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The Biological Value of Pig Meat of Different Genotypes of Danish Selection.

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ABSTRACT

A study of biological value and quality indicators of pig meat imported from Denmark to Russia showed that the amino acids composition of more complete value was meat obtained from the three-breed hybrids. There was a difference between fatty acid compositions of lard in pigs of various genetics. In terms of saturated fatty acids, the double-breed hybrid pigs leaded butyric, caproic, undecanoic, heptadecanoic, arachidic, behenic and tricosanoic acids, the three breed hybrids – the lauric, myristic and docosadienoic acids and purebred landrace – caprylic, capric, myristoleic, palmitic, stearic and tetracosanoic acids. According to mono-saturated fatty acids: three-breed hybrids were leading for octadecenoic and gondoic, palmitoleic by two-breed hybrids and oleic acid by pure breed landrace. Iodine number turned out to be the highest spits of three breed hybrid. The content of amino acids in the longest back muscle of tryptophan in hydroxyproline, as well as the protein-quality index, were the highest in double-breed hybrids. Quality assessment showed that the whole exterior, aroma and taste were the best in landrace pigs; in terms of tenderness, juiciness, and general assessments of the quality of the meat, three-breed hybrids came first.

Keywords: Amino acid, iodine number, melting point, pig breed combinations, taste.

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INTRODUCTION

For a long time, pork is highly valued as a food product. It is used for many convenience foods, sausages and smoked meats. It is perfectly preserved and stored, without losing its taste and nutritional value [8]. Pork contains the entire spectrum of essential amino acids and polyunsaturated fatty acids, such as linoleic, linolenic, arachidonic, but less connective proteins than beef and mutton, so it is better absorbed in the human body (90-98%) [9]. According to the scientifically based standards of the Russian Research Institute of Nutrition, the consumption of meat products should be at least 85 kg per capita per year, including 24-26 kg of pork [5]. The intensive development of pig breeding allowed increasing quickly the production of cheap meat, the quality of which depends on the breed of animals, as well as on the conditions of their housing and feeding [13]. In recent years, Russia has increased pork meat by importing selected pigs based on low-fat, high growth rate and minimal cost of feed per unit of growth [5, 13, 14]. This makes it necessary to study the biological properties and quality indicators of pig's meat from different genotypes, and its practical importance for the industry processing. Only from high-quality, environmentally friendly raw materials can be developed delicious meat products.

MATERIAL AND METHODS

The experimental part of the work was carried out at the training and production complex "Pyatachok" of the Kuban collective farm, the departments of technology of storing and livestock products processing, private livestock and pig breeding at the Kuban State Agrarian University, the Krasnodar interregional veterinary laboratory in 2015. The objects of this study were animal breeds Landrace, double-breed hybrids (Landrace x Yorkshire) and three-breed hybrids (Landrace x Yorkshire x Duroc) imported from Denmark.

For the experiments, three blocks were formed, 20 animals of each, according to the principle of analogues, taking into account the breed, age, and body weight. The conditions of animals keeping and feeding of all groups by the periods of the experiments were the same, consistent with their physiological needs and sanitary and hygienic requirements.

Feed supplies were developed according to the current recommendations, adjusted for periods of age, taking into account the chemical composition of the feed. To study the biological value and meat quality indicators, meat and lard of pigs taken from fattening at an average body weight of 100 kg were used. To study the amino acid composition of the meat from experimental animals, we used the system of capillary electrophoresis' device "KAPEL-105" [12]. The composition of higher fatty acids was determined by gas-liquid chromatography on a Chrom-5 chromatograph according to Russian standards 'GOST R 51484-99/Animal fats and vegetable oils" [2]. The content of hydroxyproline according to GOST 23041-78 [1]; tryptophan content – according to the method of N. K. Zhuravskaya (1985); iodine number (according to Hanus) was determined in pure filtered fat [6]; the fat melting temperature according to GOST R 8285-91 [3].

To determine the taste characteristics of meat products from the experimental animals, a tasting of broth and boiled meat was carried out on a 9-point scale developed by the experts of the All-Russian Scientific-Research Institute of the Meat Industry according to GOST 9959-91 "Meat Products" / General Conditions for Organoleptic Evaluation [4].

RESULTS AND DISCUSSION

The biological value of meat depends on the amount and ratio of amino acids in it. A comparative amino acid analysis of pork of different genotypes was carried out to assess the quality of the protein (table 1). There were no large differences between the meats of all studied pigs according to the sum of essential amino acids concentration. In terms of the number of replaceable amino acids, three-breed hybrids had 293 mg / 100 g, than purebred analogs and 253.5 mg / 100 g than doublebred, mainly due to glycine and alanine, which affected the sum of all amino acids in the samples.

The amount of replaceable amino acids in samples of meat of three-breed hybrids was also more by 293 mg / 100 g than that of purebred landraces and by 253.5 mg / 100 g compared to samples of meat of two-

breed animals mainly due to serine, glycine, alanine, which reflected on the sum of all amino acids in the studied samples.

According to the total amount of amino acids, the meat of three-breed animals had a higher biological value in comparison with peers of other genotypes. The objectives of developing pig breeding are not only to obtain carcasses with a low level of fat, but also to preserve the taste and technological qualities of meat and bacon. These qualities depend on the fat components – fatty acids [8]. For the implementation of life processes in the human body, it is necessary to study the fatty acid composition of the subcutaneous bacon, which depends on many factors such as breed, age, and feed. For example, the consumption of 30-50 g pork's meat fat daily is enough for human body's need in essential poly-saturated fatty acids, which is 3-6 g. The absorption of fats is largely dependent on the content of unsaturated fatty acids (linoleic, linolenic, arachidonic) in them. The more fats these acids have, the more digestibility they will have [10, 14].

Table 1: Amino acid composition of pig meat, mg / 100 g

Indicators	**Group of animals**		
	landrace	landrace × yorkshire	landrace × yorkshire × duroc
Irreplaceable amino acids:			
Arginine	1924.1	1905.4	1956,7
Lysine	2469.3	2497.3	2451.2
Phenylalanine	859.7	830.4	828.2
Histidine	898.4	914.4	989.9
Leucine	1971.3	1998.8	1942.2
Isoleucine	1234.4	1263.4	1218.2
Methionine	653.5	607.4	615.5
Valin	1421.0	1384.6	1422.2
Tryptophan	234.5	321.3	308.3
Threonine	1185.7	1195.9	1175.5
The amount of essential amino acids:	12851.9	12918.8	12967.9
Replaceable amino acids:			
Proline	887.1	808.4	804.7
Serine	994.4	990.5	1083.8
Alanine	1748.8	1904.9	1991.4
Glycine	919.0	937.0	991.0
Tyrosine	827.9	773.9	798.3
Hydroxyproline	41	43	42
The amount of essential amino acids:	5418.2	5457.7	5711.2
Total:	18270.1	18376.5	18679.1

Saturated fatty acids (stearic, palmitic, arachidonic, etc.) are less susceptible to oxidation; and give the better taste to the fat (table 2). On the other hand, polyunsaturated fatty acids, such as alpha-linoleic (18: 2), eicosapentoenic (22: 5), docosahexoenic (22: 6), which are part of the famous drug "omega-3", help prevent cardiovascular diseases systems are necessary for the normal physiological function of all animal species and for human health.

The results of our research showed that saturated fatty acids in the pork lard varied from 34.02 to 35.47 %. The difference between the first and second groups was 2.45 %, and 1.45 % between the first and the third groups – in favor of purebred landraces.

Table 2: Fatty acid composition of pigs lard of different genotypes, %

№	**The name of the acids included in the fatty acid composition**	**Breed pigs**		
		landrace	Landrace × yorkshire	landrace × yorkshire× duroc

1	2	3	4	5
Saturated fatty acids				
1	C4: 0 Butane (Oily)	0.007	0.008	0.008
2	C6: 0 Hexane (Nylon)	0.005	0.007	0.006
3	C8: 0 Octane (Caprylic)	0.015	0.012	0.012
4	C 10: 0 Decanoic (Capric)	0.076	0.063	0.071
5	C11: 0 undecanoic	0.005	0.005	0.003
6	C12: 0 dodecanoic (Lauric)	0.074	0.055	0.075
7	C13 0 tridecanoicacid	-	0.003	0.004
8	C14: 0 tetradecanoic (Myristic)	1.244	0.987	1.264
9	C14: 1 Myristoleic	0.013	0.012	0.008
10	C15: 0 pentadecanoic	0.07	0.09	0.073
11	C15: 1 cis-10-pentadecanoic	0.004	-	-
12	C16: 0 hexadecanoic (palmitic)	22.344	19.214	21.922
13	C17: 0 heptadecanoic	0.363	0.527	0.398
14	C17: 1 cis-10-heptadecanoic	0.278	0.308	0.285
15	C18: 0 octadecanoic (stearic)	10.821	9.512	10.525
16	C20: 0 eicosanoic (arachidic)	0.159	0.186	0.163
17	C21: 0 heneicosanoic	0.016	0.015	0.008
18	C22: 0 docosanoic (Behenic)	0.009	0.013	0.011
19	C23: 0 tricosanoic	0.003	0.011	0.007
20	C22:2 docosadienoic acid	0.01	0.008	0.01
21	C24: 0 tetracosanoic (lignoceric)	0.006	0.005	0.004
22	C24:1 tetracosanoic acid selacholeic acid	0.084	0.105	0.099
1	2	3	4	5
Monosaturated Fatty Acids				
1	C16: 1, hexadecenoic (Palmitoleic)	1.771	1.595	1.683
2	C18: 1 trans-octadecenoic 1n9t	0.242	0.243	0.241
3	C18: 1n9c cis-Octadecenoic (Oleic)	36.457	35.29	35.319
4	C20:1 eicosenoicacid(Gondoic)	1.336	1.664	1.458
5	C22: 1n9 docosanoic (erucic)	0.199	0.199	0.213
Polyunsaturated fatty acids				
1	C18: 2n6c cis-octadecadienoic (linoleic)	22.146	27.419	23.782
2	C18: 3n6 γ-octadecatrienoic (γ -linolenic)	0.045	0.074	0.045
3	C18: 3n3 octadecatrienoic (Linolenic)	0.633	0.553	0.622
4	C20: 2 cis-11,14 Eicosadienoic	0.893	0.963	0.933
5	C20 3n6 cis-8 11 14-eicosatrienoic	0.110	0.147	0.121
6	C20 3n3 cis-11 14 17-eicosatrienoic	0.199	0.199	0.213
7	C20: 4n6 Arachidonic	0.39	0.496	0.427
8	C20: 5n3 cis-5,8,11.14,17 Eicosapentaenoic	0.023	0.037	0.029
9	C 22: 6n3 cis-Docosahexaenoic	0.094	0.106	0.109
Fat melting point t ºC				
1	GOST R 52179-03	27.0 ± 1.9	27.0 ± 1.9	27.0 ± 1.9

The greatest weight among the saturated fatty acids in the subcutaneous bacon piglets is occupied by palmitic (19,21-22,34%) and stearic (9,51-10,82%) acids. They determine the consistency of bacon. Our research found that there was more in bacon pigs Landrace these acids than their counterparts of two - and three-pedigree hybrids.

In terms of the amount of monounsaturated fatty acids contents, the piglet bacons of the first group exceeds the second and third group to 1,01-1,30 %. The main one is oleic acid (35,29-36,45%). It is known that the fattier these acids are, the faster they are oxidized [7, 11]. Fats containing a large percentage of polyunsaturated fatty acids are biologically valuables. It has been established that an increased content of polyunsaturated fatty acids in the diet of people contributes to a decrease in the level of cholesterol and triglycerides in the blood [9, 11].

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The highest content of unsaturated fatty acids in our studies was noted in the lard of two and three-breed hybrids compared to their peers Landrace by 3.46 and 2.75 %, respectively, which indicates its greater biological usefulness, which is suitable for use as a raw material in products baby food.

An important indicator characterizing the quality of subcutaneous bacon is the melting point and iodine number (table 3).

Table 3: fat quality performance

Indicators	Landrace	Landras × Yorkshire	Landrace × Yorkshire × Duroc
Melting point, ºC	27.0 ± 1.9	27.1 ± 1.9	26.1 ± 1.9
Iodine number, units	59.8 ± 0.13	60.0 ± 0.57 ***	62.3 ± 0.13 ***

*** P < 0.001

The lowest melting point in our studies in three breed hybrids samples was 26.1 ºC; in other groups it was the same and slightly higher by 1.0 -1.1 ºC than its counterparts. The highest index of the iodine number, which determines the degree of fatty acids saturation contained in the fat, was noted in samples of pork fat of three-breed hybrids, and the smallest - landrace (62.3 and 59.8 units), respectively. Thus, the subcutaneous bacon of experimental pigs is solid, with good digestibility; however, samples of three breed hybrids were significantly superior to their analogues.

The biological value of meat depends on the amount and ratio of amino acids in it (table 4). By determining the ratio of tryptophan to hydroxyproline, indicating the development of muscle and connective tissue in the meat, we get the amount of protein-quality indicator.

Table 4: The biological value of the longest back muscle, mg /%

Indicators	Breed		
	Landrace	landrace × yorkshire	landrace × yorkshire × duroc
Tryptophan	234	321	308
Hydroxyproline	41	43	42
Protein quality indicator	5.70	7.46	7.33

In our studies, the content of hydroxyproline in all groups was approximately the same – 41- 43 mg / 100 g. In terms of the amount of tryptophan in muscle tissue, which characterizes the protein usefulness of meat, two- and three-breed hybrids exceeded their analogs of purebred landraces by 87–74 mg / 100 g, respectively, and the protein-quality indicator was 5.70; 7.46 and 7.33 mg / 100 g

Muscular tissue, in which the ratio of tryptophan to hydroxyproline from 5 to 6 and above has the optimum biological value, the average value of this ratio is within 4-5; lower - characterizes lower quality meat. Consequently, the muscle tissue of pigs of the studied genotypes is characterized by a high biological value, but the hybrids were distinguished by the best indicators.

The taste and nutritional properties of meat are determined by its physico-chemical properties [15]. The results of the analysis of acidity (pH), accessories of meat to the Pale Soft Exudative (PSE) and Dark Firm Dry (DFD), normal (NOR) groups are presented in table 5.

Table 5: Results of the analysis of acidity (pH) (M ± m), n = 9

Indicator	Breed		
	L	L x Y	L x Y x D
Belonging to groups:	NOR	NOR	NOR
PSE (pH_{24}<5.3)	-	-	-
DFD (pH_{24}>6.3)	-	-	-

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The acidity value in the meat of experimental animals indicates that the pH_1 and pH_{24} levels were within the normal range (pH_1 NOR > 6; pH_{24} NOR = 5.3–6.2). However, in the first hour after slaughter, the meat of purebred landraces was 6.17 units, which was slightly lower and better than the compared values of acidity, and after 24 hours of cooling, two and three breed animals were less and amounted to 5.80 and 5.93 units. - accordingly, which can serve as the basis for the normal course of autolysis in the post-slaughter period and the good quality of the pork obtained from them.

Thus, the results of our research indicate that the pork of all animals studied belongs to NOR. At the same time, it should be noted that a more intensive process of meat ripening an hour after slaughter proceeded in the carcasses of landrace pigs, and after 24 hours of cooling in carcasses of double-breed animals. The organoleptic and tasting evaluation of meat and broth has a great importance when buyers choose pork.

The commission tasting carried out (table 6) made it possible to establish that the meat and broth of all groups of pigs had good quality. According to the ball assessment, the boiled meat of the three-breed animals was 7.5 points and the quality of the broth (appearance, taste, richness) exceeded those of other groups.

Table 6: Tasting assessment of meat and broth quality

Indicator	Group					
	Landrace		landrace × yorkshire		landrace × yorkshire × duroc	
	score	Rank	score	rank	score	rank
Meat						
Appearance	8.38 ± 0.26	1	8.25 ± 0.31	2	8.00 ± 0.33	3
Aroma	8.13 ± 0.23	1	8.00 ± 0.27	2	7.88 ± 0.35	3
Taste	7.88 ± 0.29	1	7.75 ± 0.31	2	7.63 ± 0.42	3
Consistency (tenderness, hardness)	6.63 ± 0.37	2	6.50 ± 0.38	3	7.25 ± 0.36	1
Juiciness	5.63 ± 0.19	3	6.13 ± 0.40	2	6.80 ± 0.31	1
Overall meat quality assessment	7.33 ± 0.27	1.6	7.32 ± 0.33	2.2	7.5 ± 0.35	2.2
Broth						
Appearance	6.57 ± 0.37	3	7.71 ± 0.30	2	8.00 ± 0.38	1
Aroma	8.00 ± 0.38	1	7.43 ± 0.57	3	7.71 ± 0.28	2
Taste	7.14 ± 0.52	3	7.71 ± 0.60	2	8.00 ± 0.53	1
richeness	8.00 ± 0.78	2	7.14 ± 0.46	3	8.14 ± 0.55	1
General quality assessment of broth	7.43 ± 0.51	2.3	7.50 ± 0.48	2.5	7.96 ± 0.44	1.25
Total	7.38 ± 0.39	1.95	7.41 ± 0.41	2.35	7.73 ± 0.40	1.73

The highest number of points for appearance, aroma, taste, meat samples obtained from Landrace pigs, exceeded the three-pedigree hybrids on these indicators by 0.38; 0.25; 0.25 points, and double breed hybrids by- 0.13; 0.13; 0.13 points, respectively. However, in terms of consistency and juiciness, three-breed hybrids had the highest points in the tasting assessment of meat; they surpassed the double-breed hybrids - by 0.67; 0.18 points and purebred by 1.17; 0.17.

According to the ranking, the meat and broth of three-breed hybrids occupied the first place, the third place by two-breed hybrids, and purebred landraces occupied the intermediate position. Evaluation of the organoleptic characteristics of the finished product showed that meat of all studied pig groups is suitable as a raw material for the production of sausage, delicatessen products, however, products made from meat of three breed hybrids were the most valuable in terms of food.

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CONCLUSIONS

Our research has established that the genotype of pigs affects the amino acid composition of meat, fatty acid composition of bacon, biological value, as well as the quality of the products being tasted.

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