 32.1 kg. The SF 50 CH 50 lambs were slaughtered at an average age of 181 days at a live weight of 38.4 kg. The SF 50 IW 50 lambs were slaughtered at an average age of 174 days at a live weight of 37.1 kg. The meat production characteristics such as live weight (LWS), age at slaughter and average daily gain (ADG) were evaluated on the day of slaughter. On the following day, after a chilling period of approximately 24 h, the cold carcass weight (CCW), dressing percentage and the content of kidney fat were evaluated and samples of the *Quadriceps femoris* muscle were collected. The kidney fat percentage was determined as the ratio of the weight of kidney fat to the weight of CCW.

The dry matter content was determined in homogenized meat samples mixed with dry sea sand; the samples were pre-dried at the temperature of 60 °C for two hours and then dried at 105 °C for 6 h. The protein content was calculated as percentage of nitrogen multiplied by

6.25. The ash content was determined by burning in a laboratory furnace at the temperature of 550 °C for 8 h. The fat content was determined by extraction with diethyl ether in Soxhlet extractor for 6 h. The extraction was performed without acid hydrolysis.

The FA were methylated with sodium methylate and subsequently with boron trifluoride in methanol. The FAME were analysed on a gas chromatograph CHROM 5 (Laboratorni pristroje, Prague, CR) with a flame ionizing detector (FID). The temperature of the column rose from the initial 100°C up to 250°C. The carrier gas was nitrogen. The injector and detector (FID) were set at 280°C. For each analysis 2 µl of the sample was injected into the gas chromatograph equipment. The analysed FAME were identified on the basis of elution times and compared with elution times of standard methyl esters of fatty acids. For identification, the reference sample of FAME Mix 37 was used. The CI-105 integrator (Laboratorni pristroje, Prague, CR) was used for quantitative evaluations of chromatographic analysis. The result of the evaluations is the content (%) of fatty acids. Atherogenic and thrombogenic indices were calculated according to ULBRICHT and SOUTHGATE (1991) as follow:

$$\text{Atherogenic index (AI)} = \frac{C12{:}0 + 4 \cdot C14{:}0 + C16{:}0}{\Sigma\,MUFA + \Sigma\,PUFA(n\text{-}6) \text{ and } (n\text{-}3)} \quad (1)$$

$$\text{Thrombogenic index (TI)} = \frac{C14{:}0 + C16{:}0 + C18{:}0}{0.5\,\Sigma\,MUFA + 0.5\,\Sigma\,PUFA(n\text{-}6) + 3\,\Sigma\,PUFA(n\text{-}3) + (n\text{-}3)/(n\text{-}6)} \quad (2)$$

A statistical analysis was carried out using STATISTICA CZ version 6. ANOVA analysis was applied to study the differences in the animal live weight, age at slaughter, gain, carcass traits and chemical composition of the *Quadriceps femoris* muscle as three independent groups of genotypes. When the analysis of variance showed significant differences between the groups, the Fisher's LSD test was applied. The effect of genotype on the differences in the FA composition and FA ratios of muscle tissue was studied by analysis of covariance (ANOVA), where the live weight at slaughter was included as covariate. The differences were considered significant if $P<0.05$.

Results

The age and live weight at slaughter, average daily gain, carcass traits (cold weight, content of kidney fat) and the basic chemical composition of the *Quadriceps femoris* muscle are summarized in Table 1. SF 75 CH 25 lambs displayed a significantly lower LWS and CCW than both of the other genotypes and also a lower content of kidney fat compared to the SF 50 CH 50 lambs. The genotype did not have any significant effect on ADG or carcass dressing percentages. A slightly lower average age at the slaughter of the SF 75 CH 25 crossbreds was found to be insignificant as well.

Concerning the chemical composition of the *Quadriceps femoris* muscle, only the content of protein was significantly affected by the different genotypes, and the SF 75 CH 25 crossbreds had the lower level ($P\leq0.05$). A somewhat higher presence of intramuscular (IM) fat in SF 75 CH 25 lambs when compared to both of the other genotypes was not statistically confirmed.

Table 1
The effect of genotype on the growth, carcass quality traits and chemical composition of the *Quadriceps femoris* muscle
Der Effekt der Genotypen auf das Wachstum, die Schlachtkörperqualitätsmerkmale und chemische Zusammensetzung des Quadriceps Femoris

Traits	Genotype		
	SF 75 CH 25	SF 50 CH 50	SF 50 IW 50
	$\bar{x} \pm$ SEM	$\bar{x} \pm$ SEM	$\bar{x} \pm$ SEM
Birth weight, kg	3.8 ± 0.38	4.1 ± 0.26	4.1 ± 0.33
LWS, kg	$32.1^{A,a}$ ± 1.08	38.4^{B} ± 1.70	37.1^{b} ± 1.67
Age at slaughter, day	150.0 ± 16.15	181.0 ± 10.93	173.8 ± 12.78
ADG, g/day	198.3 ± 12.09	190.8 ± 4.33	193.9 ± 9.16
CCW, kg	$14.1^{A,a}$ ± 0.49	16.8^{B} ± 0.59	16.0^{b} ± 0.61
Dressing percentage, %	43.79 ± 0.333	44.10 ± 0.890	43.27 ± 0.941
Kidney fat, %	0.11^{A} ± 0.021	0.29^{B} ± 0.051	0.20 ± 0.022
Quadriceps femoris composition			
Dry matter, g/kg	234.26 ± 1.874	231.74 ± 2.602	232.22 ± 2.826
IM fat, g/kg	26.93 ± 1.530	21.20 ± 2.275	22.81 ± 3.114
Protein, g/kg	192.43^{a} ± 1.939	197.91^{b} ± 1.025	197.01^{b} ± 1.365
Ash, g/kg	11.23 ± 0.011	11.24 ± 0.009	11.49 ± 0.005

$^{A, B}P<0.01$, $^{a, b}P<0.05$, LWS live weight at slaughter, ADG average daily gain, CCW cold carcass weight, IM intramuscular

The results for the fatty acid profile, fatty acid ratios and indexes of the *Quadriceps femoris* muscle are presented in Table 2. The SF 75 CH 25 lambs showed a significantly higher proportion of lauric acid (C12:0), myristic acid (C14:0) and palmitic acid (C16:0) compared to the SF 50 CH 50 and SF 50 IW 50 lambs, while a higher proportion of stearic acid (C18:0) was found in the SF 50 CH 50 lambs. The total content of saturated fatty acids (SFA) was significantly higher in the SF 75 CH 25 crossbreds, whereas the content between the SF 50 CH 50 and SF 50 IW 50 genotypes did not differ.

The total content of monounsaturated fatty acids (MUFA) did not vary among the evaluated genotypes. However, the genotypes significantly affected the content of palmitoleic acid (C16:1) having its highest presence in the SF 75 CH 25 lambs while the lowest presence was found in the SF 50 CH 50 lambs. Between these two genotypes there were also found different proportions of C18:1.

In polyunsaturated fatty acids (PUFA) proportion, the SF 50 IW 50 lambs had higher contents of linoleic acid (C18:2-n6), arachidonic acid (C20:4-n6) and docosatetraenoic acid (C22:4-n6) than the SF 50 CH 50 lambs. The total content of PUFA was not affected by the different genotypes of the Suffolk crossbreds.

The SF 50 IW 50 lambs showed significantly higher values ($P \leq 0.05$) of the P/S ratio, the sum of n-6 PUFA and the n-6/n-3 PUFA ratio compared to the SF 50 CH 50 lambs.

A significantly higher atherogenic index (AI) was found in the SF 75 CH 25 crossbreds and a lower thrombogenic index (TI) in the SF 50 IW 50 crossbreds. The SF 50 CH 50 genotype displayed a significantly lower level of Δ^9-desaturase (16) index.

Table 2
The effect of the genotype on the fatty acid profile (g/100g of total fatty acids), fatty acid ratios and indexes of the *Quadriceps femoris* muscle composition
Der Effekt der Genotypen auf das Fettsäurenprofil (g/100g des Gesamtinhalts), das Fettsäurenverhältnis und die Indizes des Quadriceps Femoris

Fatty acid	Genotype		
	SF 75 CH 25	SF 50 CH 50	SF 50 IW 50
	$\bar{x} \pm$ SEM	$\bar{x} \pm$ SEM	$\bar{x} \pm$ SEM
C12:0	$0.32^{B} \pm 0.047$	$0.18^{A} \pm 0.033$	$0.19^{A} \pm 0.023$
C14:0	$4.08^{B} \pm 0.399$	$2.63^{A} \pm 0.365$	$2.80^{A} \pm 0.294$
C16:0	$23.70^{b} \pm 0.716$	$21.93^{a} \pm 0.657$	$21.82^{a} \pm 0.670$
C18:0	$19.86^{a} \pm 0.737$	$22.25^{b} \pm 0.848$	$20.43^{a} \pm 0.746$
C16:1	$2.40^{C} \pm 0.092$	$2.01^{A} \pm 0.112$	$2.17^{B} \pm 0.114$
C18:1	$38.63^{a} \pm 0.703$	$41.21^{b} \pm 0.541$	$41.03^{a,b} \pm 1.158$
C20:1	0.44 ± 0.028	0.54 ± 0.053	0.50 ± 0.035
C18:2-n6	$5.61^{a,b} \pm 0.127$	$4.82^{a} \pm 0.205$	$5.87^{b} \pm 0.511$
C18:3-n6	0.03 ± 0.003	0.04 ± 0.005	0.03 ± 0.003
C18:3-n3	2.26 ± 0.153	2.05 ± 0.108	2.17 ± 0.149
C20:4-n6	$1.11^{a,b} \pm 0.076$	$1.00^{a} \pm 0.087$	$1.35^{b} \pm 0.157$
C20:5-n3	0.51 ± 0.034	0.49 ± 0.057	0.58 ± 0.064
C22:4-n6	$0.07^{a,b} \pm 0.006$	$0.05^{a} \pm 0.006$	$0.09^{b} \pm 0.018$
C22:5-n6	0.02 ± 0.004	0.02 ± 0.003	0.02 ± 0.003
C22:5-n3	0.76 ± 0.037	0.62 ± 0.053	0.77 ± 0.067
C22:6-n3	0.19 ± 0.012	0.16 ± 0.018	0.18 ± 0.015
SFA	$47.97^{B,b} \pm 0.679$	$46.99^{a} \pm 0.381$	$45.24^{A} \pm 0.606$
MUFA	41.47 ± 0.643	43.76 ± 0.541	43.70 ± 1.116
PUFA	10.56 ± 0.265	9.26 ± 0.493	11.06 ± 0.943
UFA	$52.03^{A} \pm 0.679$	$53.01^{a} \pm 0.381$	$54.76^{B,b} \pm 0.606$
P/S	$0.22^{a,b} \pm 0.007$	$0.20^{a} \pm 0.011$	$0.24^{b} \pm 0.021$
n6	$6.84^{a,b} \pm 0.162$	$5.94^{a} \pm 0.295$	$7.36^{b} \pm 0.674$
n3	3.73 ± 0.147	3.32 ± 0.222	3.70 ± 0.278
n-6/n-3	$1.85^{a,b} \pm 0.064$	$1.82^{a} \pm 0.089$	$1.98^{b} \pm 0.062$
C18:2-n6/C18:3-n3	$2.54^{a,b} \pm 0.143$	$2.39^{a} \pm 0.130$	$2.71^{b} \pm 0.123$
Atherogenic index	$0.78^{B,b} \pm 0.055$	$0.65^{a} \pm 0.057$	$0.61^{A} \pm 0.038$
Thrombogenic index	$1.33^{b} \pm 0.037$	$1.33^{b} \pm 0.034$	$1.22^{a} \pm 0.032$
Δ9-desaturase (16) index	$9.20^{B} \pm 0.119$	$8.36^{A} \pm 0.259$	$9.04^{B} \pm 0.288$
Δ9-desaturase (18) index	66.09 ± 0.865	65.00 ± 1.004	66.74 ± 1.045

$^{A,B}P<0.01$, $^{a,b}P<0.05$, SFA saturated fatty acids, MUFA monounsaturated fatty acids, PUFA polyunsaturated fatty acids, UFA=MUFA + PUFA, P/S PUFA/SFA, n6=C18:2-n6 + C18:3-n6 + C20:4-n6 + C22:4-n6 + C22:5-n6, n3=C18:3-n3 + C20:5-n3 + C22:5-n3 + C22:6-n3, Δ9-desaturase (16) index=100×[C16:1 / (C16:0 + C16:1)], Δ9-desaturase (18) index=100×[C18:1 / (C18:0 + C18:1)]

Discussion

Genotype had a significant effect on live weight at slaughter, respectively on cold carcass weight, while the intensity of growth did not vary. So, a lower LWS of the SF 75 CH 25 lambs was brought about by their insignificantly lower age at slaughter. Generally, it can be stated that the ADGs of all Suffolk-sired genotypes were relatively low as compared to results for Suffolk crossbreds published by BIANCHI *et al.* (2003) and SNOWDER and DUCKETT (2003). The lower ADGs can be explained by the extensive nutrition and relatively unfavourable

climatic conditions like high rainfall and low night temperatures. On the other hand, the low ADGs of the Suffolk crosses in our experiment are in accordance with the findings of FANTOVÁ and ČISLÍKOVSKÁ (1991) and DA CUNHA *et al.* (2000).

The results do not indicate any significant effect of crossbreeding on carcass dressing percentage which is in agreement with results reported by KUCHTÍK and HORÁK (2001) and GUTIÉRREZ *et al.* (2005). In contrast, KREMER *et al.* (2004) reported a significant effect of genotype on dressing percentage in lambs. As for kidney fat, the SF 50 CH 50 lambs showed a higher level as compared to the SF 75 CH 25 lambs, which was likely attributed to the different LWS of these genotypes. The weight of kidney fat varied from 110 to 290 g, which corresponds to the findings of ARCHIMEDE *et al.* (2008) in ovine Martinik lambs. In addition, in their experiment the level of kidney fat increased progressively with the inclusion ratio of dietary concentrates.

The contents of dry matter, IM fat and ash in the *Quadriceps femoris* muscle were not affected by genotype. The dry matter content was almost identical in all Suffolk-sired genotypes, while its values were in accordance with the findings of KUCHTÍK *et al.* (1996) and FOTI *et al.* (2005). The IM fat content varied from 2.1 to 2.7 %. Similar values for IM fat in various muscles of the Charollais and Stavropol Merino lambs were also presented by KUCHTÍK *et al.* (1996). If the IM fat content is less than 5 %, the meat can be regarded as lean meat (FOOD ADVISORY COMMITTEE, 1990). Genotype significantly affected the protein content of the *Quadriceps femoris* muscle. A lower presence of protein was found in the SF 75 CH 25 lambs compared to the SF 50 CH 50 and IW type crossbreds. The protein content in the *Quadriceps femoris* muscle of Suffolk-sired crossbreds in our experiment corresponds to the findings of FOTI *et al.* (2005) in the *Longissimus dorsi muscle*.

In order to eliminate the effect of varying live weight on FA composition, the LWS was included as a covariant in the statistical model (NÜRNBERG *et al.* 1999). Genotype affected the composition of saturated fatty acids. The content of C12:0, C14:0, C16:0 and total SFA was significantly higher in the SF 75 CH 25 crossbreds compared to both of the other genotypes, whereas the content of C18:0 was significantly higher in the SF 50 CH 50 crossbreds. The C16:0 made up the greatest proportion of SFA both in the SF 75 CH 25 and IW type lambs, which was in agreement with POPOVA (2007). In this experiment, meat from lambs always comprised the highest proportion of C16:0 from SFA in anatomically different muscles and/or different rearing systems. Similar results were also discovered by JOY *et al.* (2008) in lambs and by WARREN *et al.* (2008) in cattle. In our experiment, the highest proportion of C18:0 from all SFA in the SF 50 CH 50 crossbreds most likely points to a different potential of this genotype to synthesize diverse proportions of a particular SFA. It has been reported that different dietary SFA have different physiological effects. SFA influence plasma cholesterol, though C18:0 is considered neutral in this regard (DIETSCHY 1998) and C12:0, C14:0 and C16:0 are hypercholesterolemic (YU *et al.* 1995). In addition, YU *et al.* (1995) suggested that C14:0 is 5-6 times more atherogenic, or hyper-cholesterolaemic, than either C12:0 or C16:0. Thus, the meat from SF 75 CH 25 lambs in our experiment contained a less desirable proportion of particular SFA with respect to human health. MARINO *et al.* (2008) found that when the slaughter weight of lambs increased, the FA composition changed because of an increased proportion of SFA, which doesn't correspond with our results. In contrast, the significantly lower LWS of the SF 75 CH 25 crossbreds in our experiment displayed a higher proportion of total SFA.

Concerning MUFA, the genotype significantly affected the content of C16:1. In the case of different methods of crossing between SF and CH breeds, there was also observed a lower proportion of C18:1 in SF 75 CH 25 lambs, compared to SF 50 CH 50 lambs. Generally the C18:1 comprised the greatest proportion out of the observed FA in all genotypes, which is in agreement with POPOVA (2007). The enzyme responsible for the conversion of all SFA to their respective MUFA, as well as trans-vaccenic acid to rumenic acid (cis-9, trans-11 CLA), is Δ^9-desaturase (HAUSMAN *et al.* 2009). As for ruminants, fatty acids in the feed are chemically reduced by microorganisms in the rumen and absorbed as saturated fatty acids. The composition of FA stored in the fat depots reflects the previous action of Δ^9-desaturase on substrates such as C18:0 or C16:0 (KIM and NTAMBI 1999, YANG *et al.* 1999). Given its determinant role in fatty acid oxidation, Δ^9-desaturase is a candidate for genetic variation in fatty acid composition (TANIGUCHI *et al.* 2004b). In our study, a lower value of Δ^9-desaturase (16) index was found in the SF 50 CH 50 crossbreds compared to the SF 75 CH 25 and IW type lambs, when the values of Δ^9-desaturase (18) index did not vary among the Suffolk-sired genotypes. Similarly ZAPLETAL *et al.* (2009) found out the differences in values of Δ^9-desaturase (16) index in phylogenetically related breeds of cattle, while their Δ^9-desaturase (18) index did not differ. TANIGUCHI *et al.* (2004a) reported that the stearoyl-CoA desaturase (SCD) mRNA expression level was related to the MUFA percentage in cattle and described single nucleotide polymorphism, which contributed to a higher MUFA percentage and a lower melting point in IM fat. According to TANIGUCHI *et al.* (2004b) the sterol regulatory element binding proteins (SREBP) may have a certain effect on FA composition and the fat melting point via transcription activation of the SCD expression level in cattle. Likewise, HOASHI *et al.* (2007) demonstrated that the bovine SREBP-1 polymorphism was associated with MUFA proportion in the composition.

The total content of PUFA was not affected by genotype. However IW genotype showed higher contents of C18:2-n6, C20:4-n6, C22:4-n6 and total n-6 PUFA proportion compared to the SF 50 CH 50 genotype. Generally, the n-6/n-3 PUFA ratio set for human nutrition is 4-5 ≤ 1 of dietary fat (SIMOPOULOS 2002, GERMAN SOCIETY OF HUMAN NUTRITION 2004). In our experiment, meat from all Suffolk-sired crossbreds contained the favorable ratio of n-6/n-3 FA, while a significantly lower value was found in the SF 50 CH 50 lambs (1.82) compared to the IW type lambs (1.98). DE SMET *et al.* (2004) pointed out that the n-6/n-3 ratio of the total lipid fraction of muscle may vary depending on the n-6/n-3 ratio of the phospholipid and triacylglycerol fractions though this ratio is much more affected by the feeding regimes of the animals than by genetics. The authors also suggest that no general relationship between the level of fatness and the n-6/n-3 ratio in the meat can be expected due to the overriding effect of the dietary n-6/n-3 ratio, which corresponds with our findings relating to the IM fat content of different Suffolk-sired genotypes ($P \geq 0.05$). The minimum P/S ratio set for human nutrition is at least 0.45 (SIMOPOULOS 2004) and generally should be around 0.7 (RAES *et al.* 2003). If fat from ruminant meat is highly saturated, it is considered to have detrimental effects on human health (MONTEIRO *et al.* 2006). Generally, reducing the intake of SFA (which are known to raise the total and LDL cholesterol) and increasing the intake of n-3 PUFA is particularly encouraged (WHO 2003). In our experiment, a significantly higher value of P/S ratio was found in IW type lambs compared to the SF 50 CH 50 genotype. Generally the P/S ratio of the *Quadriceps femoris* muscle in our experiment fluctuated from

0.20 to 0.24 which corresponds to the findings of ORIANI *et al.* (2005) and BRZOSTOWSKI *et al.* (2006). Moreover, ORIANI *et al.* (2005) observed a significantly higher P/S ratio in the Semimembranosus muscle compared to the *Quadriceps femoris* and *Longissimus dorsi muscles*. Conversely, a higher P/S ratio was presented by MARINO *et al.* (2008) found in the longissimus dorsi muscle of Altamurana and Trimeticcio lambs. SCOLLAN *et al.* (2003) also pointed out association between fatness and P/S ratio. According to previous authors the content of SFA and MUFA increases more rapidly with increased fatness in cattle, than does the content of PUFA. However, in our case, a tendency towards a higher proportion of IM fat in SF 75 CH 25 lambs ($P \geq 0.5$) did not lead to a lower P/S ratio in muscle. Fatty acids can promote or prevent atherosclerosis and coronary thrombosis based on their effects on serum cholesterol and low-density lipoprotein-cholesterol concentrations (MARINO *et al.* 2008). Favourable lower AI and TI, in our experiment, were found in the IW crossbreds, which would indicate a lower risk of atherosclerosis and coronary thrombosis as a result of consuming this particular type of meat. Likewise, SALVATORI *et al.* (2004) observed the effect of genotype on the differing values of AI in all of the evaluated muscles of crossbred lambs. In our experiment, the values of AI and TI were lower, compared to the results published by SALVATORI *et al.* (2004) or ORIANI *et al.* (2005).

Generally, the findings concerning the FA composition of Suffolk-sired crossbreds in our experiment confirmed the opinion of LABORDE *et al.* (2001), that certain breeding methods may be used in order to improve the FA composition of intramuscular fat with regard to human consumption and health.

In conclusion, our experiment revealed a major effect of the Suffolk-sired genotype on the fatty acid profile of the *Quadriceps femoris* muscle. Lambs of the IW genotype had a lower saturated fatty acids proportion and lower values of atherogenic and thrombogenic indexes and a higher P/S ratio in their meat than lambs of the CH genotypes. This resulted in better nutritional characteristics of their meat with regard to human health. As for crossing between the Suffolk and Charollais breeds, a favourable fatty acids profile of meat was observed in the F1 crossbred as compared to the F11 crossbred.

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Corresponding author:

DAVID ZAPLETAL
email: zapletald@vfu.cz

Department of Nutrition, Animal Husbandry and Animal Hygiene, Faculty of Veterinary Hygiene and Ecology
University of Veterinary and Pharmaceutical Sciences Brno, Palackého 1-3, 612 42 Brno, Czech Republic