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Effect of carcass muscling on culinary and technological pork properties in fatteners of three genetic groups*

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The aim of the study was to estimate the influence of genetic group and meat deposition in pigs imported from Denmark on culinary and technological value of pork, The investigations were conducted on 238 fatteners of three genetic groups: Landrace (group I, n=55), Landrace × Duroc (group II, n=140) and Landrace × Yorkshire (group III, n=43). The mean lean meat content of carcass reached 56.01 ±2.13 at hot carcass weight of 85.3 ±7.68 kg. No quality defects of pork were found. Culinary and technological value of meat from all three groups were found high, while fatteners from group III exhibited slightly lower culinary value. There were noted unprofitable changes in intramuscular fat content, drip loss at 144 h and drip loss from 48h to 96h *post mortem* (storage temp 4°C) accompanying the increase in meat content of carcass. Effect of interaction, genetic group × sex was not found significant on analysed traits of culinary and technological value of pork.

KEY WORDS: fatteners / meat culinary value / meat technological value / pork

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Growing competition on the meat market makes quality control of final product increasingly important [Carden 2000, Koćwin-Podsiadła *et al*. 2001]. Simultaneously, the choice of the product by the consumer is related to its apperance. So, the control of the technology process conditions connected with a gain of the meat, both culinary as processing, demands the proper raw materials base.

The aim of the present work was to estimate the influence of genetic group and meat deposition rate in pigs imported from Denmark on culinary and technological properties of their meat.

Material and methods

The investigations were conducted on 238 fatteners of three genetic groups: Landrace (n=55), Landrace × Duroc (n=140) and Landrace × Yorkshire (n=43) imported from Danmark and kept in Jagodne farm. Analysed material was equalized under the environmental, feeding and slaughtering conditions. Pigs were slaughtered at Sokołów meat processing plant in autumn and winter season (IX-III) using the electrical stunning method (250V for 2.5 s) and recumbent bleeding out. Each genetic group was divided into two subgroups differing in the lean meat content of carcass: I subgroup – 50.1-55% and II subgroup – 55.1-60%. Lean meat content was estimated according to the standard procedure used in Polish Pig Testing Stations (SKURTCh) – Różycki [1996].

The culinary (protein and intramuscular fat content; tenderness; meat lightness; drip loss) and technological (protein content; cooking loss; technological yield in the cured thermal meat processing – TY, water holding capacity – WHC, $pH_{24;}$ electrical conductivity (EC) in 120 min. and 24 h and change of dynamics of pH (35 min-144 h), and drip loss (24-144 h)] properties of meat were estimated. The pH and EC were determined direct in the LL tissue, while the other parametres in LL samples. The pH values were recorded immediately in muscle tissue (35 min, 24, 48, 96 and 144 h *post mortem*) using pH-meter MASTER Dramiński firm. The electrical conductivity (EC) was estimated using conductometer LF-Star Matthaüs 120 min and 24h after slaughter. The lightness of muscle tissue (L*) was determined using Minolta CR310 apparatus 24 h *post mortem*. WHC was defined according to Grau and Hamm [1952] method in modification by Pohja and Ninivaara [1957] (24 h), drip loss according to Prange *et al.* [1977], 48, 96 and 144 h *post mortem*, and TY as RTN – by Naveau *et al*. [1985] in own modification for meat market conditions (thermal processing – 72°C in geometrical centre) in 24 h after slaughter.

The tenderness determined as share force (N/cm^2) was carried out instrumentally with Warner-Bratzler countershaft using Instron 1140 apparatus, 144 h *post mortem*. The total protein content was estimated with Kjeldahl method according to Polish Standard PN-73/A-82110, and intramuscular fat content with Soxhlet method according to PN-73/A-82111. To determine the cooking loss, 50 g sample of LL muscle was subjected to heating in water (100°C for 10 min.).

The terminal values of pH_1, pH_{24} and meat lightness (L*) accepted by Joo [1995] and Koćwin-Podsiadła *et al*. [1998] served to determine the frequency of PSE, DFD and acid meat.

The results were analysed using two-way (genetic group and meat content of carcass) analysis of variance in non-orthogonal scheme. The significance of differences between means were evaluated with NIR test [Ruszczyc 1981].

Results and discussion

Means obtained in this work independently of genetic group and lean meat content are typical for normal meat. No meat was found with known quality defect.

The overall mean lean meat content of carcass was 56.01 ±2.13%, while hot carcass weight was 85.33 ±7.68 kg (Tab. 1).

The analysis of variance showed the effect of genetic group on pH recorded 24 h *post mortem,* electrical conductivity (EC) measured 120 minutes and 24 h, meat lightness (L*), protein and intramuscular fat content, RTN, WHC, drip loss at 144 h, dynamics of pH (35 min-24 h and 35 min-96 h), EC (120 min-3 h) and drip loss changes (24-144 h) – at $P<0.001$ while share force and dynamics of pH (35 min-48 h) and EC (120 min –24 h) at $P<0.005$. The effect of lean meat content of carcass was showed for intramuscular fat content, drip loss at 144 h and dynamics of drip loss changes (24-96 h) at $P<0.05$). Effect of interaction genetic group x sex on traits analysed was not found significant.

The meat of fatteners Landrace × Yorkshire was less profitable in terms of culinary value (lowest intramuscular fat content – 1.09 ±0.52%, highest meat lightness – 55.08 ±2.72 and highest, but not significantly, drip loss at 48 h – 7.23 ±2.25%). However, the highest and similar to that of Landrace protein content – 22.57 and 22.54% – and largest technological yield TY – 104.42 and 103.32%, respectively, allow to anticipate the use of this meat for processing.

Similar results for protein and intramuscular fat content have been reported by Lee *et al.* [2002] who studied five genetic lines (Landrace, Yorkshire, Duroc, Landrace × Yorkshire and [(Landrace × Yorkshire) × Duroc)]. In their work, the crossbreeds of Landrace × Yorkshire (L×Y) showed the highest protein (22.9%) and lowest intramuscular fat content (1.1%). It seems interesting that intramuscular fat content for L×Y fatteners was similar to that of Yorkshires. Too low intramuscular fat content in crossbreeds L×Y showed in the present study (and according to Woods' *et al*. [1994] unacceptable to consumer) probably is the result of Yorkshire line. Proof at this can be obtained by above-mentioned Lee *et al* [2002] who reported significant ($P<0.05$) difference between Landrace and Yorkshire fatteners in intramuscular fat content (1.7 *vs* 1.1%).

Interesting seem results dealing with technological properties of meat expressed by technological yield in the cured thermal meat processing (TY). It was particularly shown in two genetic groups, *i. e*. Landrace and Landrace × Yorkshire crosses (slightly above 103 and 104% respectively).

For the most of traits considered the analysis of variance did not show the significant effect of lean meat content of carcass on culinary and technological properties of meat.

Table 1 The effect of genetic group and meat content of carcass on selected culinary and technological traits of pork

Item		Genetic group L, meat content class 50.1–55 (n=21)	L, 55.1–60 (n=41)	L × D, 50.1–55 (n=18)	L × D, 55.1–60 (n=104)	L × Y, 50.1–55 (n=30)	L × Y, 55.1–60 (n=31)	total, 50.1–55 (n=70)	total, 55.1–60 (n=164)	Infl. of genetic group P_{emp}	Infl. of meat content P_{emp}	Interaction P_{emp}
Hot carcass weight (kg)	mean	86.60	85.47	84.91	84.51	89.21	85.41	86.41	84.88	1.79	1.00	0.71
	SD	7.15	7.77	7.97	9.91	7.79	4.57	6.41	8.17	ns	ns	ns
	total	85.72|7.61		84.61|8.40		87.11|4.32		85.71|7.68				
Meat content in carcass (%)	mean	53.94	56.91	53.61	57.19	53.19	57.09	53.78^a	57.10^B	1.00	116.7	0.48
	SD	1.58	1.16	1.06	1.16	1.40	1.25	1.26	1.29	ns	**	ns
	total	56.06|1.08		56.33|1.64		55.38|1.16		56.01|1.17				
Culinary traits												
Protein content (%)	mean	23.61	23.53	23.33	23.08	23.61	23.56	23.31	23.19	5.10	0.74	0.01
	SD	0.75	0.50	0.49	0.57	0.33	0.46	0.47	0.58	**	ns	ns
	total	23.54^B|0.47		23.12^A|0.55		23.57^B|0.39		23.33|0.55				
Intramuscular fat content (%)	mean	1.66	1.51	1.86	1.80	1.16	1.05	1.80^a	1.68^b	9.80	5.74	1.79
	SD	0.66	0.64	0.68	0.56	0.71	0.71	0.74	0.60	**	*	ns
	total	1.65^B|0.73		1.83^B|0.59		1.09^A|0.51		1.71|0.64				
Shear force 144 h (N/cm²)	mean	16.46	47.14	15.04	16.01	18.07	40.89	16.41	40.01	3.15	3.74	1.05
	SD	7.82	11.41	5.09	5.97	2.71	7.79	4.45	9.19	*	ns	ns
	total	45.81^b|11.41		15.84^a|15.76		19.95^a|16.51		19.29|8.61				
Meat lightness (L*)	mean	53.80	53.99	53.75	53.51	54.89	56.25	53.70	53.88	5.46	1.54	0.44
	SD	3.20	3.14	3.33	3.61	3.61	3.86	3.11	3.87	**	ns	ns
	total	53.74^a|3.16		53.48^a|3.78		54.08^B|3.72		53.81|3.91				
Drip loss 48 h (%)	mean	6.69	6.71	6.34	6.50	6.67	7.71	6.44	6.61	1.66	0.54	0.80
	SD	1.57	1.86	3.61	1.90	1.91	3.44	3.18	3.64	ns	ns	ns
	total	6.79|1.79		6.41|1.81		7.31|3.25		6.56|1.51				
Drip loss 144 h (%)	mean	11.72	12.80	17.68	15.77	11.81	12.53	12.18^a	17.68^b	17.78	6.61	0.34
	SD	3.45	3.71	3.87	3.16	3.74	3.77	3.23	3.33	**	*	ns
	total	12.36^A|3.89		15.08^B|3.47		12.34^A|3.75		13.19|3.39				

Table 1 Continued

Item		Genetic group: L, meatiness class 50.1-55 (n=11)	L, 55.1-60 (n=41)	L x D, meatiness class 50.1-55 (n=18)	L x D, 55.1-60 (n=101)	L x Y, meatiness class 50.1-55 (n=10)	L x Y, 55.1-60 (n=11)	Total, meatiness class 50.1-55 (n=70)	Total, 55.1-60 (n=68)	Infl. of genetic group P_{exp}	Infl. of meatiness P_{exp}	Interaction P_{exp}
						Technological traits						
Protein content (%)	mean	11.61	11.51	11.11	11.08	11.61	11.55	11.11	11.19	5.10	0.14	0.01
	SD	0.15	0.50	0.49	0.57	0.11	0.46	0.47	0.58	**	ns	ns
	total	11.54^B / 0.47		11.11^A / 0.55		11.57^B / 0.19		11.11 / 0.55				
pH45	mean	5.56	5.51	5.59	5.57	5.51	5.54	5.57	5.55	5.57	1.44	0.59
	SD	0.08	0.07	0.11	0.09	0.11	0.17	0.1	0.09	**	ns	ns
	total	5.51^A / 0.08		5.58^B / 0.09		5.51^A / 0.11		5.56 / 0.10				
EC 120 min (mS/cm)	mean	1.47	1.96	1.58	1.55	1.94	1.17	1.16	1.59	5.68	1.01	1.11
	SD	0.46	1.04	1.05	0.81	0.54	0.54	0.89	0.85	**	ns	ns
	total	1.85^B / 0.96		1.56^B / 0.88		1.11^A / 0.56		1.51 / 0.87				
EC 24 h (mS/cm)	mean	1.91	1.71	1.05	1.16	1.10	1.41	1.17	1.46	5.10	0.11	0.81
	SD	0.97	1.04	0.97	0.91	1.44	1.08	1.15	0.98	**	ns	ns
	total	1.77^B / 1.01		1.18^A / 0.94		1.16^A / 1.15		1.41 / 1.04				
Cooking loss 48 h (%)	mean	18.06	19.77	14.81	18.84	11.51	19.01	17.90	19.17	1.61	0.11	1.41
	SD	0.81	5.45	6.50	6.05	5.10	1.55	6.10	5.10	ns	ns	ns
	total	19.55 / 5.11		18.11 / 6.11		19.86 / 1.70		18.88 / 5.44				
TY (%)	mean	104.61	101.96	101.16	100.91	105.44	101.51	101.01	101.79	8.11	1.40	0.46
	SD	4.44	1.87	6.89	5.97	7.18	1.69	5.94	5.08	**	ns	ns
	total	101.11^B / 1.10		101.00^A / 6.11		104.41^B / 1.05		101.16 / 5.17				
WHC (cm²)	mean	4.04	4.54	5.15	5.81	5.15	4.71	4.69	5.14	7.19	0.81	1.61
	SD	1.10	1.05	1.69	1.59	1.17	1.84	1.55	1.84	**	ns	ns
	total	4.17^A / 1.19		5.64^B / 1.64		4.91^A / 1.59		5.11 / 1.76				
					Dynamics of change in selected physico-chemical meat properties post mortem							
pH120/pH45	mean	1.14	1.05	0.97	0.99	1.17	1.17	1.06	1.01	11.07	1.14	1.17
	SD	0.17	0.19	0.11	0.10	0.19	0.11	0.11	0.10	**	ns	ns
	total	1.07^B / 0.19		0.99^A / 0.11		1.15^B / 0.10		1.01 / 0.11				

Table 1 Continued

Item		Genetic group								Int. of genetic group	Int. of neuroticism	Interaction
		L		L x D		L x Y		total				
		neuroticism class		neuroticism class		neuroticism class		neuroticism class				
		SD 1-55 (n=21)	56 1-60 (n=41)	SD 1-55 (n=18)	56 1-60 (n=10)	SD 1-55 (n=10)	56 1-60 (n=11)	SD 1-55 (n=70)	56 1-60 (n=68)	P_{emp}	P_{emp}	P_{emp}
pH45–pH24	mean	1.19	1.16	1.14	1.15	1.18	1.15	1.11	1.17	6.17	1.59	1.70
	SD	0.18	0.10	0.11	0.18	0.17	0.19	0.11	0.19	s	ns	ns
	total	1.19^b/0.11		1.15^c/0.19		1.16^b/0.18		1.18/0.10				
pH45–pH48	mean	1.71	1.18	1.11	1.08	1.18	1.15	1.11	1.15	11.70	7.60	0.81
	SD	0.18	0.11	0.15	0.10	0.18	0.10	0.11	0.11	ss	ns	ns
	total	1.21^a/0.11		1.09^d/0.11		1.16^a/0.19		1.17/0.11				
pH45–pH144	mean	1.11	1.11	1.11	1.09	1.11	1.18	1.19	1.11	1.47	1.89	0.76
	SD	0.16	0.11	0.19	0.18	0.16	0.10	0.10	0.10	ns	ns	ns
	total	1.17/0.11		1.10/0.18		1.19/0.18		1.14/0.10				
EC24–EC45	mean	-0.09	0.01	0.86	0.54	-0.11	-0.19	0.17	0.11	15.11	0.19	1.08
	SD	0.51	0.68	1.16	0.71	0.60	0.46	1.05	0.75	ss	ns	ns
	total	0.01^d/0.66		0.64^a/0.89		-0.11^d/0.51		0.34/0.86				
EC144–EC45	mean	-0.16	0.11	0.54	0.18	-0.16	-0.10	0.14	0.15	4.66	0.44	1.08
	SD	0.68	1.70	1.06	1.01	1.76	1.04	1.10	1.09	s	ns	ns
	total	0.11^cb/1.10		0.38^b/1.05		-0.11^c/1.19		0.15/1.11				
Drip loss 24 h – 96 h	mean	-1.49	-4.71	-4.81	-4.77	-3.65	-3.60	-3.85^c	-4.51^a	9.17	4.11	1.58
	SD	1.45	1.81	1.51	1.18	0.86	1.84	1.19	1.04	ss	s	ns
	total	-4.44^a/1.01		-4.78^a/1.18		-3.16^d/1.51		-4.11/1.14				
Drip loss 24 h – 144 h	mean	-5.01	-6.59	-7.11	-7.89	-4.88	-5.17	-5.44	-6.81	11.50	7.85	0.86
	SD	1.61	1.17	1.14	1.18	1.60	1.11	1.14	1.48	ss	ns	ns
	total	-6.15^d/1.11		-7.77^a/1.16		-5.01^c/1.99		-6.44/1.49				

a,d – within rows means bearing different superscripts differ significantly: small letters – $P \le 0.05$, capitals – $P \le 0.01$

Significant differences (P<0.05) between groups differing in meat content od carcass were noted only for three culinarily important traits, *i.e.* intramuscular fat content, drip loss at 144 h and dynamic changes of drip loss from 24 to 96 h *post mortem*. In fatteners with lean meat content ranging from 50.1 to 55% compared to those with 55.1 to 60%, a higher intramuscular fat content and smaller range of drip loss changes from 24 to 96 h *post mortem* occurred (1.80-3.85% and 1.68-4,53%, respectively). On the basis of reported in literature [De Vol *et al*. 1988, Wood *et al*. 1994, 1996, Baulian *et al*. 2000] positive relations between intramuscular fat content and sensory meat traits (flavour, tenderness, juiciness) it can be anticipated that sensory quality of meat of fatteners with 50.1-55% meat content (mean 53.38 ±1.26) will be higher than of those with meat per cent ranging from 55.1 to 60 (mean 57.10 ±1.29).

Summarizing, slightly worse meat culinary properties were found in Landrace × Yorkshire compared to Landrace or Landrace × Duroc crossbred pigs. Increase in lean meat content of carcass was accompanied by udesirable changes in intramuscular fat content, drip loss at 144 h and changes of drip loss from 24 h to 96 h *post mortem* (storage temp 4°C). In the investigated groups of pigs imported from Denmark (Landrace and its crosses with Duroc and Yorkshire breed) a high technological value of meat was found as expressed by high protein content of LL muscle – 22.22% – and especially high yield of cured meat in thermal processing (72°C in geometrical centre) – 102.16%.

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Oddziaływanie mięsności na wartość kulinarną i przetwórczą mięsa tuczników trzech grup genetycznych

S t r e s z c z e n i e

Celem pracy była analiza oddziaływania grupy genetycznej i mięsności świń ras importowanych z Danii na wartość kulinarną i przetwórczą mięsa wieprzowego. Badaniami objęto 238 tuczników trzech grup genetycznych: Landrace (n=55) Landrace × Duroc (n=140) oraz Landrace × Yorkshire (n=43) utrzymywanych w Ośrodku Hodowli Zarodowej Jagodne. Tuczniki charakteryzowały się średnią zawartością mięsa w tuszy równą 56,01 ±2,13% przy średniej masie tuszy ciepłej 85,33 ±7,68 kg. Wśród przebadanej populacji tuczników nie odnotowano ani jednego przypadku wystąpienia którejś ze znanych jakościowych wad mięsa. Przy stwierdzonej wysokiej wartości kulinarnej i przetwórczej mięsa badanych tuczników Landrace i mieszańców Landrace z rasą Duroc i Yorkshire, nieznacznie mniej korzystne parametry odnotowano w przypadku wartości kulinarnej mięsa tuczników Landrace × Yorkshire. Wzrost mięsności tusz niekorzystnie oddziaływał na poziom tłuszczu śródmięśniowego oraz wyciek soku mięsnego w 144 godzinie, a także na wyciek w czasie przechowywania mięśni LD w temp. 4°C w okresie od 28 do 96 godzin *post mortem.* Nie odnotowano wpływu współdziałania badanych czynników (grupy genetycznej i płci) na żadną z analizowanych cech wartości kulinarnej i przetwórczej mięsa wieprzowego.