Histological structure of the *musculus longissimus lumborum et thoracis* in pigs with the same ryanodine receptor genotype (CC) in relation to carcass indicators

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ABSTRACT: The aim of this study was to investigate the histological structure of the longissimus muscle in pigs in relation to carcass value indicators. A total number of 16 pigs of about 101.28 kg average live weight were used. The animals were raised at a Fattening and Carcass Value Experimental Station (FCVES) of Slovak University of Agriculture in Nitra in equal conditions, receiving a standard diet fortified with vitamin-mineral mixture, and they were slaughtered in an experimental abattoir of FCVES. Samples from the musculus longissimus lumborum et thoracisi (MLLT) for histological evaluation were taken within 30 minutes *post mortem*, immediately frozen in liquid nitrogen and stored at a temperature of –20°C. In the experimental abattoir of FCVES feeding indicators, and indicators of meat quality and carcass value were examined. Samples were processed histochemically and single types of muscle fibres were differentiated according to reactions on SDH on the basis of Vacek's (1974) method. Nikon microscopic system, Pixelink digital camera and LUCIA software for image analyses for the morphometric analysis of MLLT structure were used. The highest abundance of white and the lowest abundance of intermediate muscle fibres was obtained in the analyzed musculus longissimus lumborum et thoracisi of pigs. Red muscle fibre abundance was only slightly higher than intermediate muscle fibre abundance. Concerning the average muscle fibre diameter, the highest values in white and the lowest values in red muscle fibres were found. Positive correlations of white muscle fibre abundance with loin meat weight, thigh meat weight, carcass length, ribcase length, hot right half weight, valuable meatiness parts in kilograms, thigh weight, thigh percent in the half-carcass and MLLT area weight were obtained. In the case of all fat content and weight indicators negative correlations were obtained except loin fat weight. Red muscle fibre content showed positive correlations with shoulder fat weight, neck meat weight, neck fat weight, head weight, thigh fat weight, average backfat thickness and MLLT area. Correlation coefficients between white muscle fibre diameter and shoulder meat weight, thigh meat weight, carcass length, ribcase length showed weak positive correlations. An increase in the white muscle fibre diameter corresponds with an increase in loin meat weight, valuable meatiness parts in kg, valuable meatiness parts in percents, thigh weight, thigh percent in the half-carcass weight and MLLT area. Concerning the red muscle fibre diameter weak positive correlations were obtained in relation to neck meat weight, thigh meat weight, thigh weight and moderate positive correlations to shoulder meat weight, loin meat weight, valuable meatiness parts in kilograms and percents, thigh percent in half-carcass and MLLT area.

Keywords: pig; MLLT; muscle fibres; carcass value

The target of breeding programs in pig production is still to increase muscle mass on the animal body and in this way to improve the percentage of valuable meatiness parts, carcass yield and other indicators of carcass value. The most present constituents of muscle – muscle fibres participate

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in muscle mass production to the largest extent. Postnatal growth of skeletal muscle is mainly realized by an increase in the length and diameter of muscle fibres, but not, with some exceptions, by an increase in the muscle fibre number. Muscle fibre hyperplasia in mammals is mostly completed during gestation and fixed by about the time of birth, while many factors will affect the size of fibres postnatally (Rehfeldt et al., 1999).

Muscle fibres – having different morphological, contractile and metabolic characteristics, connective tissue, fat tissue, blood vessels and nerves are the main components of mammalian skeletal muscles. Different histochemical identification methods lead to non-identical classification of muscle fibre types. Guth and Samaha (1970) based their classification on actomyosin Ca^{2+} ATPase stability, after pre-incubation in acid or alkaline buffers, and divided muscle fibres into muscle fibres of type I (slow – red) and type II (fast – white). Three subclasses can be identified within type II in humans: II A, II B, and II C according to the ATPase reaction after acid pre-incubation. This method was adapted to different pig muscles by Suzuki and Cassens (1980) and three subtypes were also identified within myofibres of type I and II. Ashmore et al. (1972) classified muscle fibres to oxidative – β-red, oxido-glycolytic – α-red and glycolytic – α-white. Based on monoclonal antibodies that recognize specific myosin isoforms, muscle fibres are identified as type I (slow-twitch oxidative metabolism), type II B (fast-twitch glycolytic metabolism), type II X (fast-twitch intermediate metabolism).

The muscle fibre composition is affected by growth rate on the one hand and, on the other, it itself affects the carcass lean content. Moreover, it is specific of different pig breeds or lines (Klosowska et al., 1994; Larzul et al., 1997; Ruusunen and Poulanne, 1997). Intensive selection for lean muscle growth in pigs may have caused considerable changes in the fibre type composition. Thus in contemporary highly productive domestic pigs, compared with native breeds, one may observe a higher proportion of glycolytic fibres and an increase in the mean fibre diameter (Rahelič and Puac, 1981).

The aim of this study was to investigate the histological structure of the longissimus muscle – abundance of single types of muscle fibres, tissue and fat tissue content, average diameter of single types of muscle fibres – in relation to indicators of carcass value in pigs with CC RYR-1 genotype.

MATERIAL AND METHODS

Experimental animals

For histological evaluation of the *musculus longissimus lumborum et thoracis* (MLLT) in pigs a total number of 16 pigs (9 females and 7 castrated males) with the same ryanodine receptor genotype (CC) of about 101.28 kg average live weight were used. The animals were raised at a Fattening and Carcass Value Experimental Station (FCVES) of Slovak University of Agriculture in Nitra. Rearing and feeding conditions were equal for all animals.

Nutrition

The animals were fed pre- and after-weaning feedstuff (to 25 kg of BW), A-1 feedstuff (from 25 to 45 kg of BW) and VUL feedstuff (from 46 kg of BW to slaughter) fortified with vitamin-mineral mixture assigned for the production of complete feedstuff used in an intensive pre-feeding process.

Slaughtering, sample and data collecting

Animals were slaughtered in an experimental abattoir of FCVES after 24-hour starvation. Samples from the *musculus longissimus lumborum et thoracis* (MLLT) – a part of the *musculus longissimus dorsi* (MLD) were taken for histological evaluation within 30 minutes post mortem. Muscle samples (approximately 1 cm^3) were taken from the region between the 8th and 9th rib with a scalpel, immediately frozen in liquid nitrogen and stored until histochemical processing at a temperature of –20°C.

In the experimental abattoir of FCVES post mortem indicators of carcass value were examined.

Determination of ryanodine receptor genotype by PCR

A tissue sample 100–200 mg was lysed overnight in 150 µl K buffer (20mM Tris-HCl pH = 8.3, 1.5mM $MgCl_2$, 25mM KCl, 0.5% (v/v) Tween 20 supplemented with 1 mg/ml proteinase K at 58°C. Prior to the PCR reaction, proteinase K was heat

inactivated (95°C, 15 min) and the cell debris was removed by centrifugation (14 000 × g, 3 min). For the PCR reaction 1 µl of the supernatant containing approximately 50–100 ng DNA was used.

The PCR reaction was performed in a final volume of 25 µl with 1× PCR buffer, 0.2mM of each dNTP, 25 pmol of each primer and 1 U Platinum Taq DNA polymerase (Invitrogen). After an initial denaturation step (94°C, 2 min) PCR was carried out with 30 s denaturation step at 94°C, 30 s annealing at 63°C and 40 s polymerization at 72°C for 35 cycles in a PTC-200 (MJ Research). The PCR products were analysed in a 2% agarose gel stained with ethidium bromide (Zinovieva et al., 1996).

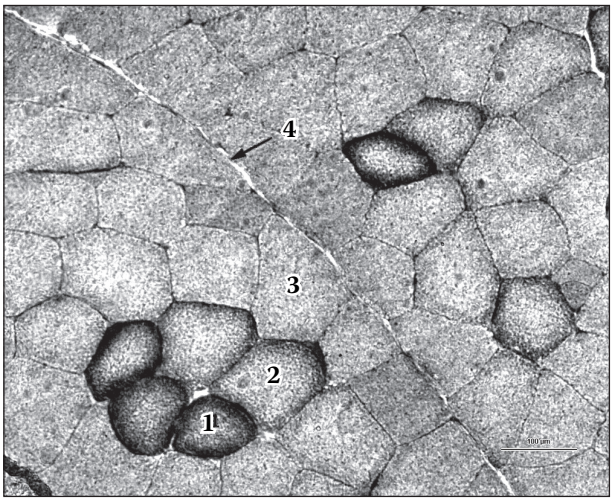

Figure 1. Histological structure of MLLT in pigs
1 – β-red fibre, 2 – α-red fibre, 3 – α-white fibre, 4 – connective tissue

Histological processing and evaluation of samples

Samples for histological evaluation were chopped into 10–15 µm thick slices on a Minicryostat MTC instrument at a temperature of –20°C. Sections were stained with oil-red to prove neutral lipids. Single types of muscle fibres were differentiated according to the reaction on succinate dehydrogenase (SDH) into three groups: white (αW), intermediate (αR) and red (βR) muscle fibres, on the basis of Vacek's (1974) method. Sections were evaluated subjectively and quantitatively. The percent abundance of muscle fibres, connective tissue and fat tissue and average thickness of single types of muscle fibres were evaluated by a microscopic system Nikon Eclipse E 600 and Pixelink (PL-A642) camera in connection with Lucia 4.8 software for image analyses. Basal statistical indicators and correlations were calculated from obtained data using Microsoft Office and Statgraphics statistical software.

RESULTS AND DISCUSSION

Histological structure of MLLT

Basic statistical indicators of the longissimus muscle structure in pigs are shown in Table 1. The highest abundance of white and the lowest abundance of intermediate muscle fibres (82.82 and 7.36%, respectively) were obtained in the analyzed musculus longissimus lumborum et thoracis of pigs. Red muscle fibre abundance (8.38%) was only slightly higher than intermediate muscle fibre abundance. Concerning the variability of muscle

Table 1. Basic statistical indicators of the longissimus muscle structure in pigs

Indicator	Muscle fibre abundance (%)			Connective tissue (%)	Fat tissue (%)	Muscle fibre diameter (µm)		
	αW	αR	βR			αW	αR	βR
$\bar{x}$	82.82	7.36	8.38	1.05	0.39	121.73	81.78	67.86
s	4.01	2.33	2.50	0.72	0.42	8.61	8.85	4.98
sx	1.00	0.58	0.62	0.18	0.11	2.15	2.21	1.24
Min.	72.12	4.44	4.04	0.00	0.00	104.16	67.80	58.61
Max.	87.47	13.74	13.94	2.83	1.41	135.40	101.67	81.14
V (%)	4.84	31.67	29.79	69.05	107.39	7.07	10.83	7.33

n = 16
αW = white muscle fibres; αR = intermediate muscle fibres; βR = red muscle fibres; $\bar{x}$ = mean; *s* = standard deviation; *sx* = standard mean error; min. = minimum; max. = maximum; *V* (%) = coefficient of variation; *n* = number of analyzed animals

Table 2. Basic statistical indicators of carcass value indicators (kg)

Indicator	Shoulder meat	Shoulder fat	Neck meat	Neck fat	Loin meat	Loin fat	Head	Cheek	Belly	Thigh meat	Thigh fat	Hind leg	Hind trotter
$\bar{x}$	4.19	1.24	3.27	0.80	4.46	1.66	2.04	1.28	7.75	7.88	2.01	1.29	0.37
s	0.35	0.21	0.14	0.15	0.25	0.53	0.12	0.14	0.37	0.73	0.42	0.07	0.03
sx	0.09	0.05	0.03	0.04	0.06	0.13	0.03	0.04	0.09	0.18	0.10	0.02	0.01
Min.	3.48	0.85	3.03	0.47	4.06	0.74	1.78	0.99	6.99	6.27	1.06	1.16	0.32
Max.	4.64	1.59	3.47	1.03	4.83	3.22	2.25	1.52	8.60	9.02	2.61	1.41	0.44
V (%)	8.37	16.97	4.28	18.65	5.51	31.94	5.95	11.27	4.73	9.30	20.74	5.21	8.56

n = 16

$\bar{x}$ = mean; s = standard deviation; sx = standard mean error; min. = minimum; max. = maximum; V (%) = coefficient of variation; n = number of analyzed animals

Table 3. Basic statistical indicators of carcass value indicators

Indicator	Fore trotter (kg)	Foreleg (kg)	Lard (kg)	Carcass length (cm)	Ribcase length (cm)	Hot right half weight (kg)	Right half weight after 24 h (kg)	Average backfat thickness (cm)	Valuable meatiness parts (kg)	Valuable meatiness parts (%)	Thigh weight (kg)	Thigh percent in half (%)	MLLT area (cm^2)
$\bar{x}$	0.31	0.79	0.61	97.72	78.59	40.56	40.00	1.88	19.99	49.79	7.99	19.93	40.76
s	0.02	0.10	0.20	2.32	2.54	0.96	0.98	0.39	1.19	3.11	0.71	1.74	5.04
sx	0.01	0.03	0.05	0.58	0.63	0.24	0.25	0.10	0.30	0.78	0.18	0.44	1.26
Min.	0.28	0.66	0.25	94.50	71.50	39.00	38.50	1.07	17.05	42.62	6.27	15.68	28.50
Max.	0.35	0.97	1.06	103.50	83.00	43.00	42.50	2.47	21.52	55.90	9.02	22.73	50.40
V (%)	6.85	12.86	32.30	2.38	3.23	2.38	2.46	20.93	5.96	6.25	8.86	8.73	12.36

n = 16

$\bar{x}$ = mean; s = standard deviation; sx = standard mean error; min. = minimum; max. = maximum; V (%) = coefficient of variation; n = number of analyzed animals

fibre abundance, the highest values in red and the lowest values in white muscle fibres were found. As for the connective and fat tissue, the highest values of connective tissue and the lowest values of fat tissue abundance were obtained. The highest abundance of white and the lowest abundance of intermediate muscle fibres in the longissimus muscle, similarly like in our study, were reported by Swatland and Cassens (1973), Uhrín et al. (1986a), Gentry et al. (2002) and Ruusunen et al. (2004), but they obtained higher red and intermediate muscle fibre and lower white muscle fibre abundance in comparison with our results. Klosowska et al. (2004) also obtained the highest values of white and the lowest values of intermediate muscle fibre content in the same muscle, with nearly the same values of intermediate and red muscle fibre content. In contrast with our results and results of the above-mentioned authors Fazarinc et al. (2002) reported the lowest abundance of not intermediate, but red muscle fibres. Different percentage abundance of single types of muscle fibres in MLLT confirmed the results of other authors: red muscle fibre abundance ranges from 7.6% (Bader, 1983) to 30.2% (Swatland and Cassens, 1973) while Dildey et al. (1970) reported 85.7% of white muscle fibres, Swatland and Cassens (1973) 52.9% only.

Concerning the average muscle fibre diameter in the musculus longissimus lumborum et thoracis of pigs, the highest values of white muscle fibre diameter and the lowest values of red muscle fibre diameter were obtained (121.73 μm and 67.86 μm, respectively) while the variability was nearly the same in both indicators. The same tendency of muscle fibre diameter in MLLT was reported by Lengerken et al. (1994), who observed nearly the same white muscle fibre diameter (119.99 μm), but the diameter of intermediate and red muscle fibres exceeded our results. Fiedler et al. (2003) observed the white muscle fibre diameter 61.5 μm, intermediate muscle fibre diameter 49.1 μm and red muscle fibre diameter 51.7 μm, with a considerable difference in the white muscle fibre diameter when compared with our results. Ruusunen et al. (2004) reported a higher white muscle fibre diameter (85.86 μm), but a lower intermediate and red muscle fibre diameter in MLLT (61.28 μm and 59.17 μm, respectively). Most thin red and most thick white muscle fibres were also reported by Kiessling et al. (1982), Uhrín et al. (1986b), Klosowska and Fiedler (2003) and Klosowska et al. (2005). Concerning the above-mentioned results it is necessary to emphasize that different pig breeds and sampling methods were used.

Relation between MLLT structure and indicators of carcass value

From the principles of skeletal muscle growth it becomes clear that growth depends on the number of prenatally formed fibres and on the degree of their postnatal hypertrophy. This has been confirmed by significant positive correlation coefficients of muscle mass or lean meat percentage with both the fibre number and size (Dietl et al., 1993; Henckel et al., 1997; Larzul et al., 1997).

In the present study we also investigated the relation between histological structure of MLLT and indicators of carcass value (Tables 2 and 3) using Pearson's correlation coefficients. Concerning the content of single types of muscle fibres in MLLT positive correlations of white muscle fibres with loin meat weight, cheek weight, belly weight, thigh meat weight, carcass length, ribcase length and hot right half weight were obtained. Positive correlations of white muscle fibre content were obtained in relation to valuable meatiness parts in kilograms, thigh weight, thigh percent in half-carcass and MLLT area. Negative correlations were obtained for all fat content and weight indicators except loin fat weight. Providing all of these indicators it was only a weak non-significant correlation except carcass length, which showed a moderate correlation (0.4382). Red muscle fibre content showed a positive correlation with shoulder fat weight, neck meat weight, neck fat weight, head weight, thigh fat weight, average backfat thickness and MLLT area, in the other indicators the correlations were negative. Providing of all indicators it was a weak non-significant correlation, expect carcass length, average backfat thickness (moderate non-significant correlation: –0.4542, 0.4661, respectively), and neck fat weight (moderate significant correlation: 0.5585^{+}). A significant moderately negative correlation was obtained between fat tissue abundance in MLLT and belly weight (-0.5762^{+}).

Pearson's correlation coefficients of white muscle fibre diameter showed weak positive correlations with shoulder meat weight, thigh meat weight, carcass length, ribcase length and moderate positive correlations with loin meat weight, valuable meatiness parts in kg, valuable meatiness parts in percents, thigh weight, thigh percent in the half-

Table 4. Correlations between MLD structure and indicators of carcass value

		Indicators of carcass value (kg)													
		shoulder meat	shoulder fat	neck meat	neck fat	loin meat	loin fat	head	cheek	belly	thigh meat	thigh fat	hind leg	hind trotter	fore trotter
Percentage abundance	Muscle fibre αW	−0.1671	−0.1902	−0.0549	−0.2856	0.2722	0.0181	−0.0429	0.1158	0.2786	0.1418	−0.0521	0.3536	0.1333	−0.1240
		0.5362	0.4805	0.8399	0.2835	0.3078	0.9471	0.8745	0.6693	0.2960	0.6003	0.8480	0.1790	0.6225	0.6473
	Muscle fibre αR	0.1734	0.3052	−0.1680	−0.1089	−0.3576	0.1337	0.0307	−0.0641	−0.2232	−0.2597	0.0142	−0.1467	0.0792	0.2832
		0.5207	0.2504	0.5341	0.6881	0.1739	0.6215	0.9100	0.8135	0.4060	0.3315	0.9585	0.5878	0.7707	0.2878
	Muscle fibre βR	−0.0146	0.0861	0.2589	0.5585*	−0.1388	−0.0369	0.1178	−0.0051	−0.0303	−0.0356	0.2098	−0.5014*	−0.2949	−0.0740
		0.9572	0.7513	0.3330	0.0245	0.6083	0.8921	0.6640	0.9850	0.9114	0.8958	0.4355	0.0479	0.2675	0.7853
	Connective tissue	0.2851	−0.1953	−0.0682	0.0504	0.0276	−0.2656	−0.1326	−0.4188	−0.3852	0.1162	−0.2347	0.1466	−0.0063	0.0471
		0.2845	0.4686	0.8019	0.8528	0.9191	0.3200	0.6245	0.1064	0.1407	0.6683	0.3816	0.5880	0.9814	0.8624
	Fat tissue	0.2237	−0.0536	0.0328	−0.0730	0.1640	−0.2350	−0.2337	0.0053	−0.5762*	0.0984	−0.4217	0.1688	0.0534	−0.0270
		0.4049	0.8436	0.9041	0.7881	0.5439	0.3809	0.3837	0.9845	0.0195	0.7168	0.1037	0.5319	0.8442	0.9209
Muscle fibre diameter (μm)	αW	0.3084	−0.2344	−0.0521	−0.3189	0.3308	−0.1994	−0.4978*	−0.4570	−0.2346	0.1794	−0.3486	0.0625	−0.1489	−0.2907
		0.2452	0.3822	0.8481	0.2286	0.2108	0.4590	0.0497	0.0751	0.3818	0.5061	0.1857	0.8180	0.5822	0.2747
	αR	0.3964	0.1311	0.0905	0.0789	0.0681	−0.2212	−0.5962*	−0.3345	−0.3843	−0.0129	−0.1636	0.0372	−0.0329	−0.2710
		0.1285	0.6285	0.7390	0.7716	0.8021	0.4103	0.0148	0.2055	0.1416	0.9623	0.5449	0.8912	0.9038	0.3099
	βR	0.3805	−0.2007	0.2303	−0.1831	0.3430	−0.4068	−0.1034	−0.3770	−0.3648	0.3014	−0.3125	−0.2102	−0.1802	−0.4544
		0.1459	0.4561	0.3908	0.4972	0.1934	0.1178	0.7032	0.1501	0.1647	0.2567	0.2386	0.4345	0.5042	0.0770

*$P < 0.05$;

P = difference significant at the level α = 0.05, α = 0.01, β or α = 0.001

Table 5. Correlations between MLLT structure and indicators of carcass value

		Indicators of carcass value											
		foreleg (kg)	lard (kg)	carcass length (kg)	ribcase length (kg)	hot right half weight (kg)	right half weight after 24 h (kg)	average backfat thickness (cm)	valuable meatiness parts (kg)	valuable meatiness parts (%)	thigh weight (kg)	thigh percent from half (%)	MLLT area (cm^2)
Percentage abundance	Muscle fibre αW	0.3715	0.1600	0.4382	0.1770	0.2507	0.2760	−0.2499	0.0774	−0.0347	0.1402	0.0352	0.1528
		0.1565	0.5538	0.0896	0.5119	0.3489	0.3007	0.3507	0.7757	0.8986	0.6046	0.8971	0.5721
	Muscle fibre αR	0.0728	−0.0865	−0.2300	−0.0634	−0.2327	−0.2225	0.0539	−0.2679	−0.1351	−0.3406	−0.2290	−0.4670
		0.7886	0.7501	0.3914	0.8156	0.3857	0.4076	0.8428	0.3158	0.6180	0.1968	0.3936	0.0682
	Muscle fibre βR	−0.5067*	−0.0934	−0.4542	−0.2915	−0.0417	−0.0669	0.4661	−0.0568	−0.0290	−0.0729	−0.0379	0.1228
		0.0452	0.7308	0.0772	0.2733	0.8783	0.8055	0.0688	0.8346	0.9151	0.7884	0.8893	0.6505
	Connective tissue	−0.3047	−0.1005	−0.1613	0.0309	−0.2640	−0.3143	−0.2722	0.4354	0.4581	0.4145	0.4514	0.2466
		0.2512	0.7111	0.5507	0.9095	0.3232	0.2358	0.3078	0.0919	0.0743	0.1104	0.0793	0.3572
	Fat tissue	−0.4114	−0.3173	0.0741	0.3426	−0.3975	−0.4579	−0.2145	0.3347	0.4619	0.2724	0.3824	−0.0251
		0.1134	0.2312	0.7851	0.1940	0.1274	0.0745	0.4249	0.2052	0.0717	0.3074	0.1438	0.9266
Muscle fibre diameter (μm)	αW	0.0497	−0.1342	0.0191	0.1403	−0.1409	−0.1925	−0.4662	0.4155	0.4278	0.3465	0.3506	0.4035
		0.8551	0.6203	0.9441	0.6043	0.6028	0.4750	0.0687	0.1095	0.0983	0.1885	0.1831	0.1212
	αR	−0.1015	−0.2074	−0.0524	0.0757	−0.2327	−0.3388	−0.1208	0.2537	0.3368	0.1047	0.1690	0.0031
		0.7083	0.4408	0.8473	0.7806	0.3859	0.1992	0.6559	0.3430	0.2021	0.6996	0.5314	0.9908
	βR	−0.3290	−0.3928	−0.1639	−0.1638	−0.1850	−0.2770	−0.2069	0.3790	0.4758	0.2958	0.3800	0.4067
		0.2135	0.1323	0.5441	0.5445	0.4927	0.2989	0.4420	0.1477	0.0625	0.2661	0.1466	0.1180

*$P < 0.05$

P = difference significant at the level α = 0.05, α = 0.01, or βα = 0.001

carcass weight and MLLT area. In relation to the other indicators of carcass value weak negative correlations were obtained, except head weight (–0.4978^{+}), cheek weight, thigh fat weight and average backfat thickness. Concerning the red muscle fibre diameter weak positive correlations were obtained in relation to neck meat weight, thigh meat weight, thigh weight and moderate positive correlations to shoulder meat weight, loin meat weight, valuable meatiness parts in kilograms and percents, thigh percent in half-carcass and MLLT area. In the other indicators negative correlations were obtained. Correlations between MLLT structure and indicators of carcass value are shown in Tables 4 and 5.

Larzul et al. (1997) reported a significant negative correlation between white fibre percentage and lean percentage, which is in contradiction with the well-accepted idea that lean content and percentage of white fibres are positively related. The above-mentioned authors observed that the loin area was positively related to mean fibre diameter, whereas average backfat thickness was negatively related, which is in agreement with our results. Positive correlations between fibre diameters and lean percentage were also reported by Lengerken et al. (1994). Significant positive correlation coefficients of muscle mass or lean meat percentage with both fibre number and size were reported by Staun (1972).

CONCLUSIONS

The highest abundance of white and lowest abundance of intermediate muscle fibres in the musculus longissimus lumborum et thoracis of pigs were obtained. Red muscle fibre abundance was only slightly higher than intermediate muscle fibre abundance. Concerning the average muscle fibre diameter, the highest values in white and the lowest values in red muscle fibres were found. Positive correlations of white muscle fibres with loin meat weight, thigh meat weight, carcass length, ribcase length, hot right half weight, valuable meatiness parts in kilograms, thigh weight, thigh percent in half-carcass and MLLT area were observed. In relation to white muscle fibre diameter the same tendency of correlations was detected. These correlations indicate that with an increase in white muscle fibre abundance in the longissimus muscle of pigs there is an increase in weight and percent of valuable meatiness parts in carcass. Our results of the highest percent abundance of white muscle fibres with the above-mentioned correlations confirmed the uppermost share of white muscle fibres in muscle mass formation in domestic pigs and the effect of intensive selection on muscle fibre distribution in muscles. On the other hand, positive correlations of red muscle fibre content with shoulder fat weight, neck fat weight, thigh fat weight and average backfat thickness proved increased fat content in the carcass of animals with higher abundance of red muscle fibres in their muscles.

REFERENCES

Ashmore C.R., Tompkins G., Doerr L. (1972): Postnatal development of muscle fibre types in domestic animals. J. Anim. Sci., 34, 1, 37–41.

Bader R. (1983): Vergeleichende histometrische und histologische Untersuchungen an der Skelettmuskulatur von Wild- und Hausschweinen. Berl. Münch. Tierärztl. Wschr., 96, 89–97.

Dietl G., Groenveld E., Fiedler I. (1993): Genetic parameters of muscle structure traits in pig. In: Proc. 44th Ann. Meet. EAAP, Vol. IIp. 18 Aahus, Denmark. 30, 157–184.

Dildey D.D., Aberle E.D., Forrest J.C., Judge M.D. (1970): Porcine muscularity and properties associated with pale, soft, exudative muscle. J. Anim. Sci., 31, 681–685.

Fazarinc G., Čandek P.M., Uršič M., Vrecl M., Pogačnik A. (2002): Giant muscle fibres in pigs with different Ryr1 genotype. Anat. Histol. Embryol., 31, 367–371.
Fiedler I., Nurnberg K., Hardge T., Nurnberg G., Ender K. (2003): Phenotypic variation of muscle fibre and intramuscular fat traits in Longissimus muscle in F2 population Duroc × Berlin miniature pig and relationship to meat quality. Meat Sci., 63, 131–139.

Gentry J.G., McGlone J.J., Blanton J.R. Jr., Miller M.F. (2002): Impact of spontaneous exercise on performance, meat quality, and muscle fibre characteristics of growing/finishing pigs. J. Anim. Sci., 80, 2833–2839.
Guth L., Samaha F.J. (1970): Procedure for the histochemical demonstration of actomyosin ATPase. Exp. Neurol., 28, 365–367.

Henckel P., Oksjberg N., Erlendsen E., Barton-Gade P., Bejerholm C. (1997): Histo- and histochemical characteristics of the longissimus dorsi muscle in pigs and their relationship to performance and meat quality. Meat Sci., 47, 311–321.

Kiessling K.H., Lundström K., Petersson H., Stalhammar H. (1982): Age and feed related changes of fibre composition in pig muscle. Swed. J. Agric. Res., 12, 69–75.

Klosowska D., Fiedler I. (2003): Muscle fibre types in pigs of different genotypes in relation to meat quality. Anim. Sci. Pap. Rep., 21, 49–60.

Klosowska D., Klosowski B., Kapelańsky W., Wegner J. (1994): Muscle composition and fibre characteristics in *m. longissimus lumborum* of the pigs different breeds. In: Proc. 2nd Int. Conf. The Influence of Genetic and non Genetic Traits on Carcass and Meat Quality, 218–223.

Klosowska D., Kuryl J., Elminowska-Wenda G., Kapelański W., Walasik K., Pierzchala M., Cieślak D., Bogucka J. (2004): A relationship between the PCR-RFLP polymorphism in porcine MYOG, MYOD1 and MYF5 genes, and microstructural characteristics of m. longissimus lumborum in Pietrain × (Polish Large White × Polish Landrace) crosses. Czech J. Anim. Sci., 49, 99–107.

Klosowska D., Kuryl J., Elminowska-Wenda G., Kapelanski W., Walasik K., Pierzchala M., Cieslak D., Bogucka J. (2005): An association between genotypes at the porcine loci MSTN (GDF8) and CAST and microstructural characteristics of *m. longissimus lumborum.* A preliminary study. Arch. Tierz., Dummerstorf, 48, 50–59.

Larzul C., Lefaucheur L., Ecolan P., Gogue J., Talmant A., Sellier P., Le Roy P., Monin G. (1997): Phenotipic and genetic parameters for longissimus muscle fibre characteristics in relation to growth, carcass and meat quality traits in Large White pigs. J. Anim. Sci., 75, 3126–3137.

Lengerken Von G., Maak S., Wicke M., Fiedler I., Ender K. (1994): Suitability of structural and functional traits of skeletal muscle for the genetic improvement of meat quality in pigs. Arch. Tierz. Dummerstorf, 37, 133–134.

Rahelič S., Puac S. (1981): Fibre types in longissimus dorsi from wild and highly selected pig breeds. Meat Sci., 5, 439–450.

Rehfeldt CH., Stickland N.C., Fiedler I., Wegner J. (1999): Environmental and genetic factors as sources of variation in skeletal muscle fibre number. Basic Appl. Myol., 9, 235–253.

Ruusunen M., Puolanne E. (1997): Comparison of histochemical properties of different pig breeds. Meat Sci., 45, 119–125.

Ruusunen M., Puolanne E. (2004): Histochemical properties of fibre types in muscles of wild and domestic pigs and the effect of growth rate on muscle fibre properties. Meat Sci., 67, 533–539.

Staun H. (1972): The nutritional and genetic influence on number and size of muscle fibres and their response to carcass quality in pigs. World Rev. Anim. Prod., 3, 18–26.

Suzuki A., Cassens R.G. (1980): A histochemical study of myofibre type in muscle of the growing pig. J. Anim. Sci., 51, 1449–1461.

Swatland H.J., Cassens R.G. (1973): Observation on the post mortem histo-chemistry of myofibres from stress-susceptible pigs. J. Anim. Sci., 37, 885–891.

Uhrín V., Kulíšková Ľ., Bulla J., Poltársky J. (1986a): Histochemická analýza niektorých svalov finálnych hybridov ošípaných. Živoč. Výr., 31, 1065–1074.

Uhrín V., Kulíšková Ľ., Poltársky J., Bulla J. (1986b): Mikroskopická stavba niektorých svalov ošípaných zaradených do hybridizačného pokusu. Živoč. Výr., 31, 839–847.

Vacek Z. (1974): Histológia a histologická technika. Osveta, Martin. 387 pp.

Zinovieva N., Vašíček D., Aigner B., Müller M., Brem G. (1996): Single tube allele specific (STAS) PCR for direct determination of the mutation in the porcine ryanodine receptor gene associated with malignant hyperthermia. Anim. Biotech., 7, 173–177.

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