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Institute of Genetics and Animal Breeding, Jastrzębiec, Poland

Profile of fatty acids and activity of elongase and Δ5 and Δ9 desaturase of growing pigs differ in concentration of intramuscular fat in *musculus longissimus dorsi*

Grzegorz Skiba[1], Staniaława Raj[1], Ewa Poławska[2,*]

[1] The Kielanowski Institute of Animal Physiology and Nutrition, Polish Academy of Sciences, 05-110 Jabłonna, Poland

[2] Institute of Genetics and Animal Breeding, Polish Academy of Sciences, Jastrzębiec, 05-552 Magdalenka, Poland

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Pigs of Pietrain (P) and Polish Synthetic line of 990 (S) were slaughtered at 25, 70, 90, 110 and 130 kg BW and the chemical composition of *musculus longissimus dorsi* and its fatty acid profiles were determined. The Pietrain pigs were characterised by lower (P<0.01) concentration of intramuscular fat, total SFA (P<0.05) and MUFA (P<0.01) than pigs of the synthetic line 990 at each BW (P<0.05). Simultaneously the Pietrain breed were characterised by higher (P<0.01) concentration of all acids belonging to PUFA group. Concentration of total SFA increased (P<0.01) along with increased body mass of pigs. MUFA was similar at each investigated BW. However, in the case of Pietrain breed increasing concentration of the PUFA was observed till animals reached approximately 110 kg BW, while in Synthetic line only till 70 kg BW. Similar course was observed in the change of C18:2n-6 concentration. However, the concentration of C18:3n-3 decreased (P<0.05) along with the growth of the animals. The course of changes in concentration of C20:3n-6 and C20:4n-6 generally agreed with the course detected for total amount of PUFA. Activity of the Δ5 desaturase was higher (P<0.01) in the pigs of the synthetic line. The activity of the investigated enzymes did not differ between breeds. Activities of the elongase and Δ5 desaturase decreased during the growth of the pigs. Estimated values of the Pearsons' correlation between body mass/age of the pigs and activity of investigated enzymes showed the opposite relationship between them. However, they were stronger and statistically more significant for the synthetic line of pigs.

*Corresponding author: e.polawska@ighz.pl

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It is well known that the nutritive value of meat depends on the fat content and fatty acids (FA) profile of muscle, as both factors strongly influence human health. It is thus important to select production conditions that simultaneously maximise the quality and healthiness of meat. The fatty acid composition of fat tissues of monogastric animals, including pigs and poultry, is directly influenced by the fat composition of diets [Bee *et al*. 2002, Kouba *et al*. 2003, Nguyen *et al*. 2003, Poławska *et al*. 2011]. Due to successful breeding for a high protein/meat content and reduced amount of fat/adipose tissue in the carcass, the contribution of polyunsaturated fatty acids (PUFA) is improved in modern pigs [Edwards *et al.* 2003], however, differs between breeds [Monziols *et al.* 2007, Wood *et al*. 2004]. Literature data [e.g. Pascual *et al*. 2007] show that particular breeds of pigs differ in ratio of PUFA:SFA and n-6:n-3 group of fatty acids in the body/muscle as well as in the intramuscular fat content. Moreover, recent studies investigated these issues, in most cases on pigs during finisher growth period and were usually connected with supplementation of diet with different sources of plant oil [Nguyen *et al*. 2003, Pascual *et al*. 2007, Flachowsky *et al*. 2008]. Thus, observed changes in fatty acid composition and their metabolism in investigated tissues were forced mainly by fats supplement. In available research studies there is lack of information about processes of fat metabolism and its intensity in pigs' muscles observed during whole fattening period, especially in pigs early life which, is characterised by fast growth and intense metabolism of both protein and fat.

In this study it was assumed that a fatty acids profile of muscle and metabolism of fatty acids expressed as the activity of enzymes connected with SFA, MUFA and PUFA should differ between pigs of Pietrain and Synthetic line 990 representing respectively thin and fat type of pigs. Moreover, the profile of fatty acids and the activity of enzymes connected with SFA, MUFA and PUFA metabolism will differ depending on the stage of growth. Using the same diet for both breeds during the whole investigated period will enable determining a clear effect of breed and body weight on investigated features. Thus, the aim of the study was to determine the influence of breed and body weight on fatty acids profile and activity of chosen enzymes (Δ9 and Δ5 desaturases, and elongese) in intramuscular fat of *musculus longissimus dorsi* (MLD) in pigs growing from 25 to 130 kg BW.

Material and methods

Animals and diet

Sixty gilts growing from 25 to 130 kg BW, of breeds: Pietrain (P) and Polish Synthetic line of 990 (S) each of 30 animals were used. All pigs were free of the halothane gene and kept individually in pens of 2.6 m^2 on concrete floor without straw.

Feed (contained 2,5% of rapeseed oil) was offered *ad libitum*. One kind of diet was used during the study to allow animals to fully exhibit their growth potential.

The composition, nutritive value and fatty acid profile of the diet are shown in Table 1 and 2. The digestible energy value and nutrient digestibility were determined at approximately 110 kg BW by the three-day faeces collection and indicator (Cr_2O_3) method was used. The metabolisable energy of the diet was calculated from the digestible energy=concentration [Noblet *et al*. 1989]. Feed intake and body weight were recorded weekly and average feed consumption and body weight gain were calculated for successive growth period from 25 to 130 kg BW.

Table 1. Composition and nutritional value of feed

Item	
Ingredients (g/kg)	
maize	503.1
barley	250.0
soybean meal	190.0
mineral-vitamin mix.[1]	25.0
ca co_3	4.0
oil rapeseed	25.0
amino acids [2] (g)	
L-Lysine-HCL	1.10
DL-Methionine	0.85
L-Threonine	0.60
L-Tryptophan	0.35
Chemical composition (g/kg)	
dry matter	875.8
crude protein	177.5
ether extract	47.9
ash	52.2
nitrogen-free-extract	570.8
crude fibre	27.4
NDF	147.3
ADF	65.2
Nutritive value (g/kg)	
digestible crude protein (g)	144
apparent ileal digestible lysine [2] (g)	8.93
metabolisable energy (mj/kg)	13.2

[1] Microelements and vitamins supplied per kg of diet: Fe 60 mg, Zn 80 mg, Cu 25 mg, Mn 30 mg, J 0.5 mg, Se 0.15 mg; vitamin A 15000 IU, vitamin D_3 2000 IU, vitamin E 15 mg, vitamin K_3 1.5 mg, vitamin B_1 1 mg, vitamin B_2 5 mg ,vitamin B_6 1.5mg, vitamin B_{12} 0.015 mg; biotin 0.03 mg, folic acid 0.5 mg, nicotinic acid 15 mg, calcium pantothenate 8 mg, choline chloride 150 mg.
[2] Calculated according to CVB (1995), ratio of lysine : methionine : threonine : tryptophan 100:32:57:18.

Sample preparation

All of pigs were electrically stunned and slaughtered in the experimental slaughtering house of the Institute of Animal Physiology and Nutrition after 16 hours period of starvation at 25, 70, 90, 110 and 130 kg BW. At particular slaughter weight

Table 2. Fatty acids content (% total FA) of feed

Fatty acids (% total fatty acids content)	
C14:0	0.24
C16:0	15.71
C16:1n-7	0.45
C18:0	3.93
C18:1n-9	28.37
C18:2n-6	46.37
C18:3n-3	3.30
C20:0	0.32
C20:1n-9	0.63
C20:2n-6	0.35
C20:3n-6	0.08
ΣSFA	20.20
ΣMUFA	29.45
ΣPUFA	50.10

ΣSFA – total saturated fatty acids content, ΣMUFA – total monounsaturated fatty acids content, ΣPUFA – total polyunsaturated fatty acids content.

six animals per each breed were slaughter. Then, the carcass and non-carcass parts (visceral organs, empty digestive tract and blood) were weighed separately. The carcasses were chilled at 4°C for 24 hours and weighed.

After the chilling period the *musculus longissimus dorsi* (MLD) was separated from the left half-carcass, and then weighed. From each muscle a sample was collected at the last rib region, packed into foil bags, frozen and kept at -20°C until analysis of FA. The right half-carcass was dissected into edible tissues (meat + subcutaneous and intramuscular fats) and inedible parts (bones and skin). The edible part of the carcass was grounded; however, the inedible part was autoclaved (temperature of 110°C and pressure of 1.3 atmospheres) during six hours. Then, from both parts of the carcass a representative sample was also taken for chemical analysis.

Analytical methods

Dry matter, crude protein, ether extract and ash in the diet, faeces and carcass (edible tissues and inedible parts) and additionally crude fibre in the diet and faeces were analyzed according to AOAC [2007] procedures. The content of neutral detergent fibre (NDF) and acid detergent fibre (ADF) in the diet and faeces were determined using Fibertec System M using methods described by Van Soest and Wine [1967] and Van Soest [1973]. The gross energy concentration in the diet and faeces were determined by combustion of samples in a bomb calorimeter. Chromic oxide in the diets and faeces was assayed according to the method described by Fenton and Fenton [1979]. Lipids from the diet were extracted by diethyl ether.

Samples of MLD were homogenized and one gram of sample was extracted with chloroform-methanol 2:1(v/v) according to Folch *et al*. [1957]. Fatty acid methyl esters (FAME) were analyzed using a GC-7890 Agilent gas chromatograph equipped with a 60 m capillary column (Hewlett-Packard-88, Agilent J&W GC Columns, USA) with 0.25 mm inner diameter and coating thickness of 0.20 μm. A 1 μl sample was injected at a split ratio of 1:40. Helium was used as a carrier gas at a flow rate 50 $mL.min^{-1}$. The temperature program with a total run time of 47 min. was: from 140°C (held for 5 min) at a rate of $4°C.min^{-1}$ to 190°C and then to 215°C at a rate $0.8°C.min^{-1}$. Individual fatty acid peaks were identified by comparison with known reference methyl esters (Supelco 37 Component FAME Mix, 47885-U, Sigma-Aldrich Co.). All FA values were expressed as a weight percentage of total fatty acids.

Enzymes activity

Metabolism of a particular group of fatty acids was expressed as the activity of some enzymes involved in this process. The activity of the enzymes involved in desaturation of MUFA – Δ9 desaturase and n-6 PUFA – Δ5 desaturase and elongation of SFA – elongase was measured based on the ratio of product (g) and its precursor (g). The following formulas were used:

Activity of Δ9 desaturase = C18:1 n-9/C18:0
Activity of Δ5 desaturase = C20:4 n-6/C20:3n-6
Activity of elongase = C18:0/C16:0

Statistical analysis

Statistical analysis was performed using Statgraphics Centurion (version XV-2005) software. The chemical composition of the muscle, as well as FA of intramuscular fat, was analysed by two way ANOVA analysis using a body weight and breed as factors. An interaction between experimental treatments was also determined. The significance of differences between treatments was calculated using the Tukey test. The relationship between body mass and activity of elongase, Δ9 and Δ5 desaturases was determined using Pearsons' correlation.

Results and discussion

Performance of pigs

Feed consumption and growth rate of pigs during successive period of the study are presented in Table 3. The Pietrain pigs consumed on average 20% less ($P<0.01$) feed and grew over 20% slower ($P<0.01$) than animals of synthetic line.

Chemical composition of the carcass and muscle

Average mass of carcass of the Pietrain pigs was greater by 3.1 kg ($P<0.01$) than in pigs of the synthetic line 990 (Tab. 4). Carcass of the Pietrain animals contained

Table 3. Performance of pigs

Item	Breed	Live weight range (kg)			
		25-70	25-90	25-110	25-130
Daily feed intake (kg)	P	1.78^{A}	1.95^{A}	2.02^{A}	2.20^{A}
	S	2.10^{B}	2.35^{B}	2.54^{B}	2.78^{B}
	SE	0.08	0.10	0.12	0.13
Average daily gain (g)	P	681^{A}	694^{A}	666^{A}	647^{A}
	S	762^{B}	784^{B}	796^{B}	823^{B}
	SE	32	37	40	28

[aA...]Within columns means bearing different superscripts differ significantly at: small letters – P<0.05; capitals – P<0.01.

Table 4.Carcass weight (kg) and chemical composition (%)

Item	Breed (B)	Live weight, LW (kg)					mean	SEM	Interaction B×LW
		25	70	90	110	130			
Carcass weight (kg)	P	18.1	59.3	74.0	92.7	110.0	70.8^{B}		
	S	18.8	54.4	71.0	90.5	103.7	67.7^{A}		
	mean	18.5^{A}	56.9^{B}	72.5^{C}	91.6^{D}	106.9^{E}	69.3	0.58	NS
Fat (g/kg)	P	113	165	218	200	230	185^{A}		
	S	108	155	221	247	301	206^{B}		
	mean	111^{A}	160^{B}	220^{C}	223^{C}	265^{D}	200	8.95	NS
Protein (g/kg)	P	169	171	171	173	170	172^{b}		
	S	165	173	166	163	155	164^{a}		
	mean	167^{b}	172^{bc}	168^{b}	168^{b}	163^{a}	168	2.52	0.05
Ash (g/kg)	P	26.95	29.49	26.59	28.47	25.87	27.47		
	S	26.86	27.31	29.67	28.51	27.62	27.99		
	mean	26.91	28.40	28.13	28.49	26.74	27.73	0.93	NS
Water (g/kg)	P	691	635	584	580	579	616^{b}		
	S	700	644	582	560	517	600^{a}		
	mean	695^{E}	640^{D}	583^{C}	570^{B}	548^{A}	608	8.01	NS

[aA...] Within columns means bearing different superscripts differ significantly at: small letters – P<0.05; capitals – P<0.01. NS – non significant.

less fat (by 10%, P<0.01) but more protein (by 4.9%, P<0.05) and more water (by 2.7%, P<0.05) compared to carcass of pigs of the synthetic line.

Fatness of the carcass increased (P<0.01) but water content decreased (P<0.01) when pigs were older (Tab. 4). However, an interaction (P<0.05) found for the amount of protein in the carcass showed that compared types of pigs behaved differently. This carcass component in the Pietrain pigs was stable but in the remained group of pigs decreased together with the increase of the age.

Fat content in the carcass increased linearly, in both types of animals. Relationships between body mass and fatness of the carcass are expressed in equation 1 (for synthetic line) and in equation 2 (for the Pietrain pigs), where Y = fat content in the carcass, X = body mass.

$Y = 57.83(\pm 12.08) + 1.77(\pm 0.14) \times X \quad r = 0.93, P<0.0001$ (equation 1)

$Y = 88.14(\pm 11.84) + 1.13(\pm 0.14) \times X \quad r = 0.85, P<0.0001$ (equation 2)

Along with the increase of body mass intramuscular fat in the MLD increased (P<0.01, Tab. 5), however, faster in the synthetic line of pigs. The content of fat in the muscle of the Pietrain pigs increased only till 90 kg BW. The carcass of heavier pigs had less (P<0.05) water than younger ones.

Table 5.Chemical composition (%) of the *musculus longissimus dorsi*

Item	Breed (B)	Live weight, kg (LW)						SEM	Interaction B×LW
		25	70	Mean	110	130	mean		
Fat (%)	P	1.00	1.31	1.68	1.58	1.56	1.43^{A}		
	S	1.40	1.63	2.07	2.51	2.74	2.07^{B}		
	mean	1.20^{a}	1.50^{b}	1.84^{c}	2.04^{cd}	2.04^{cd}	1.75	0.23	NS
Protein (%)	P	19.23	22.19	22.31	22.50	23.36	22.12		
	S	20.06	22.28	22.61	22.56	22.19	21.93		
	mean	19.62^{a}	22.24^{b}	22.46^{bc}	23.02^{c}	22.77^{bc}	22.05	0.18	NS
Ash (%)	P	1.17	1.16	1.17	1.24	1.15	1.18		
	S	1.21	1.17	1.10	1.15	1.13	1.15		
	mean	1.19	1.16	1.13	1.19	1.14	1.16	0.25	NS
Water (%)	P	77.66	75.27	74.91	73.69	74.13	74.93		
	S	73.37	74.93	74.23	73.78	73.94	74.65		
	mean	76.01^{c}	75.10^{b}	74.57^{ab}	73.73^{a}	74.04^{a}	74.79	0.23	NS

$^{aA...}$ Within columns means bearing different superscripts differ significantly at: small letters – P<0.05; capitals – P<0.01. NS – non significant.

The Pietrain pigs were characterised by lower (P<0.01) concentration of intramuscular fat than pigs of the synthetic line 990 at each body mass (on average 1.43 *vs.* 2.07, P<0.05). Moreover, water content in meat decreased (P<0.05) as body mass increased.

The content of intramuscular fat in MLD increased linearly, in both types of animals, when the fatness of the pigs' carcass increased. Relationships between intramuscular fat content in the MLD and carcass fatness are expressed in equation 3 (for synthetic line) and in equation 4 (for the Pietrain pigs), where Y = content of intramuscular fat in the MLD, X = fat content in the carcass.

$Y = 0.70(\pm 0.14) + 0.07(\pm 0.0.007) \times X \quad r = 0.88, P<0.0001$ (equation 3)
$Y = 0.64(\pm 0.18) + 0.04(\pm 0.01) \times X \quad r = 0.66, P<0.0004$ (equation 4)

Calculated equations showed in detail that increasing a body mass of pigs by 1 kg resulted in increasing of fat concentration in their carcass respectively by 1.77 and 1.33 percentage points in animals of the synthetic line and in the Pietrain breed. However, equations expressed change in fatness of *longisimus* muscle proceed during growth of pigs (increased fat content in the carcass) showed that increasing fat content in the carcass by 1% resulted in increasing an intramuscular fat content by 0.07 percent points in animals of the synthetic line, whereas only 0.04 percent point in the Pietrain breed.

In our study, the Pietrain pigs had significantly less of intramuscular fat compared to pigs of the synthetic line. Remained chemical components of the muscle did not differ between compared breeds. The intramuscular fat concentration in the muscle is an important factor influencing pork quality. Comparing fatness of the *musculus longissimus dorsi* of our animals it should be emphasised that in animals of the synthetic line it exceeds 2% already at 70 kg body weight, whereas in the Pietrain breed it did not reach this value even in animals weighing 130 kg. In the study by Mas *et al*. [2010] in Pietrain-crossed pigs weighing approximately 110 kg intramuscular fat content in the longissimus thoracis was even lower than in our animals (1.24 and 0.94%, respectively in barrows and gilts). However, Alonso *et al*. [2009] showed a similar (to our pigs) ratio of intramuscular fat (1.60%) of the *longisimus dorsi* muscle in the Pietrain-crossed pigs and lower in Duroc-crossed animals (2.24%) at standard slaughter mass. According to the literature data [e.g. Fernandez *et al*. 1999] intramuscular fat content of 2% warrants a good eating quality (e.g. juiciness and tenderness). It means that meat of the Pietrain animals, and also their cross-breeds did not fulfill conditions of good meat quality.

Fatty acids profile of MLD

Compared to pigs of the synthetic line, the Pietrain pigs tended ($P<0.08$) to have a lower concentration of total SFA and had significantly less ($P<0.01$) of total MUFA. The highest difference was found for C18:1 acid (Tab. 6). Simultaneously the Pietrain breed was characterised by higher ($P<0.01$) concentration of total PUFA acids especially C18:2n-6 ($P<0.01$), C18:3n-3 ($P<0.05$) and C20:3n-6 ($P<0.01$) in MLD. Moreover, the Pietrain pigs had higher ratio of PUFA:SFA (0.73 *vs.* 0.61, respectively) and higher ($P<0.05$) ratio of C18:2n-6:C18:3n-3 (18.21 *vs.* 16.66, respectively).

The concentration of total SFA in MLD increased ($P<0.01$) along with increased body mass of pigs (Tab. 6) from 31.90 to 36.39%. The main representative of this group of fatty acids increased from 19.50 to 22.62% (C16:0, $P<0.01$) and from 11.36 to 12.29 ($P<0.01$) in the case of the C18:0 acid. The concentration of MUFA was similar in each investigated body mass (on average 40.00%). PUFA concentration increased ($P<0.05$) from 22.29 to 24.57% till pigs reached 90 kg of body mass, following a decrease ($P<0.05$) up to value of 20.61% at target body mass was observed. However,

Table 6. Fatty acids profile (%) in intramuscular fat of *musculus longissimus dorsi*

Item	Breed (B)	Live weight (LW), kg						SEM	B × LW
		25	70	90	110	130	mean		
C16:0	P	19.01	21.02	21.16	21.20	21.33	20.74	0.27	NS
	S	20.00	20.11	21.01	24.02	23.91	21.82		
	mean	19.50^{A}	20.56^{B}	21.08^{B}	$22.61B^{C}$	22.62^{C}	21.27		
C18:0	P	10.81	11.86	11.54	10.71	11.97	11.39	0.23	NS
	S	11.92	12.25	11.83	12.34	12.60	12.19		
	mean	11.36^{A}	12.05^{AB}	11.71^{AB}	11.52^{AB}	12.29^{AB}	11.79		
ΣSFA	P	30.87	34.15	34.03	33.35	34.78	33.47	0.40	NS
	S	32.92	33.67	34.20	37.44	38.00	35.24		P<0.08
	mean	31.90^{a}	33.91^{b}	34.11^{b}	35.39^{c}	36.39^{d}	34.34		
C16:1n-7	P	1.66	1.76	1.96	1.52	1.21	1.62	0.07	NS
	S	1.93	1.66	1.64	1.77	1.50	1.70		
	mean	1.80^{b}	1.71^{b}	1.80^{b}	1.64^{b}	1.36^{a}	1.66		
C18:1n-9	P	38.70	34.50	35.16	34.61	36.02	35.80^{A}	0.08	NS
	S	36.06	39.50	39.47	39.48	43.68	39.63^{B}		
	mean	37.38	36.98	37.31	37.05	39.85	37.72		
ΣMUFA	P	41.12	36.98	37.02	36.78	38.00	38.05^{A}	0.77	NS
	S	38.72	41.77	41.80	41.81	45.88	42.00^{B}		
	mean	39.92	39.38	39.39	39.30	41.94	40.00		
C18:2n-6	P	17.38	21.04	21.87	23.01	22.62	21.18^{B}	0.58	*
	S	17.09	19.24	20.04	16.92	13.35	17.33^{A}		
	mean	17.24^{A}	20.14^{B}	20.94^{B}	19.67^{B}	17.99^{AB}	19.26		
C18:3n-3	P	2.28	1.33	1.10	0.92	1.00	1.33^{b}	0.06	NS
	S	1.47	1.20	1.09	0.87	0.78	1.08^{a}		
	mean	1.88^{c}	1.26^{b}	1.10^{ab}	0.89^{a}	0.88^{a}	1.21		
C20:3n-6	P	0.49	1.02	0.90	0.95	0.83	0.84^{B}	0.03	NS
	S	0.49	0.76	0.79	0.64	0.54	0.64^{A}		
	mean	0.49^{a}	0.89^{c}	0.84^{bc}	0.80^{bc}	0.68^{b}	0.74		
C20:4n-6	P	2.23	2.44	1.66	1.77	1.60	1.79	0.22	NS
	S	3.12	3.15	1.68	1.59	1.16	2.14		
	mean	2.68^{C}	2.80^{C}	1.67^{AB}	1.68^{AB}	1.38^{A}	1.96		
ΣPUFA	P	22.39	25.43	25.54	27.09	25.40	24.95^{B}	0.62	*
	S	22.18	24.24	23.60	20.02	15.82	21.19^{A}		
	mean	22.29^{b}	24.83^{d}	24.57^{d}	23.55^{c}	20.61^{a}	23.07		
PUFA:SFA	P	0.73	0.70	0.69	0.81	0.73	0.73^{B}	0.02	**
	S	0.68	0.72	0.70	0.54	0.42	0.61^{A}		
	mean	0.70^{b}	0.71^{b}	0.69^{b}	0.68^{b}	0.58^{a}	0.67		
LA:ALA	P	7.91	23.07	21.02	21.2	21.30	18.21^{b}	0.70	NS
	S	11.81	17.66	17.10	17.17	19.54	16.66^{a}		
	mean	9.86^{A}	20.37^{B}	19.07^{B}	19.18^{B}	20.42^{B}	17.43		

P – Pietrain, S – Polish Synthetic line of 990; ΣSFA – total saturated fatty acids content, ΣMUFA – total monounsaturated fatty acids content, ΣPUFA – total polyunsaturated fatty acids content, PUFA:SFA – polyunsaturated fatty acids and saturated fatty acids ratio, LA:ALA – C18:2n-6/C18:3n-3 ratio.

[aA]...Within columns means bearing different superscripts differ significantly at: small letters – P<0.05; capitals – P<0.01. NS – non significant.

an interaction (P<0.05) between the body mass and the breed for this feature was detected. In the case of Pietrain breed the increase of concentration of the PUFA was observed till animals reached 110 kg body weight, while in Synthetic line the ratio of PUFA in total pool of fatty acids increased only till 70 kg body weight. Similar course of changing in concentration of C18:2n-6 was observed. However, the concentration of C18:3n-3 decreased (P<0.05) along with the growth of animals (from 1.88 to 0.88%, respectively at 25 and 130 kg body mass). However, the course of changes in the concentration of remained PUFA n-6 fatty acids (C20:3n-6 and C20:4n-6) generally agreed with the course detected for total amount of PUFA. The ratio of PUFA:SFA did not change till BW of 110 kg (on average 0.70), following a decline (P<0.05) up to value of 0.58 at target body weight. However, an interaction (P<0.05) between body mass and breed for this feature was detected. In the Pietrain pigs this ratio stayed at the same level during the whole study, whereas in the animals of the synthetic line it declined strongly when pigs reached 90 kg BW. The ratio of C18:2n-6:C18:3n-3 increased (P<0.01) from 9.86 at the beginning of the study to average value of 19.76 during the following growth period.

In our study the Pietrain pigs were characterised by a lower ratio of total SFA, however the concentration of C16:0 and C18:0 did not differ significantly between breeds. In the study by Olivares *et al*. [2009], who compared profile of fatty acid in MLD in Large White × Landrace *vs*. Duroc pigs (representing thin and fat genotype, respectively), showed also lower proportion of SFA in thinner animals, which (contrary to our results) characterised also lower amount of C16:0 and C18:0. Moreover, those authors found (opposite to our results) lower proportion of C18:1 and total MUFA in fatter pigs. Opposite results are presented by Flachowsky *et al*. [2008], who found lower ratio of C18:0 and similar amount of C16:1 and C18:1 in the MLD of crossbreed of Pietrain × Hampshire *vs*. Duroc and Duroc × Hampshire animals.

As far as the proportion of C18:2n-6 and C18:3n-3 and total PUFA in our work is concerned, it was found that the amount of these fatty acids in the Pietrain animals was higher than in pigs of synthetic line. It is in a good agreement with previous studies by Kouba *et al*. [1999] and by Wood *et al*. [2004]. These authors showed that the proportion of linoleic acid (exclusively from exogenous origin) in the tissues is higher in lean (e.g. Pietrain) than in fatter (e.g. line 990) pigs. This may be explained by the fact that the *de novo* synthesis of fatty acids is lower in leaner breeds, therefore having less endogenous fatty acids results in less dilution of exogenous linoleic acid [Girard *et al*. 1988]. On the other hand Flachowsky *et al*. [2008] and Olivares *et al*. [2009] found no difference in total proportion of PUFA as well as C18:2 between thin and fat pigs.

The ratio of PUFA:SFA in the muscle of both investigated breeds exceeds 0.4 thus, it fulfilled the recommendation of WHO. However, the ratio of C18:2n-6:C18:3n-3 was considerably higher than 4 at each investigated BW in both genotypes, which means that this indicator was far from the value implicated by this organisation.

During growth, the proportion of energy available for fat deposition in pigs increases so the rate of *de novo* fatty acid synthesis is increased [Enser *et al*. 1996]. Our results show that with the increase of body weight the proportion of the total SFA increased. In the study by Apple *et al*. [2009], who investigated the influence of dietary fat source and slaughter weight on the fatty acid composition of whole meat carcass, a total content of SFA of control pigs increased, however, only till 70 kg BW, following decreasing of their content at 115 kg BW. In our study the C16:0 as the main representative of this group of fatty acids increased, however, the C18:0 stayed unchanged, when pigs were growing. Similar findings were reported by Nürnberg *et al*. [1990], Kouba *et al*. [2003], Lo Fiego *et al*. [2005] and Wood *et al*. [2008]. These probably result from the increasing role of *de novo* tissue synthesis of SFA and the relatively declining role of direct incorporation of C18:2n-6 from the diet.

Breeds in our study had a generally greater concentration of PUFA and MUFA in the intramuscular fat than in published data, probably as a result of the 2% rapeseed oil supplementation. According to Schöne *et al*. [2002] supplementation of the diet with rapeseed press cake and, according to Kracht *et al*. [1996], supplementation of the diet with rapeseed oil, increases the concentration of oleic (C18:1n-9), linoleic (C18:2n-6) and α-linolenic (C18:3n-3) acids in the intramuscular fat.

According to our results a total MUFA ratio did not change during the growth, except from the C16:1, which proportion stayed unchanged till 110 kg BW, next decreased during last investigated period. However, the proportion of the C18:1 was similar during all growth periods. Other researchers [e.g. Apple *et al*. 2009] presented increased content of MUFA in the carcass of control pigs (fed a diet without fat supplement), however, mainly in the growth from 28 to 45 kg BW. Following time ratio of this group of fatty acids did not change significantly. These authors also reported, contrary to our results, a decrease in the content of PUFA in animals grown from 28 to 70 kg BW. During the following growth (till 115 kg BW) the PUFA ratio in these animals did not change. However, in the study by Apple *et al*. [2009] the concentration of C16:1 in the meat of whole carcass decreased, but C18:1 increased in the control animals grown from 28 to 115 kg BW.

Moreover, our data indicated that during the first growth period the ratio of C18:2n-6 (and consequently total PUFA) increased up to 90 kg BW, afterwards decreasing of its content was observed. Simultaneously, an interaction between breeds and body mass found for the concentration of these fatty acids indicate that their absorption by animals depends on the extent of body/tissue fatness, which differs between breeds and age of animals. Our results proved that in thinner pigs the content of this fatty acid increased to heavier body mass compared to fatter genotype. This may result from a greater response of lean pigs to dietary PUFA since in those pigs, *de novo* synthesis of SFA is less pronounced even to heavier body mass, whereas in fatter pigs it is more intensive, leading to differences in the PUFA concentration at particular body mass [Cameron *et al*. 1990, 1999, Hauser *et al*. 1997]. Neither breed nor body weight had any effect on the PUFA n-6:n-3 ratio in investigated muscle. In the study by Apple

et al. [2009] the concentration of C18:2n-6 and C18:3n-3 as well as the proportion between these fatty acids, in the whole meat of the carcass, gradually decreased when pigs were fed a diet not supplemented with fat.

Activity of the elongase, Δ9 desaturase and Δ5 desaturase

Activity of the Δ5 desaturase was higher (P<0.01) in the pigs of the synthetic line (3.34 *vs*. 2.13, respectively) than Pietrain pigs (Tab. 7). Whereas, the activity of the remained investigated enzymes did not differ between breeds.

Table 7. Activities of elongase, Δ9 desaturase and Δ5 desaturase in intramuscular fat of *musculus longissimus dorsi*

Item	Breed (B)	Live weight, kg (LW)						SEM	B×LW
		25	70	90	110	130	mean		
Elongase C18:0/C16:0	P	0.57	0.56	0.55	0.51	0.56	0.55	0.25	NS
	S	0.60	0.61	0.56	0.51	0.53	0.56		
	mean	0.58 ^{b}	0.59 ^{b}	0.55^{ab}	0.51^{a}	0.54^{ab}	0.55		
Δ9 desaturase C18:1/C18:0	P	3.58	2.91	3.05	3.23	3.01	3.14	0.16	NS
	S	3.03	3.22	3.34	3.20	3.47	3.25		
	mean	3.30	3.07	3.19	3.22	3.24	3.20		
Δ5 desaturase C20:4/C20:3	P	4.55	2.39	1.84	1.86	1.93	2.13^{A}	0.12	NS
	S	6.37	4.14	2.13	2.48	2.15	3.34^{B}		
	mean	5.46^{C}	3.27^{BC}	1.99^{A}	2.17^{AB}	2.04^{AB}	2.74		

$^{aA,\cdots}$Within columns means bearing different superscripts differ significantly at: small letters – P<0.05; capitals – P<0.01. NS – non significant.

Activities of the elongase and Δ5 desaturase decreased during the growth of pigs from 0.58 to 0.54 (P<0.05) and from 5.46 to 2.04 (P<0.01), respectively (Tab. 7). However, activity of Δ9 desaturase stayed unchanged (on average 3.20). Estimated values of the Pearsons' correlation between intramuscular fat content in the MLD and the activity of investigated enzymes and the amount of fatty acids (Tab. 8) showed that the activity of elongase and Δ5 desaturase was negatively but the activity of the Δ9 desaturase was positively correlated with fatness of the muscle (r = -0.71 and -0.63 and 0.61, respectively, P<0.01). In the case of ratios of the main group of fatty acids it was detected that SFA and MUFA were positively, whereas PUFA and PUFA: SFA ratio were negatively related to IMF content (r = 0.90, 0.71 and -0.73 and -0.82, respectively, P<0.01). Although, those relations was only confirmed for animals of the synthetic line. Fatty acids content of both n-6 (C18:2) and n-3 (C18:3) groups were negatively related (P<0.01) to IMF content in the Pietrain as well as in the synthetic line of animals.

Our results indicated that the activity of the elongase and Δ5 desaturase depended on body mass/age of pigs. However, decreasing of their activity, when pigs were older/ heavier, showed that the rate of fatty acid metabolism is much faster in young than in older pigs. Thus, there is still lack of literature data about fatty acids metabolism in pigs during growth.

In both investigated genotypes of pigs a positive relation between body mass/age and carcass fatness was found. The Pearsons' correlations (established in our study) between intramuscular fat content and the activity of elongase, Δ5 and Δ9 desaturases, which influence metabolism and consequently the ratio of the main group of fatty acids in the muscle, was found only for animals of the synthetic line (fatter). The lack of Pearsons' correlation for the above mentioned factors in the Pietrain breed (leaner) indicates that the fat metabolism of such pigs, opposite to fatter genotype, is only inconsiderable/or not at all connected with fatness of the muscle as it increased only till approximately 90 kg body weight. It also indicates that changes in fat metabolism occur together with increasing body mass/age and consequently carcass fatness of such animals proceeds non-linearly and other type of regression should be used.

Therefore it seems that the activity of enzymes connected with fatty acids metabolism in IMF strongly influence the obtained result and should always be taken into consideration to avoid drawing false conclusions.

Our data indicate that changes in fat metabolism occur together with the increase of body mass/age and consequently carcass fatness of such animals proceeds non-linearly.

Our data indicate that the relationship between intramuscular fat in the MLD and the activity of enzymes (elongase, Δ5 and Δ9 desaturases) which influence metabolism and the ratio of the main group of fatty acids in the muscle was found only for fatter pigs.

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