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Chemical composition of the meat and fat of pigs of various genotypes

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ABSTRACT

The article presents research materials of studying chemical composition of the meat and back fat of pigs of various genotypes grown per industrial technology at the LLC Vostochny pig-breeding complex in the Zavyalovsky district of the Udmurt Republic. Samples of rib eye and back fat have been taken from the back and sides of pig carcasses of various genotypes: (Large White (LW) x Landrace (L)), (LW x L) x Duroc (D), (LW x L) x Yorkshire (Y), and (LW x L x Y) x D. The youngest meat has been characterized by the lowest moisture content in the case of the (LW x L x Y) x D breed combination (73.0 %). With a decrease in the moisture content in the meat, the level of protein mass fraction has increased. The highest content of the intramuscular fat has been observed in the case of the LW x L breed combination (3.05 %). All samples of back fat both from the back and the sides have been different from the standpoint of general chemical composition. The moisture content has ranged from 5.51 % to 9.90 %, the fat content — from 86.54 % to 92.3 %, and the protein content — from 2.17 % to 3.58 %. All the samples of back fat from the four experimental groups have met the regulatory requirements for the mass fraction of fat (back fat according to GOST R 55485-2013: fat content should not exceed 93.0 %; protein content should be no less than 1.0 %). The samples of mid-back fat from the ((LW x L) x D; (LW x L) x Y; (LW x L x Y) x D) breed combinations have met the regulatory requirements for the fat mass fraction (mid-back fat according to GOST R 55485-2013: fat content should not exceed 90.0 %; protein content should be no less than 1.0 %). The samples of mid-back fat in the case of the (LW x L) breed combination have not met the regulatory requirements for the mass fraction of fat, which has amounted to 91.55 %. The results of the studies aimed at identifying the optimal variant of pig crossing prove that the (LW x L x Y) x D breed combination in four-breed crossing can provide the best chemical composition: rib eye meat is less fatty (2.21 %) with a fairly high protein content (22.86 %); back fat has an optimal fat content and a well-developed protein carcass.

Key words : *Various genotypes, Pig carcasses, Rib eye, Back fat, Chemical composition.*

Introduction

The demand for pork in Russia, like in the rest of the world, is gradually shifting towards more expensive types of pork – bacon pork and meat pork. To fully satisfy the demand of the Russian population for meat products in the country, it is necessary to produce 11 million tons of meat annually, including 3.3 million tons of pork (Berezovsky, 2018; Ovchinnikov, 2014; Suslina *et al.*, 2020; Perevozchikov *et al.*, 2017).

Today a high level of breeding work in the Russian meat industry is considered to be the most important factor of resource-saving technology, funds turnover, and product quality. A strategic orientation in the pedigree and commercial pig breeding should be breeding highly productive types and lines of the pigs, testing them for compatibility in

various crosses, and introducing the best combinations in commercial herds (Melnikova *et al.,* 2019; Kazantseva *et al.,* 2018; Ovchinnikov and Zatsarapin, 2011; Rud, Parkhomenko, 2016).

In characterizing pig productivity, it is important to assess the quality of the products obtained, which is determined by the pork nutritional and biological value. These properties lie in the optimal healthiness of pork that meets human physiological needs and depends on the composition, ratio, and distribution of the muscle, adipose, and connective tissues in the muscles, on acidity, moisture content, digestibility, color, and tenderness of pork, which are important for its storage and processing into meat products (Grikshas *et al.,* 2017; Solovykh, Ovchinnikov, 2008; Grikshas *et al.,* 2019).

Various crossing variants in industrial pig breeding aimed at increasing the meat content have resulted in some negative factors, which cannot be ignored since they are associated with pork quality deterioration (Batanov *et al.,* 2010; Kazantseva *et al.,* 2019; Sokolov, Zelkova, 2017).

It is necessary to systematize the available information about the productive and biologically useful qualities of hybrid young animals obtained from various crosses, taking into account the following facts: the process of industrial pig breeding for pork is gaining pace and may be considered irreversible; the optimal limit of increasing the content of muscle tissue in pig carcasses is unknown; and it has not been studied in long-term experiments what kind of subordination exists between the pork properties and other economically useful traits, for example, in the genotypes of four-breed crosses and, mainly, pork quality (Kazantseva *et al.,* 2020; Martynova, 2013; Tyutyunnikova *et al.,*2020).

In this regard, the study was aimed at assessing chemical composition of pork and back fat of the pigs of various genotypes bred according to the industrial technology of the LLC Vostochny pig-breeding complex in the Zavyalovsky district of the Udmurt Republic.

This goal in view, the tasks of the studies were the following: studying rib eye and back fat chemical composition in the carcasses of pigs of various genotypes.

Objects and Methods

For the study, samples of rib eye and back fat were taken from the back and sides of pig carcasses of various genotypes: (LW x L), (LW x L) x D, (LW x L) x Y, and (LW x L x Y) x D. In studying the quality of rib eye and back fat, the following values were determined: mass fraction of moisture, fat, and protein. The laboratory analysis was performed in the conditions of the FSBEI HE Izhevsk State Agricultural Academy according to the standard methods: GOST 33319-2015 "Meat and meat products. Method for determining the mass fraction of moisture", GOST 23042-2015 "Meat and meat products. Methods for determining fat content", and GOST 25011-2017 "Meat and meat products. Methods for determining protein content". The obtained results of scientific research were processed using the method of analysis of variance, using the standard statistical analysis suite Microsoft Excel 2007 on a PC.

Results

Meat quality and nutritional value are determined by its chemical composition which depends on the quantitative shares of the muscle, connective, adipose, bone, and cartilage tissues. Detailed knowledge of meat chemical composition allows judging about the stability of meat properties during storage. It is known that pig meat chemical composition changes with age. The content of intramuscular fat, protein, and minerals in the muscle tissues increases with age, and the content of water decreases. The presence of the adipose tissues gives the pork high calorific value, makes it tender, juicy, and full-flavored.

For a deeper assessment of raw meat, chemical studies were performed for determining the content of moisture, protein, and fat in the samples (Table 1).

Of all the groups of the animals, the lowest moisture content was noted in the young meat from the (LW x L x Y) x D breed combination (73.0 %). In the studies, with decreasing the moisture content in the meat, the level of protein mass fraction increased. The highest content of the intramuscular fat was observed in the case of the LW x L breed combination (3.05 %). The lowest content of intramuscular fat was found in the case of the (LW x L x Y) x D pig breed combination (2.21 %), while the muscle tissues in this group of animals had the minimum moisture content (73.0 %).

Detailed knowledge of muscle tissue chemical composition in many ways allows explaining the

orientation of many biochemical processes that occur in raw meat during its maturation and allows predicting its functional and technological properties. It is known that the quality of the muscle tissue maturation and its functional and technological properties directly depend on the quantitative and qualitative composition of the protein compounds in it.

Besides, the process quality of back fat directly depends on its behavior during further processing and storage. The consistence of back fat and its ability to develop hydrolytic breakdown are determined by the content of fat and water, the state of collagen "support", and the nature of the fatty acids that make up triglycerides. For example, a decrease in the fat content and an increase in moisture content cause consistence deficiencies in back fat. The so-called "empty back fat" (poorly filled with fat) is observed in the case of the lipid content of 75 % to 84 %. "Empty back fat" is typical for young animals, and is a concomitant phenomenon in genetic selection aimed at increasing the mass fraction of muscle tissues in the carcass. The presence of connective tissue fibers in back fat allows keeping it hard at ambient temperatures, and to some extent protects against fat egress when the temperature increases. Therefore, the content and the nature of the connective tissues are important in the formation of the process characteristics of adipose tissues.

In this regard, the authors performed a differentiated analysis of back fat and mid-back fat chemical composition in young pigs of various genotypes (Table 2).

The analysis of Table 2 shows that both back fat and mid-back fat samples differed in terms of general chemical composition. The moisture content ranged from 5.51 % to 9.90 %, the fat content — from 86.54 % to 92.3 %, and the protein content — from 2.17 % to 3.58 %.

In the case of the breed combination (LW x L; (LW x L) x D; (LW x L) x Y; (LW x L x Y) x D), all back fat samples taken from the four experimental groups complied with the regulatory requirements for the mass fraction of fat (back fat according to GOST R 55485-2013: fat content should be no more than 93.0 %, protein content – no less than 1.0 %). Of the samples of mid-back fat taken from the four experimental groups, three samples ((LW x L) x D; (LW x L) x D; (LW x L x Y) x D) met the regulatory requirements by the mass fraction of fat (mid-back fat according to GOST R 55485-2013: the fat content should be no more than 90.0 %, the protein content – no less than 1.0 %). The mid-back fat samples taken from the first experimental group (LW x L) did not meet the regulatory requirements for the mass fraction of fat; the mass fraction of fat amounted to 91.55 %. However, the form of rationing the limit values of protein and fat mass fractions, which has been adopted for most food products (fat, no more than; protein, no less than), is probably not appropriate for back fat. The main value of back fat is still the maximum possible fat content. Besides,

Table 1. Rib eye chemical composition in pig carcasses of various genotypes

Group No.	Breed combination	Moisture content, %	Mass fraction of fat, %	Mass fraction of protein, %
1	LW x L	74.3 ± 0.31	3.05 ± 0.43	20.65 ± 1.19
2	(LW*L) x D	73.5 ± 0.46	2.86 ± 0.39	21.6 ± 1.45
3	(LW*L) x Y	73.8 ± 0.48	2.83 ± 0.41	22.4 ± 1.63
4	(LW*L*Y) x D	73.0 ± 0.53	2.21 ± 0.37	22.89 ± 1.58

Table 2. Carcass back fat chemical composition in pigs of various genotypes

Indicators		Breed combination			
		LW x L	(LW x L) x D	(LW x L) x Y	(LW x L x Y) x D
Moisture content, %	back fat	5.51 ± 0.47	7.52 ± 0.54	9.63 ± 0.46	9.86 ± 0.53
	mid-back fat	6.2 ± 0.51	8.61 ± 0.44	8.73 ± 0.49	9.90 ± 0.61
Mass fraction of fat, %	back fat	92.30 ± 0.65	89.50 ± 0.71	87.12 ± 0.63	86.54 ± 0.56
	mid-back fat	91.55 ± 0.48	88.24 ± 0.33	88.07 ± 0.64	87.00 ± 0.48
Mass fraction of protein, %	back fat	2.17 ± 0.12	2.96 ± 0.10	3.22 ± 0.15	3.58 ± 0.17
	mid-back fat	2.20 ± 0.32	2.94 ± 0.28	3.00 ± 0.41	3.08 ± 0.52

given the practical experience, increased moisture and protein content are undesirable, given decreased resistance of back fat to hydrolytic, oxidative, and microbiological changes during storage.

Discussion

The problem of making back fat suitable for industrial processing and obtaining high-quality meat products is quite relevant today not only in the Russian Federation but also in several foreign countries. Undoubtedly, this is due to the changes in pig breeding that have occurred in the last ten years, from breeding decisions to the technologies of intensive pigs raising and fattening.

It is practically impossible to level the problems associated with the quality of back fat in the process of its direct processing since they directly depend on the characteristics of the animals sent for slaughter. In the near future, the situation with the quality of back fat in the meat industry is unlikely to improve, since the existing economic problems of pig breeding with an insignificant mass fraction of adipose tissues in the carcass, on the one hand, and, the views of nutritionists of the consumption of saturated fats and fats in general, on the other hand, only aggravate the current situation.

A way to a new level of solving this problem may be a differential approach to pig feeding and creating hybrids with optimal characteristics of the adipose tissues, depending on the requirements of customers, such as retail sales, meat processing enterprises, and consumers.

Pig growth intensity and pig productivity have remained until now the critical criteria for genetics, which only have led to achieving an increased muscle mass in the carcass. However, achievements in the field of using hybrid pigs of three breed crosses for industrial purposes have caused a decrease in back fat thickness and affected its quality.

The results of the studies aimed at identifying the optimal variant of pig crossing prove that the (LW x L x Y) x D breed combination in four-breed crossing can provide the best chemical composition: rib eye meat is less fatty (2.21 %) with fairly high protein content (22.86 %); back fat has optimal fat content and well-developed protein carcass.

Conclusion

Thus, although pig growing and fattening are influenced by the conflicting requirements of consumers and the industry (economic factors, biological value, organoleptic, functional, and technological characteristics), back fat quality management in living pigs is possible. It should be done by coordinating the specific requirements for back fat with the customers and choosing the genotype of animals and the appropriate conditions for pig growing and feeding.

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