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The Ratio of Qualitative Indicators of Pork With lipid Metabolism in Pigs of Different Breeds.

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ABSTRACT

Animals of five breeds of pigs were evaluated: Large White (LW), Duroc (D), Landrace (L), Kemerovo (K), and Pietren (P) for quality of carcasses, organoleptic indicators of meat and fat, fatty acid composition, lipid peroxidation (LPO), and antioxidant status of tissues. The P-pigs (i.e. Pietren) had a significantly larger ($p < 0.01$) cross-sectional area of the longest muscle in the back (51.7 cm2 versus 28.5-39.1 in other breeds, and the thickness of the spinal fat was less (21.1 mm vs. 28.5-35.1) ($p<0.05$.) In L-pigs, a low level of intramuscular fat (IF) was observed in the longest muscle of the back (1.8±0.28%) against 4.9 ± 1.36% for the K-pigs. Organoleptic parameters of meat and fat quality in the K-pigs were significantly better than in pigs of the following breeds: P ($p < 0.05$), LW ($p < 0.01$), and L ($p < 0.05$). Muscular tissue of pigs of the P breed had a higher level of monounsaturated fatty acids (MUFA) in comparison with pigs of the D breed, 52,5% and 49,2% accordingly ($p<0.05$). The D breed was significantly different from the breeds LW, L, and K in terms of having the smallest palmitic acid in the IF ($p < 0.05$). The most resistant to oxidation of lipoproteins of low protein (LLP) were the P-pigs. For them, the level of oxidation after 30 minutes was equal to 3.9 nmol MDA/mg protein, which was less than the WL-pigs (7.1, $p < 0.05$) and D-pigs (9, $p < 0.01$) had. In the blood serum of the P-pigs, a lower level of antioxidants was observed, namely β-carotene and xanthophylls. The level of antioxidants retinol and tocopherol in the LLP of the P-pigs was, on the contrary, higher than in other breeds ($p < 0.05$).

Keywords: pig breeds, meat, fat, taste, fatty acids, lipoproteins.

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INTRODUCTION

Pig breeding is one of the most important sources of income of fats in the diet. Over the past 30 years, medicine has been dominated by a concept based on limiting fat consumption, especially saturated animal fats, which was based on a direct relationship between the amount of saturated fat and cholesterol in the diet and the incidence of coronary heart disease [1, 2, 3]. It is known that fat contains a lot (about 40%) of saturated fatty acids; therefore, breeds of pigs with a low fat content in carcasses and a reduced amount of saturated fatty acids have been created. However, recent scientific studies have shown that the harm of saturated fats is greatly exaggerated [4]. No evidence has been found that a diet of people with a low content of saturated fat prolongs life [5]. Therefore, first of all, you need to know the characteristics of the products, which gives pig production, especially, the characteristics of lipid metabolism in animals, and what factors affect it.

PROBLEM STATEMENT

The production of pork of the desired quality (that it is not only tasty, but also useful) does not shorten the life span and largely depends on the breeds of animals. Since the lard and meat of pigs are one of the main sources of saturated fatty acids in people's diet, the study of the quality of intramuscular fat (IF) and spinal fat of pigs of different breeds is of particular importance. It is necessary to know the positive and negative qualities of pork obtained from different, sometimes very different, breeds of pigs and to develop appropriate methods for breeding, feeding, and keeping animals so that the production of pigs is as good as possible for human health.

RESEARCH QUESTIONS

The quality of meat and fat, as well as the viability and productivity of farm animals, largely depends on the fat content of the muscles [6-8], the composition of fatty acids (FA), the rate of their free radical oxidation, the degree of oxidation-antioxidant processes occurring in their tissues [9,10]. For example, the oxidation rate of polyunsaturated fatty acids (PUFA) is 11 times for the oleic acid, 114 times for linoleic, and it is 200 times higher for the arachidonic acid than saturated fatty acid (SFA, or stearic acid) [11]. Unsaturated fatty acids can rapidly oxidize, leading to the formation of free radicals and peroxides, which are nonspecific toxic agents. Lipid peroxides stimulate the appearance of atherosclerotic lesions, which are aggravated by stress [12]. The greater the amount of unsaturated fatty acids is, the more intense the formation of peroxides is, especially in environments that are unusual for them (during acclimatization and periods of stress), which can lead to the depletion of energy reserves and the decrease in the survival rate of animals. The key role in this is played by the fatty acid composition of animal tissues and feed, consumed by animals, especially PUFA acids, lipid peroxidation products (LPO), and antioxidant systems (alpha-tocopherol, retinol, beta-carotene, etc.). This is well studied and used in medical practice, especially in cardiology [13].

PURPOSE OF THE RESEARCH

The purpose of this study was to evaluate a number of pigs from different breeds for the quality of meat and fat, the composition of the FA, the intensity of the LPO blood, and the antioxidant status in order to use these parameters in animal breeding and improve the quality of the products obtained, positively affecting the population's health, as well as to develop appropriate feeding and searching for genetic markers of the indicated traits.

MATERIALS AND METHODS

The study was carried out using 75 pigs of five different breeds: Large White (LW), Duroc (D), Landrace (L), Kemerovo (K), and Pietren (P). Each 15 pigs were bred on a large industrial farm. The animals were kept indoors and fed a standard diet intended for fattening, which corresponded to the norms of nutrition. Feeding animals of all breeds were kept together in pens with a floor area of 0.8 m^2 per pig. The LW, D, L, K, and P breeds reached the weight of 100 kg for 180, 178, 173, 183, and 174 days, respectively. Fifteen pigs from each breed (3 in each group) were clogged when they reached epy weight of 90 to 97 kg. The average weight of the LW, D, L, K, and P-pigs at slaughter was 96, 97, 90, 94 and 97 kg, respectively. The thickness of spinal bacillus was measured at the level of the sixth-seventh thoracic vertebrae, and the cross-sectional area of the longest muscle of the back (muscular ocellus, or MO) was measured at the level of the first lumbar vertebra. To compare the characteristics of different breeds, the data were recalculated to live weight of 100 kg using a regression

coefficient of 0.02 cm per 1 kg of live weight for the thickness of the dorsal fat, 0.1 cm^2 per 1 kg of weight for the muscle area. Samples of the longest back muscle and the spinal fat were taken for chemical analysis and tasting at the level of the lumbar vertebrae in the amount of 300-400 g from each carcass. Samples of the meat and lard for the study of the IF and FA chemical composition were taken at the level of 1-3 lumbar vertebrae. Blood samples were taken before slaughter from 3 castrated pigs from each group. Samples of blood serum (10 ml) were isolated and stored at -18°C.

The group of tasters consisted of 9 participants tasting the meat (from *longissimus dorsi m.*). And there were 14 participants for tasting the salted lard. The quality of the meat was assessed on a 9-point scale, where, for example, a taste with a score of 1 meant very bad, 2 – bad, 3 – unacceptable, 4 – tasteless, 5 – medium, 6 – not delicious, 7 – quite tasty, 8 – tasty, 9 – very tasty), including its appearance, flavor, taste, tenderness, and juiciness. The salted lard was evaluated on a 5-point scale, including appearance, tenderness, and taste. Tasting data (sensory evaluation) were used to calculate the average quality of the meat and lard.

Chemical analysis was also performed using *m. longissimus dorsi* at the level of the first to the seventh lumbar vertebrae. The fatty acid composition was determined by the lipid extraction with chloroform/methanol according to J. Folch [14]. The determination of the composition of the FA of the muscle tissue was carried out on a gas chromatograph HP 6890 (Hewlett Packard, Germany). The initial level of the lipid peroxidation (LP) of products in low-density lipoprotein (LDL), being isolated from resistance to serum and LDL oxidation *in vitro* during the oxidation of LDL with copper ions of 30 min, and the concentration of lipophilic antioxidants in LDL were performed in accordance with the method of Yu. I. Ragino and others [15, 16]. Serum LDls were obtained by precipitation with buffer heparin, being washed and dissolved in 1 M NaCl solution. The LDL protein concentration was determined by the Lowry's method; the concentration of alpha-tocopherol, retinol, beta-carotene, and xanthines was determined by fluorimetric methods.

Oxidative modification of LDL was carried out in isotonic NaCl containing Cu^{2+} ions at 37°C. The degree of oxidation of LDL was assessed by the fluorometric method for the concentration of one of the end products of lipid peroxidation, namely malonic dialdehyde (MDA), at the beginning (before incubation) and after 3, 6, 15 and, 30 minutes of incubation in a Versafluor spectrofluorimeter. The concentration of antioxidants, fat-soluble vitamins E and A was measured directly in the LDL and not in the serum, which allowed to have more accurate assessment of the oxidative-antioxidant system of LDL.

Later, with K- and P-pigs, a repeated experiment was conducted using the same technique, in which the slaughter and biochemical properties of blood, muscle, and fat were determined for 5 animals from each breed.

Statistical processing of the results was carried out by the application package “Statistica 6.1 for Windows.” The results are presented as mean values with their standard error (M±SE). Differences were considered statistically significant at $p \leq 0.05$. The calculations were performed using a single-factor analysis of variance by the criterion of a significantly significant difference according to Tukey. All data were tested for outliers using Tukey’s procedure. An F-protected Least Significant Difference test was also used.

RESULTS AND DISCUSSION

The qualitative characteristics of meat and fats of pigs of different breeds were evaluated (Table 1). There were significant differences between the breeds. The P breed differed from LW, L, D, and K, in particular it had the largest area of the muscular ocellus (51.7 ± 2.71 cm2 vs. 39.1 ± 0.45, 28.5 ± 005, 38.1 ± 1.65, and 36.0 ± 3.12 cm2, respectively ($p < 0.05$). Also, it had the smallest thickness of the fatback (21.3 ± 2.28 mm vs. 31.8 ± 1.06, 32.3 ± 4.31, 32.7 ± 2.25, and 38.4 ± 3.32 mm, respectively ($p<0.05$). The A breed had a significantly less level of the IF than in it was in the K breed (1.8 ± 0.28% and 4.9 ± 1.36%, respectively ($p < 0.05$).

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Table 1: Indicators of quality of carcasses and meat of pigs of different breeds, N = 15 pigs from each breed.

Breed	Thickness of fatback on 6-7 thoracic vertebrae, mm	The area of the muscular ocellus (longissimus dorsi muscle), cm^2	Intramuscular fat content (IF), %	Quality of meat, points	Quality of salted lard, points
Large white (LW)	31.8±1.06[a]	39.1±0.45[a]	4.0± 0.10[ab]	6.6±0.07[ab]	2.9±0.26[a]
Duroc (D)	32.7±2.25[a]	28.5±0.05[b]	4.3± 0.15[ab]	6.5±0.11[ab]	3.2± 0.19[ab]
Landras (L)	32.3±4.31[a]	38.1± 1.65[a]	1.8± 0.28[b]	6.0±0.34[a]	2.9± 0.21[a]
Kemerovo (K)	38.4±3.32[a]	36.0 ±3.12[a]	4.9 ±1.36[a]	7.2±0.10[b]	3.9± 0.15[b]
Pietren (P)	21.3±2.28[b]	51.7 ±2.71[c]	2.4± 0.94[ab]	6.8±0.10[ab]	2.4± 0.27[a]
F-statistic	4.7	17.5	3.0	3.8	8.6
P-value	0.02	<0.001	0.07	0.02	<0.001

[a,b,c] Superscripts within each column means values differ at (p<.05).

In the experiment, the IF tended to be higher in the K breed than in the P breed (4.9 ± 1.36% and 2.4 ± 0.94%, respectively), p>0.05. However, in an additional experiment with the K-pigs, the IF was significantly (p <0.001) more than in P-pigs (3.0 ± 0.34% vs. 0.7 ± 0.19%). Meat quality indices did not differ between these two breeds, the lard of K in comparison with the P breed received a higher score (3.9 ± 0.15 vs. 2.4 ± 0.27 out of 5 points for the P breed). The IF of the K breed was significantly larger than that of the L breed (4.9 ± 1.36% and 1.8 ± 0.28%, respectively, p <0.05.) In general, the P breed had the thinnest layer of fatback and a large area of the muscular ocellus if compared to other breeds. The K breed surpassed the A breed by the quality of meat, as well as the LW, L, and P breeds by the quality of its lard (p<0.05).

The K breed was better than all other breeds in terms of meat quality, which included average parameters of its appearance, flavor, taste, consistency, and juiciness (7.2 ± 0.10 out of 9 points, p <0.05). They also had better taste. The quality of salted lard was also higher (3.9 ± 0.15 out of 5 points) in the K breed (p <0.05), including appearance, tenderness, and taste. The L breed showed the lowest quality of meat (6.0 ± 0.34 points out of 9), and the P breed had the lowest quality of salted lard (2.4 ± 0.21 points out of 5).

The quality of meat and fat is largely due to the fatty-acid composition of these tissues, which is affected by the features of animal feed and their pedigree [17-21]. It is believed that a low IF content adversely affects the taste of pork [22]. However, this statement is not always confirmed in our studies. The K breed had a lot of IF in the meat and had a better taste than the L-type meat, which had less IF. More than that, the P-breed had a little of IF in the meat, but it did not taste like that of the LW and D-type meat, in which IF fat was higher. Interestingly, the salted lard of the K breed was much more delicious than the lard of P. This may be due to the much higher content of palmitic acid in fat of the K-pigs (25.6 ± 1.96%) than in the P breed (23.0 ± 0.59%). According to Cameron and Enser [23], the improvement in the taste of the products occurs as the concentration of monounsaturated fatty acids increases and the content of polyunsaturated fatty acids decreases. The composition of fatty acids (FA) is an important indicator of not only flavoring, but also of technological qualities of meat products. It influences the oxidative processes in the body of the animal, affects the melting temperature of fat and the duration of storage of products. For example, the melting point of the pig backfat of Irish breeds ranges from 29°C to 32°C compared to 38°C to 39°C of the Russian breeds, which have more palmitic and stearic FA and less of polyunsaturated FA [24, 25].

The composition of FA in IF of all species was identified (Table 2). No differences were found between the breeds in the total amount of MUFA and polyunsaturated fatty acids (PUFA). The P-type animals tended to have a lower content of unsaturated fatty acids (UFA) than those of D and K and were significantly inferior to the LW and L breeds. In a further experiment, P-pigs were also inferior to the K breed by the content of UFA in the IF (38.3 vs. 42.2%). Palmitic acid occupies the highest level in the IF in the K, LW, and L breeds (25.3 ± 0.05%, 24.5 ± 0.14, 25.3 ± 0.51, respectively, vs. 22.6 ± 0.94% in the P breed, p<0.05). In a further experiment, the superiority of the K breed over the P breed was preserved: 27.0 ± 0.90 vs. 23.5 ± 1.12% (p<0.05). The content of oleic acid was higher (p <0.05) in the P breed (49.6 ± 0.65) than it was in the D-pigs (46.0 ± 0.37).

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Table 2: Fatty acids of intramuscular fat (IF) of the pigs from different breeds.

Fatty acid	Breed					F-statistic	P-value
	Large White (LW)	Duroc (D)	Landras (L)	Kemerovo (K)	Pietren (П)		
Myristic $C_{14:0}$	0.8±0.07	0.9±0.02	1.0±0.02	1.0±0.03	0.9±0.14	1.02	0.45
Pentadecanoic $C_{15:0}$	0.0±0.00	0.02±0.02	0.02±0.02	0.01±0.01	0.0±0.00	-	-
Palmitic $C_{16:0}$	24.5±0.14^{a}	24.1±0,07^{ab}	25.3±0.51^{a}	25.3±0.05^{a}	22.6±0.94^{b}	4.80	0.02
Margaric $C_{17:0}$	0.4±0.11	0.4±0.06	0.4±0.05	0.3±0.02	0.5±0.06	1.12	0.40
Stearic $C_{18:0}$	14.9±1.48	14.5±0.37	14.1±0.57	13.4±1.01	13.5±0.51	0.62	0.65
Nondekanoic $C_{19:0}$	0.0±0.00	0.0±0.00	0.01±0.01	0.02±0.02	0.02±0.02	-	-
Arachinic $C_{20:0}$	0.1±0.05	0.1±0.01	0.1±0.01	0.1±0.02	0.1±0.05	1.24	0.37
Total SFA	40.7±1.53^{a}	40.1±0.32^{ab}	40.9±0.96^{a}	40.2±0.76^{ab}	37.6±0.9^{b}	2.83	0.08
Palmitoleic $C_{16:1}$	1.5±0.22	1.8±0.09	1.6±0.14	1.6±0.20	1.5±0.25	0.41	0.79
Geptadetsenoic $C_{17:1}$	0.3±0.06	0.3±0.10	0.2±0.01	0.2±0.10	0.4±0.09	0.83	0.54
Oleic $C_{18:1}$	46.4±2.90^{ab}	46.0±0.37^{a}	46.7±1.04^{ab}	46.7±0.94^{ab}	49.6±0.65^{b}	1.90	0.18
Gondoic $C_{20:1\ \omega9}$	1.2±0.12^{a}	1.1±0.03^{ab}	0.8±0.10^{b}	0.9±0.10^{ab}	1.0±0.11^{ab}	2.28	0.13
Total MUFA	49.4±3.06	49.2±0.53	49.3±1.15	49.4±0.79	52.5±1.04	1.56	0.26
Linoleic $C_{18:2\ \omega6}$	9.4±1.36	10.2±0.18	9.3±0.35	10.0±0.06	9.6±0.44	0.64	0.65
Eykozadienoic $C_{20:2\omega6}$	0.4±0.13	0.4±0.04	0.3±0.16	0.3±0.15	0.3±0.06	0.27	0.89
Arachidonic C20:4ω6	0.1±0.02	0.2±0.01	0.2±0.03	0.1±0.04	0.1±0.05	1.52	0.28
Total PUFA	9.9±1.51	10.8±0.21	9.8±0.47	10.3±0.15	9.9±0.51	0.54	0.70

$^{a–b}$ Within a row, least squares means (±SE) lacking a common superscript differ, $p<0.05$.

Studies of the FA composition in the eight main breeds of pigs, namely Yorkshire (Y), Duroc (D), Hampshire (D), Spotted (S), White Chester (WC), Polish-Chinese (PC), Berkshire (B), and Landrace (L), that was conducted in the United States [21] showed that the breed significantly affects the concentration of individual FAs and the total IF content. It is interesting to note that this study shows a high concentration of palmitic acid (C16:0) in the IF of the B breed if compared to other breeds. The same pattern is observed in pigs of the K breed in our studies, in the pedigree of which there is the B breed.

To assess the different breeds of pigs by the level of oxidative processes in the body, we measured the oxidative properties of the LDL blood (Table 3). We believe that oxidative processes in blood vessels can be used to judge the susceptibility to oxidation of muscles (meat and fat) in animals and its effect on the health of consumers of such products, since low-density cholesterol is atherogenic and leads to a number of cardiovascular diseases [26].

The main process of cellular oxidation of LDL in vivo occurs in the subendothelial wall of blood vessels (the fibrous wall of blood vessels, lymphatic vessels, and endocardium form thin elastic and collagen fibers) in the presence of reactive oxygen metabolites (ROM) and high concentrations of metal ions (Cu2+ и Fe2+). Oxidation of isolated LDL caused in vitro by copper ions creates an experimental copy of LDL oxidation in vivo and assesses how fast and significantly LDL can oxidize in the body, in the vascular wall. From Table 3 we see that the initial level of the lipid peroxidation of LDL in all breeds of animals was 2.19 nmol MDA/mg of the LDL protein. Also, the LDL resistance to copper ions decreased for 30 minutes, but it was differently for different breeds of pigs.

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Table 3: Characteristics of LDL in the pigs of different breeds.

Breed	Initial level of lipid peroxidation of LDL	The level of *nmol* MDA/*mg* of the LDL protein through:			
		3 min	6 min	15 min	30 min
White Large (WL)	3.5±1.09	4.3±0.42^{ab}	5.5±0.52^{b}	6.59±0.31^{ab}	7.1±0.89^{a}
Duroc (D)	2.3±0.76	7.6±2.91^{a}	8.7±3.27^{a}	9.1±3.02^{a}	9.0±4.22^{a}
Landras (L)	1.7±0.46	4.6±1.01^{ab}	5.4±0.10^{b}	6.0±0.43^{b}	6.2±0.23^{ab}
Kemerovo (K)	1.8±0.25	4.3±0.62^{ab}	5.0±0.25^{b}	5.8±0.25^{bc}	6.4±0.22^{ab}
Pietren (P)	1.7±0.79	2.1±0.72^{b}	2.9±0.22^{b}	3.1±0.24^{c}	3.9±0.23^{b}
All breeds	2.19	4.58	5.50	6.12	6.51
F-statistic	1.4	3.9	5.5	6.5	4.3
P-value	0.30	0.04	0.01	0.007	0.03

^{a,b,c} Superscrips within each column differ at (p<.05).

^{a,b,c} Superscript indices of the reliability of the difference within each count (p<.05).

Animals of the LW breeds had the highest initial level (3.5 ± 1.09) of LDL peroxidation, it increased to 7.1 ± 0.89 *nmol MDA/mg* of the LDL protein within 30 minutes and became almost the same in other breeds: 9.0 ± 4. 22 (D), 6.2 ± 0.23 (A), and 6.4 ± 0.22 (K), except for the P breed. The P-type animals were the most resistant to oxidation of LDL with values from 2.1 ± 0.72 at 3 min to 3.9 ± 0.23 *nmol MDA/mg* of the LDL protein after 30 min ($p<0.05$). In a further experiment, the baseline MDA level in the P-pigs was 0.9 ± 0.93 vs. 1.4 ± 0.08 *nmol MDA/mg* of the LDL protein in the K breed ($p<0.001$); after 30 min of oxidation, it was 8.5 ± 0.22 and 10.3 ± 1.08, respectively. In general, the rate and oxidation level of LDL in the B breed for 30 minutes of oxidation were lower than in other breeds. Perhaps, this was affected by a lower level of palmitic acid in the intramuscular fat of this breed being compared to other breeds.

There were no significant differences in antioxidant levels of retinol or tocopherol in the blood serum between the breeds (Table 4). The P breed had lower levels of xanthophylls than the K breed, as well as lower levels of β-carotene than those of the K and LW breeds ($p<0.05$).

Table 4: The level of antioxidants and protein in the serum of pigs.

Breed	Retinol (ug/ml)	Tocopherol (mg / ml)	β-carotene (mg / ml)	Xanthophylls (mg / ml)	Protein by Lowry (mg / ml)
White Large (WL)	1.8±0.25	5.9±0.33	0.08±0.03^{a}	0.36±0.19^{ab}	71.9±0.64
Duroc (D)	1.8±0.10	7.5±3.01	0.05±0.00^{ab}	0.27±0.05^{ab}	72.7±0.35
Landras (L)	1.3±0.08	4.3±1.96	0.05±0.01^{ab}	0.22±0.06^{ab}	78.7±10.03
Kemerovo (K)	1.3±0.12	6.3±1.52	0.09±0.04^{a}	0.54±0.33^{a}	73.3±7.89
Pietren (P)	1.7±0.37	5.3±0.87	0.03±0.01^{b}	0.04±0.04^{b}	76.6±3.92
F-statistic	1.7	0.7	1.2	2.2	0.2
P-value	0.2	0.6	0.4	0.1	0.9

^{a,b} The mean least squares (±SE) in the same column within the category with different upper indices differs (p<.05).

^{a,b} Means least squares means (±SE) in the same column within category with different superscripts differ (P < .05).

It is interesting to note that the baseline level of the lipid peroxidation of products in LDL in pigs is not very different from the baseline level of a human [13].

Table 5: Level of antioxidants in LDL.

Breed	Retinol (ug/ mg, protein)	Tocopherol (mg/mg, protein)	β-carotene (mg/mg, protein)	Xanthophylls (mg/mg, protein)
Large White (LW)	0.5±0.19[a]	0.07±0.02[a]	0.15±0.02	0.6±0.18
Duroc (D)	0.8±0.28[ab]	0.11±0.02[a]	0.14±0.05	0.9±0.20
Landras (L)	0.2±0.16[a]	0.06±0.02[a]	0.04±0.03	0.2±0.10
Kemerovo (K)	0.6±0.21[a]	0.08±0.00[a]	0.08±0.01	0.5±0.10
Pietren (P)	1.9±0.66[b]	0.38±0.17[b]	0.17±0.10	0.8±0.41
F-statistic	3.5	6.0	1.1	1.3
P-value	0.05	0.01	0.41	0.33

[a,b] Superscript indices of the reliability of the difference within each column (p<.05).
[a,b] Superscripts within the same column differ at (p< .05).

It is known that the initial oxidation rate of LDL depends on the content of antioxidants, such as alpha-tocopherol, retinol, beta-carotene, and others, inhibiting the oxidation of PUFA in LDL to complete the depletion of the antioxidant capacity of LDL under the action of active oxygen metabolites [27, 28]. The P breed had less fat on the carcasses, but they had elevated levels of antioxidants retinol and tocopherol in LDL (p<0.05) (Table 5). Apparently, these indicators and, in particular, a clear tendency to the superiority of the P-pigs on the level of antioxidants in LDL contribute to the greater stability of LDL of this breed to dependent oxidation (Cu^{2+}).

At present, there is no precise knowledge of what the levels of saturated fats should be and what kinds of saturated fatty acids are optimal for health [29]. There are reports that the saturated fats are not the only cause of heart disease, and the causes are multifactorial [30, 31]. Current literature data do not confirm a clear relationship between the large consumption of red meat and pork lard with an increased risk of myocardial ischemia. Moreover, some researchers recommend that daily intake of PUFA does not exceed 10% of the total energy of food [32], and fat that is rich in UFA has other positive properties [33]. From many sources it follows that the harm of saturated fats in the human diet is greatly exaggerated and their strict restriction in the human diet is insufficiently justified. Therefore, with regard to the consumption of pork, it is best to study its positive and negative properties and to develop appropriate methods for breeding, feeding, and keeping animals. Consequently, the production of pork will be as good as the human health.

CONCLUSION

There are significant differences between the five breeds of pigs according to morphological features, chemical composition, and organoleptic properties of meat and fat. In pigs of the P breed, the largest cross-sectional area of the longest muscle of the back (muscular ocellus) is 51.7 cm^2; there are also the thinnest layer of dorsal fat (21.3 mm), the lowest content of IF (2.4%), the lowest level of UFA, and the lowest level of palmitic acid in the IF (if compared to other breeds). This breed has a high level of antioxidants retinol and tocopherol in the LDL blood and has better resistance to oxidation of LDL than other breeds do. However, this breed has the worst qualities of salted lard, both in taste and its consistency. The K breed, being created with a wide use of the B breed, has the thickest fatback (38.4 mm), the highest IF percentage (4.9%), the high level of palmitic acid in the IF, and the best taste and consistency of salted lard. In other studied breeds, intermediate indices were obtained for most of the characters. The research will help nutritionists better use the breed variety of pigs to improve the taste and dietary qualities of meat products. The research would be also helpful for pig breeders. They could search for those feeds that would improve the dietary and taste qualities of the products obtained, as well as for genetic markers for the selection of pigs to create healthy products.

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CONFLICTS OF INTERESTS

The authors declare no conflict of interest.

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