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PIG CARCASSES – QUALITY AND OPTIONS OF CONTROL

DISSERTATION ABSTRACT

For acquiring the scientific degree

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The dissertation consists of 251 pages (35 of which are literature) and includes 58 tables, 39 graphs and 27 photographs. The reference list contains 423 literary sources, of which 73 are in Cyrillic and 350 are in Latin. The numbering of the sections, figures and tables in the auto-reference do not correspond to those in the dissertation.

The data were obtained as a result of the implementation of projects:

1. Development of methods for evaluating the meat productivity of pigs. ZH-105. (2014-2016) Agricultural Academy. Project manager: Assoc. Prof. Dr. Zhivko Nakev.
2. Possibilities for production of fattened pigs with optimal carcass and meat characteristics. Zh-144, 2018-2019, Agricultural Academy. Project manager: Assoc. Prof. Dr. Zhivko Nakev.
3. Modern aspects of natural and biological breeding of the East Balkan pig. 2010-2014. Project manager: Prof. Dsc. Y. Marchev
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The public defense of the dissertation work will take place on .... at …...... in........., according to the Regulations for the conditions and procedure for the acquisition of scientific degrees and academic positions in Agricultural Academy before

Scientific jury composed of:

The materials for the defense of the dissertation are available.

INTRODUCTION

Pork dominates global consumption, accounting for over 37% of all meat consumed (McGlone, 2013). As a food product, it is an important source of essential amino acids, available in well-balanced amounts, vitamins and trace elements, and through the lipids present in it, it supplies energy to the body. In addition to its rich composition, pork also has organoleptic qualities (juiciness, taste and aroma), which make it not only valuable in terms of nutrition, but also a pleasant product to consume. The term "meat" includes all parts of the animal's body, fresh or processed, which are suitable for human consumption. In a narrower sense, this term includes striated muscles including connective tissue components, intra and intramuscular fat, blood vessels, lymph nodes, nerves and bones.

In the developed "Basic forecasts for meat production in Bulgaria in the medium term 2018-2022", (Ivanov and Dimitrova 2018) state that pork occupies a dominant share in the production of red meat in the country - 71% of the total amount produced in 2016 d. More affordable prices relative to the income of the population compared to beef, without neglecting the importance of eating habits, determine its leading position in terms of consumption as well. Pork consumption in the country increased from 12.8 kg in 2007 to 24 kg in 2016. According to Popescu (2016), in Romania the average consumption of pork meat per capita was 29 kg in 2014, which is approximately 10% lower than in 2007 (33.4 kg). In terms of consumption level, Bulgaria lags significantly behind that of EU member states - 32 kg in 2017. The analysis of the origin of pork consumed in 2016 shows 174.32 thousand tons of domestic consumption, of which the domestically produced 73.24 thousand tons, and 104.53 thousand tons were provided from imports, and during the period the country exported 3.05 thousand tons and maintained a stock of 3.7 thousand tons of pork.

The fact that imports provide a significant part of pork consumption in the country determines the dependence on the trends of the world and European markets. In this regard, determining the quality of pork carcasses as quickly as possible is of particular importance for the rapid sale of pork produced in the country. According to EU regulations, the financial results of pig fattening are determined in slaughterhouses based on the amount of transversely striated muscles in the carcass and its weight, and the methodology is presented in a classification system - SEUROP. The use and in trade, the correct relations between pig farmers and meat processing enterprises require from it maximum accuracy. It is necessary to note that the improvement of the system does not have a universal character, and each EU member state develops the model and monitors its effectiveness in working on the reared pig population.

Grading of pig carcasses according to the SEUROP system has been carried out in the country since 2005. We believe that this is a sufficient period of time to analyze the effects and defects of the system.

In the present work, we present an analysis of the results of the application of the SEUROP system in pig farming in the North-East part of Bulgaria. In light of the requirements of the system, we examine the phenotypic manifestation of some traits determining carcass quality (percentage of lean meat, physicochemical composition of meat, fatty acid composition) in the commercial population of fattened pigs.

We have paid special attention to the characteristics of the carcass of the only domestic aboriginal pig breed - the East Balkan pig. The impossibility of using the SEUROP system in Aboriginal pigs led us to use the approach to analyze the results of carcass dissection in exact studies with different objectives. We believe that this approach provides maximum variation of the investigated traits, which gives opportunities for a more objective analysis.

The way the carcass is presented (shredded or steamed) has an impact on commercial relationships and on the production cost. Legislation in the country allows the use of the EUROP system only on steamed carcasses. Guided by the experience of Greece (the only country in the EU using scraped carcasses grading), we also present our view on the possibilities of predicting the composition of scraped carcasses.

2. AIM

The aim of the study was to assess some characteristics of swine carcasses and control abilities. The set goal required conducting research on the following tasks:

2.1. Study of some quality characteristics of pork carcasses produced in the northeastern part of the country.

2.1.1. Establishing the values of the signs percentage of lean meat and carcass weight.

2.1.2. Establishing the percentage of lean meat in carcasses of different weight categories.

2.1.3. Influence of the year and the season on the qualitative characteristics of the carcass.

2.1.4. Quality of meat in carcasses in different classes according to the EUROP system.

2.1.5. Quality characteristics of meat in two- and three- crossbreeds (2010).

2.1.6. Qualitative characteristics of meat in two hybrid combinations grown under industrial conditions. (2016).

2.1.7. Establishing the values of the signs percentage of lean meat, carcass weight and quality characteristics of m. Longissimus thoracis in purebred pigs. Fatty acid composition. (2018)

2.1.8. Establishing the values of the signs percentage of lean meat, carcass weight and quality characteristics of m. Longissimus thoracis in two crossbreeds. Fatty acid composition. (2019)

2.1.9. Slaughter qualities of pigs from the Danube white breed. Physicochemical composition of m. Longissimus thoracis.

2.1.10. Effect of rearing method on fat thickness and lean meat percentage in female pigs.

2.2. Carcass quality of the East Balkan breed.

2.2.1. Slaughter qualities of EB breed pigs in one weight class raised in different regions of the country.

2.2.2. Slaughter qualities of EB breed pigs in different weight classes.

2.2.3. Slaughter qualities of "heavy" pigs of the East Balkan breed.

2.2.4. Physicochemical composition of m. Longissimus thoracis in pigs of the East Balkan breed.

2.2.5. Fatty acid composition of m. Longissimus thoracis in pigs of the East Balkan breed.

2.3. Development of methods for evaluating the carcass quality of skinned pigs.

2.3.1. Determination of slaughtering qualities and morphological components in the carcass and its individual parts in skinned pigs.

2.3.2. Dependencies between morphological components and some dimensions of the carcass and its individual parts.

2.3.3. Dependencies between the morphological components in the carcass and its individual parts in scraped pigs.

2.3.4. Possibilities of using some dimensions found in dissection in the development of methods for evaluating the meat productivity of skinned pigs.

2.3.5. Possibilities of using the results of dissection in the development of methods for evaluating the meat productivity of skinned pigs.

3. MATERIAL AND METHODS

The studies are grouped according to the set goals, with a different number of carcasses from the commercial population of fattened pigs participating in each of them (Table 1).

Table 1. Characteristics of the studies

Origin	Number of studies	Number of carcasses	Analyzed traits	Statistical methods
4.1. Study of some quality characteristics of domestically produced pig carcasses				
	2	486834	Lean meat content (%), Carcass weight (kg)	Linear-statistical models.
4.2. Influence of the year and the season on the qualitative characteristics of the carcass				
	1	106027	Lean meat content (%), Carcass weight (kg)	Two-factor analysis (ANOVA).
4.3. Quality of meat in carcasses in different classes according to the EUROP system				
(LxLW) x D (LxD) x P (LxLW)xPL, LW,P,(DxL,(PxL)	5	138	Physicochemical composition of m. Longissimus thoracis.	
4.4. Influence of rearing method on fat thickness and lean meat percentage in female repair pigs of the Danube White and Landrace breeds.				
Danube White, Landrace	1	48	Effect of rearing method on fat thickness and lean meat percentage in female pigs.	
4.4.East Balkan swine breed				
EBSB	4	64	Linear and weight dimensions of the carcass. Quality of m. Longissimus thoracis. Fatty acid composition of meat and fat.	Dissection - Regulations, 1996
4.5. Development of methods for evaluating the meat productivity of skinned pigs.				
Youna ♀ x Pietrain ♂	1	70 swine	Lean meat content (%) in the carcass and its individual parts.	
4.5.1. Determination of slaughtering qualities and morphological components in the carcass and its individual parts in scraped pigs.				
Youna ♀ x Pietrain ♂	1	70 swine	Lean meat content (%) in the carcass and its individual parts. Linear and weight dimensions of the carcass.	Dissection Walstra et al., (1996)Predictive models, Caueseur et al., (2003), Minitab 17 software
4.5.2. Dependencies between morphological components and some dimensions of the carcass and its individual parts.				
	1	70 swine	Linear and weight dimensions of the carcass.	
4.5.3. Possibilities of using some dimensions found in dissection in the development of methods for evaluating the meat productivity of skinned pigs.				
	1	70 swine	Linear dimensions of the carcass.	Predictive models, Caueseur et al., (2003), Minitab 17 software
4.5.4. Possibilities of using the results of dissection in the development of methods for evaluating the meat productivity of skinned pigs.				
	1	70 swine	Morphological components of the carcass and its individual parts.	Predictive models, Caueseur et al., (2003), Minitab 17 software

3.1. Study of some quality characteristics of domestically produced pig carcasses. Quantitative traits for phenotypic assessment of meat productivity in pigs

3.1.1. Establishing the values of the traits percentage of lean meat and carcass weight.

3.1.2. Establishing the percentage of lean meat in carcasses of different weight classes.

The study analyzed the quality characteristics of 486,834 carcasses from the commercial population of fattened pigs produced by eight pig breeding enterprises located in eastern Bulgaria (Shumen, Varna, Burgas and Ruse regions) slaughtered in two slaughterhouses during the period 2012-2015. The experimental material is distributed as follows 2012 - 55812 (29.97%), 2013 - 24372 (13.09%), 2014 - 42052 (22.58%), 2015 - 63975 (34.36%). In the study for the period 2016-2019, the distribution of pig carcasses was: 2016 - 75628 (25.25%), 2017 - 93183 (30.92%), 2018 - 85664 (28.48%) and 2019 - 46148 (15.35%).

The weight of the carcasses was determined up to 45 minutes after slaughter with an accuracy of 0.01 kg. To establish the weight structure, the studied sample was divided into the following weight classes (kg) - < 60; 60-69.9; 70-79.9; 80-89.9; 90-99.9;>100.

3.2. Influence of the year and the season on the qualitative characteristics of the carcass.

The study covers the carcasses of 106,027 animals. fattened pigs slaughtered in a slaughterhouse in 2014 and 2015.

The effects of the year (2014 and 2015) and the season - winter (I - III), spring (IV-VI), summer (VII-IX) and autumn (X-XII), were evaluated by two-factor analysis (ANOVA).

The results were processed with the JMPv.12 software.

3.3. Quality of meat in carcasses in different classes according to the system EUROP.

Three studies were conducted with 54 animals. The experimental activity includes the following studies.

3.3.1. Quality of meat in carcasses in different classes according to the system EUROP.

The qualitative characteristics of MLD were studied in 20 pigs (LxLW)xD, divided into two groups - I group (n=8) lean meat content in the carcass in class U and II group (n=12) lean meat content in the carcass in grade E.

3.3.2. Qualitative characteristics of meat in two and three crossbreeds (2010).

The research was conducted in the "Golyamo Vranovo - Invest" pig complex with random sample of 48 fattened pigs distributed as follows:

Group I - (Landrace x Large White) x Duroc - n= 12 (6 ♂; 6♀)
II group - (Landrace x Large White) x Pietrain - n= 12 (6 ♂; 6♀)
Group III - (Landrace x Large White) x Line 331 - n= 12 (6 ♂; 6♀)
VI group - (Landrace x Large White) - n= 12 (6 ♂; 6♀)

3.3.3. Qualitative characteristics of meat in two hybrid combinations raised under industrial conditions. (2016)

The research was conducted in the "Golyamo Vranovo - Invest" pig complex with random sample of 30 fattened pigs according to the following scheme:

Table 2. Scheme of the study

I group	II group
(Landrace x Large White) Pietrain (LxLW)xP N= 15 (8♂; 7♀)	(Landrace x Duroc) Pietrain (LxD)xP N= 15 (8♂; 7♀)

♂* - barrows

The processing of the carcass was carried out by skinning according to traditional technology with vertical separation of the skin. Carcass weight in both groups was respectively in group I – (70.04 kg, Sx=0.30) and group II – (69.56 kg Sx=0.32).

3.3.4. Establishing the values of the signs percentage of lean meat, weight of the carcass and quality characteristics of m. Longissimus thoracis in purebred pigs. (2018)

The research was conducted in the Golyamo Vranovo - Invest pig farm (2018) with a random sample of 48 fattened pigs distributed as follows:

Group I - (Landrace) - n= 10 (5 ♂; 5♀)

II group - (Pietren) - n= 10 (5 ♂; 5♀)

III group - (Duroc) - n= 10 (5 ♂; 5♀)

VI group - (Large White) - n= 10 (5 ♂; 5♀)

Carcass weight is respectively for group I - Landrace – (83.39 kg, SE Mean =0.55) and group II Pietren – (84.06 kg SE Mean =0.89), group III - Duroc – (84.06 kg SE Mean =0.89), group IV – Large white - (84.84 kg SE Mean =0.76).

3.3.5. Establishing the values of the signs percentage of lean meat, weight of the carcass and quality characteristics of m. Longissimus thoracis at two-breed crosses. (2019)

The research was conducted in the Golyamo Vranovo - Invest pig complex (2019) with a random sample of 20 fattened pigs according to the following scheme. (Table 3)

Table 3. Study scheme

I group	**II group**
Duroc x Landrace (DxL) **n=10 (10♀)**	**Pietrain x Landrace** (PxL) **n=10 (10♀)**

3.3.6. Carcass quality and m. Longissimus thoracis in Danube White pigs breed.

The study includes 24 pigs of the Danube white breed from the herd of Agricultural institute – Shumen, raised in individual boxes. The pigs are 200 days old slaughtered and the percentage of lean meat was determined.

3.3.7. Influence of the method of cultivation on the thickness of fat and the percentage of lean meat in female maintenance pigs of the Danube White breeds and Landrace.

The study was conducted with a total of 48 female pigs, 24 of which from the Danube White breed and 24 from the Landrace breed from the herd at the Experimental Base of the Agricultural Institute - Shumen. The animals of each breed were equalized by the method of analogues for origin, age and live weight, and divided into three groups of 8 as follows:

The study began when the pigs reached 110 days of age and 40 kg of live weight.

3.4. East Balkan swine breed

3.4.1. Slaughter qualities of IB breed pigs in one weight class raised in different regions of the country.

The study was conducted with a sample of 17 pigs - Group I, 7 pigs raised in the region of the village of Veselinovo (Shumensko) and Group II with 10 pigs, raised in the region of the village of Tsonevo (Varnensko). The groups were equal in sex, age and weight class (90 ± 5kg).

3.4.2. Slaughter qualities of East Balkan breed pigs in different weight classes.

The subject of the study were 17 pigs of the East Balkan breed divided into two groups, respectively, Group I - 7 pigs in the 90kg weight class and Group II - 10 pigs in the 100kg weight class.

3.4.3. Slaughter qualities of "heavy" pigs of the East Balkan breed.

The research was carried out with a sample of 18 pigs equalized by gender and age, raised on the same farm, in accordance with nature according to traditional grazing technology and fed with wheat in the area of the village of Veselinovo. When they reached 90 kg, 7 pigs were slaughtered (group I) and the rest were raised up to 125 kg (group II).

The pigs subject to research (item 4.4.2.1, 4.4.2.2, 4.4.2.3) were raised under traditional conditions for the breed - free grazing, with feeding (Regulation No. 6/20.03.2007). The slaughter of the experimental animals was carried out in a licensed slaughterhouse, and for the processing of the carcass, the skinning method with vertical separation of the skin was used. After 24 hours of cooling, a slaughter analysis was performed according to the Regulations for the Assessment of Breeding Value, Production and Classification of Breeding Pigs (1996).

3.4.4. Physicochemical composition of m. Longissimus thoracis in pigs of the East Balkan breed.

The study was conducted with 16 pigs (8 female and male castrated pigs each), negative for porcine stress syndrome (PSS) raised in the village of Veselinovo, Shumen region.

The pigs were raised under traditional conditions for the breed - free grazing, with feeding (Regulation No. 6/20.03.2007). The live weight of pigs is between 95 and 100 kg. The slaughter was carried out after 40 km of transport and a 12-hour rest in a regulated slaughterhouse, in compliance with the veterinary requirements for the slaughter of animals of this breed.

The samples from m. LT were taken after storage of the carcasses 24 h post mortem (p. m.) at 4º C. After the measurement of pH 45 min p. m. two groups were formed – 11 animals with pH > 6.00 and 5 animals with pH ≤ 6.00 (PSE meat).

3.4.5. Fatty acid composition of m. Longissimus thoracis in pigs of the East Balkan breed.

The subject of the research were 10 (5♀ 5♂) East Balkan pigs with a live weight of 107±1.65 kg. After slaughter and 24 h post mortem cooling at 4º C, samples were taken from m. LT above last rib.

3.5. Development of methods for evaluating the meat productivity of skinned pigs.

Pig carcasses (Youna ♀ x Pietren ♂) slaughtered at 105±2.5 kg were used in the study, after chilling the left half, necropsy was performed according to EU reference methodology (Scheper and Scholz, 1985).

3.5.1. Determination of slaughtering qualities and morphological components in the carcass and its separate parts in skinned pigs.

3.5.2. Dependencies between morphological components and some dimensions of the carcass and its individual parts.

The coefficients of phenotypic correlation and regression were determined with the methods of variation statistics (Evtimov et al., 1982)

3.5.3. Possibilities of using some dimensions established during dissection when developing methods for evaluating the meat productivity of skinned pigs.

3.5.4. Possibilities of using the results of dissection when developing methods for evaluating the meat productivity of fattened pigs.

3.6. Research methods The following analyzes were carried out during the activities to fulfill the set tasks:

3.6.1. Postmortem analyzes Postmortem analyzes were performed after 24 hours of cooling at 4º. The following methodologies were used:

3.6.1.1. Regulations for the Assessment of Breeding Value, Performance and Grading of Breeding Swine (1996).

3.6.1.2. Reference methodology of the EU (Scheper and Scholz, 1985).

3.6.2. Physicochemical composition of m. Longissimus thoracis

The following methods were used for meat quality assessment: pH in meat was determined according to the method described by Pozhariskaia et al. (1964). The water-holding capacity (WHA) of the meat was determined by the classical method of Grau and Hamm, modified by Pinkas (1973). Meat color was determined according to the method described by Pinkas and Drbohlav (1977) using an R 45/0 remission attachment to a Spekol-10 spectrocolorimeter at a wavelength of 525 nm.

To determine possible muscle damage caused by stress, we used the methodology of Warriss, (2000), with the following critical pH values of m. Longissimus thoracis for PSE, normal and DFD meat.

Category	pH45min	pH24hr
PSE	<5.8	<5.3
Normal	5,8-6,4	5,3-6,0
DFD	>6.4	>6.0

3.6.3. Fatty acid analysis

To determine the fatty acid composition, samples of back fat (inner and outer layer) and muscle (m. Longissimus thoracis) were examined. Samples were taken at the last rib.

Total lipids were extracted by the method of Bligh and Dyer (1959) and methyl esters were obtained by the method of Christie (1973). The analysis was carried out on a C Si 200 gas chromatograph equipped with a capillary column (DM-2330:30 m×0.25 mm×0.20 μm) and hydrogen as a carrier gas. Fatty acids are presented as a percentage of the total methyl esters identified (Christie, 1973).

3.7. Lean meat content in vivo

Lean meat content in vivo was measured with a PIG log 105 apparatus using the following regression model:

$LM=63.8662-0.4465x1-0.5096x2+0.1281x3$

where: LM - percentage of lean meat in the carcass

x1 - fat thickness measured 3-4 lumbar vertebra at 7cm lateral (mm)

x2 - thickness of fat measured between the 3-4 last ribs at 7 cm lateral (mm)

x3 - thickness of m. longissimus dorsi between the 3-4 last ribs at 7 cm lateral (mm)

3.8. Post-mortem lean meat content measured with an Ultra FOM 200 device

The classification was carried out with an Ultra FOM 200 device, and the lean meat content was determined according to the model:

$Y = 67.13 – 0.3284 X1 – 0.3725 X2 +0.01515 X3$

where: Y- lean meat content (%)

X1- thickness of fat and skin, measured 7 cm from the midline of the carcass, between the 3rd and 4th last lumbar vertebrae (mm)

X2- thickness of fat and skin measured 7 cm from the midline of the carcass, between the 3rd and 4th last rib (mm)

X3- thickness of the MLD (musculus Longissimus dorsi) measured at point X2.

3.9. Statistical processing

The results of the experiments were processed according to the methods of variational statistics.

Influence of the year and season on the quality characteristics of the carcass was evaluated by means of a two-factor analysis (ANOVA). The results were processed with the JMPv.12 software.

The obtained results of the fatty acid analyzes were processed with the statistical package JMP v7. When processing the results, t-test and one-factor variance analysis with subsequent multiple comparisons Tukey post-hoc test were applied.

Mathematical models for predicting the percentage of lean meat in the carcass were developed according to the method of Caueseur et al., (2003) with the Minitab 17 software.

$\hat{y} (x) = \beta o + \beta 1 x 1 +.... + \beta p x p$

where, $\hat{y}$ (x) – estimated value of the percentage of lean meat in the carcass

β o – constant β1…..p – regression coefficients (weight factor)

x1…..p – values of the variables used

The effectiveness of the predictive models will be determined by the values of the coefficient of determination (R2) and the residual standard error (RSE).

5. RESULTS AND DISCUSSION

5.1. Study of some quality characteristics of pig carcasses produced in the country.

5.1.1. Establishing the values of the signs percentage of lean meat and carcass weight.

The main qualitative characteristics of pig carcasses established for the period 2012 - 2015 are shown in Table 4. The percentage of lean meat for the period under study is 56.01%. The average weight of quality pig carcasses is 84.58 kg. The results show that within the individual classes of the (S)EUROP system, reliable differences in carcass weight are established.

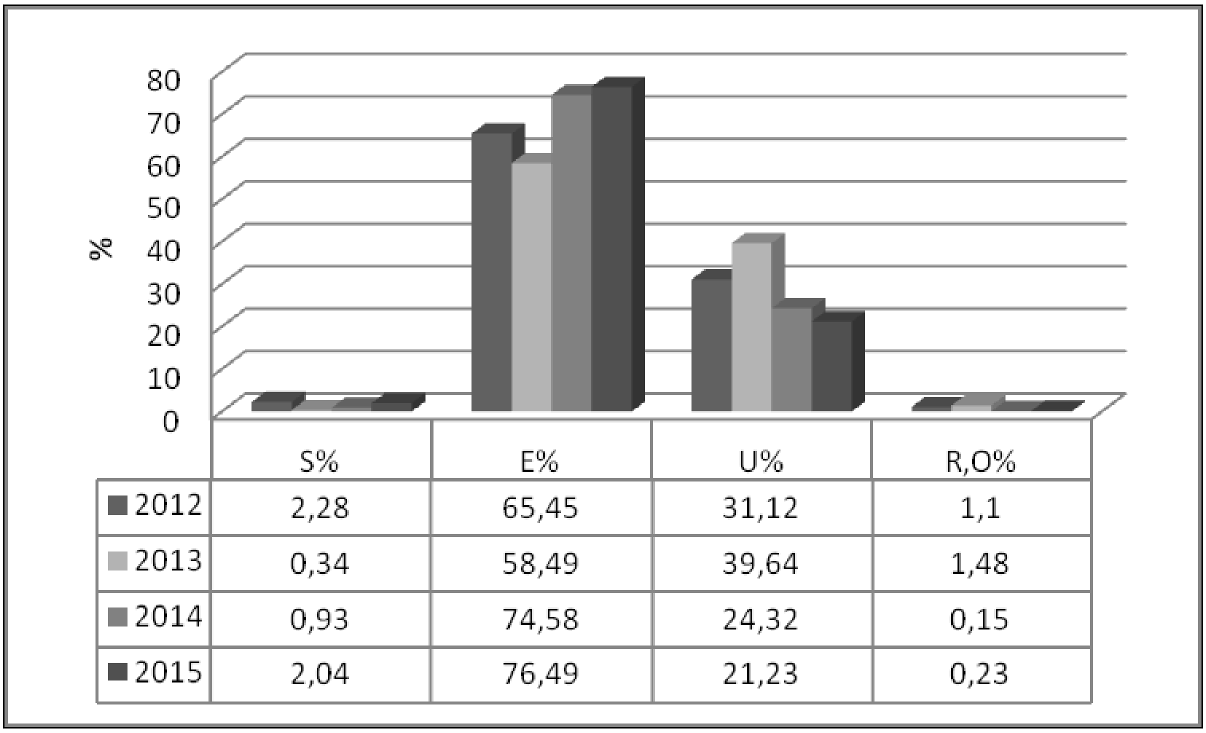
Slaughter carcasses with a high content of lean meat in the carcass were characterized by lower weight ($P \leq 0.001$). In class S, the established value for the characteristic chilled carcass weight is 78.350 kg, which is 5.25 kg, 8.80 kg, 14.53 kg and 15.31 kg less than those in classes E, U, R and O ($P \leq 0.001$).

Class E carcasses are lighter than those in classes U, R and O by 3.55 kg respectively, 9.28 kg and 10.05 kg.

Table 4. Weight and content of lean meat in carcasses of different classes under the SEUROP system.

Class			Number	Chilled carcass, kg				Lean meat content, %		
			n	$\bar{x}$	C	E	t-test	$\bar{x}$	C	E
Class according to SEUROP	1	S	3055	78,35	9,92	0,18	1-[2;3;4;5]*** 2-[3;4;5]*** 3-[4;5]***	61,41	2,27	0,04
	2	E	128867	83,60	10,1	0,03		56,91	2,09	0,01
	3	U	53077	87,14	9,68	0,04		53,70	2,07	0,01
	4	R	1182	92,87	10,1	0,30		48,82	2,21	0,06
	5	O	30	93,65	10,7	1,96		43,31	3,41	0,62
Total			186211	84,58	10,2	0,02		56,01	3,69	0,01

During the individual years of the study, there was a slight increase in carcasses in class S and a decrease in those in classes U and R by 13.89% and 0.89%, respectively (Graph 1). The relative share of class E increased from 65.45% in 2012 to 76.49% in 2015. The differences are due to the fact that class S in our study occupies a very low percentage of the sample.



Graph 1. Distribution of carcasses by classes of lean meat

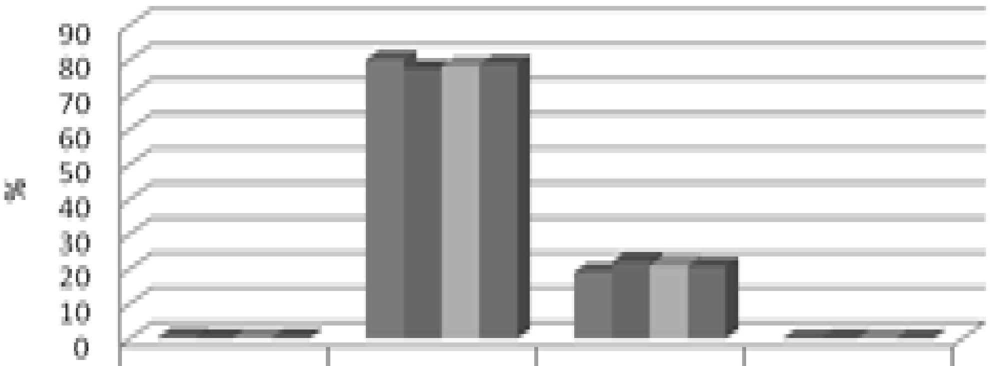
The results of another study of the main quality characteristics of pig carcasses established for the period 2016-2019 are shown in table 5. The percentage of lean meat for the study period was 56.25%.

Table 5. Weight and content of lean meat in carcasses of different classes under the SEUROP system.

Class			Number	Chilled carcass, kg				Lean meat content, %		
			n	$\bar{x}$	sd	C	t-test	$\bar{x}$	sd	C
Class according to SEUROP	1	S	1124	78.856	7.84	9.95	1-(2,3,4,5)*** 2-(3,4,5)*** 3-(4,5)*** 4-5***	60.34	0.43	0,72
	2	E	236624	83.837	9.07	10.82		56,79	1.86	1.91
	3	U	62549	87,159	9,81	11.27		53,78	1.05	1.95
	4	R	307	96.392	10,27	10.66		48,78	2,12	4.35
	5	O	19	95.080	11.90	12.51		41.59	3,32	8.00
total			300623	84,517	9.33	11.05		56.25	2.25	4.01

The average weight of quality pig carcasses is 84.517 kg. The results show that within the individual classes of the SEUROP system, reliable differences in carcass weight are established.

During the individual years of the study, a reduction of carcasses in class S by 0.3% was established (Graph 2).



	S%	E%	U%	R,O%
2016	0,53	80,18	19,2	0,08
2017	0,27	77,4	22,23	0,1
2018	0,34	78,34	21,17	0,15
2019	0,32	78,78	20,82	0,08

Graph 2. Distribution of carcasses by classes of lean meat

The relative share of class U increased from 18.67% in 2016 to 20.82% in 2019. For the same period, carcasses classified in class E decreased from 80.18 to 78.78% respectively. Pulkrábek st. al. (2011), in the study of 4 subgroups of pigs - I - 9502 pcs., II - 31610 pcs., III - 9679 pcs. and IV - 15,311 animals, slaughtered in 1995, 2001, 2005, and 2010, found a carcass weight of 89.14, 87.66, 86.68. and 90.89 kg and percentage of lean meat 55.05, 54.64, 55.60 and 56.33%. For the studied period, the relative share of carcasses from classes S, E and U increased from 68.4% in 1995 to 96.1% in 2010. During this period, the share of classes R and O decreased from 26.4% and 4.8% to 3.6 and 0.3%.

Carcasses classified in class E occupy a very low share in the researched sample that for the researched period 2012-2019. In 2012 and 2015, this class occupied a little over 2%, and in the period after 2016, a permanent tendency to decrease to 0.27-0.32% was established. The small number of produced pigs classified in the highest class of the system can be explained by the lack of interest in the market for this product. On the other hand, the extreme values (over 60%) of lean meat in the carcasses create prerequisites for deterioration of the quality characteristics of the carcass.

5.1.2 Fat thickness and m. Longissimus thoracis of pig carcasses in different classes.

The average thickness of fat in 2014, measured with an Ultra FOM 200 device in t x1, was 19.01 mm. (C=18.07%) moving within the limits of 12.56 mm. (C=12.4%) for class S up to 29.91 mm. (C=11.52%) for class R (Table 6). A similar trend is observed in point x2, where the differences are within the limits of 9.29 mm. (C=14.48%) to 23.54 mm. (C=15.39%). For values close to our established values, Vítek et al. al (2012). Quite logically, an inverse relationship is observed with regard to the thickness of the MLD in t x3 - the established average values for class S are 63.70 mm. (C=14.7%), and for class R - 54.54 mm. (C=12.48%).

Table 6. Fast thickness and m. Longissimus thoracis of pig carcasses in different classes.

Class		Number	x_1, mm			x_2, mm			x_3, mm		
			$\bar{x}$	E	C	$\bar{x}$	E	C	$\bar{x}$	E	C
1	S	394	12,56	0,61	12,04	9,29	0,73	14,48	63,70	0,74	14,70
2	E	31363	17,93	0,09	15,24	14,19	0,10	18,44	59,48	0,07	12,25
3	U	10228	22,46	0,12	12,26	17,98	0,15	15,13	56,28	0,13	12,89
4	R	67	29,91	1,41	11,52	23,57	1,88	15,39	54,54	1,80	14,48
Total		42052	19,01	0,09	18,07	15,08	0,10	2,97	58,73	0,06	12,68

The results of the quality characteristics of the examined carcasses are shown in Table 7. The estimate of lean meat in the examined sample was 56.21%, and the weight of the carcass was 86.529 kg. The values of the variables involved in the predictive model were respectively x1 - 19.01 mm., x2 – 15.08mm. and x3 - 58.73 mm. Class S with a carcass weight of 83.404 kg and a percentage of lean meat of 60.64%, the thickness of the fat and m. Longissimus thoracis measured at points x1 x2 x3 is 12.56 mm, 9.29 mm and 63.70 mm respectively.

In class E, the established characteristics were: carcass weight 86.184 kg, lean meat percentage 56.92, fat thickness and MLT measured in points x1 x2 x3e respectively 17.93 mm 14.19 mm 59.48 mm.

Table 7. Weight and content of lean meat in carcasses from different classes under the (S)EUROP system

Class		Number	Weight, kg			Lean meat, %		
			$\bar{x}$	E	C	$\bar{x}$	E	C
1	S	394	83,404	0,44	8,71	60.64	0.04	0.91
2	E	31363	86,184	0,05	8,36	56.92	0.01	2.07
3	U	10228	87,680	0,09	8,67	53.91	0.02	1,80
4	R	67	90,790	1,16	9,50	49,25	0,18	1,49
Total		42052	86,529	0,04	8,48	56,21	0,02	3,18

5.1.3. Determining the percentage of lean meat in slaughter carcasses from different weight classes.

The analysis of the qualitative characteristics in different weight classes of the studied sample for the period 2012-2015 (Table 8) shows a variation in the range from 2.87 to 3.67% for the weight of the carcass and from 3.3 to 4.3% for the percentage lean meat content.

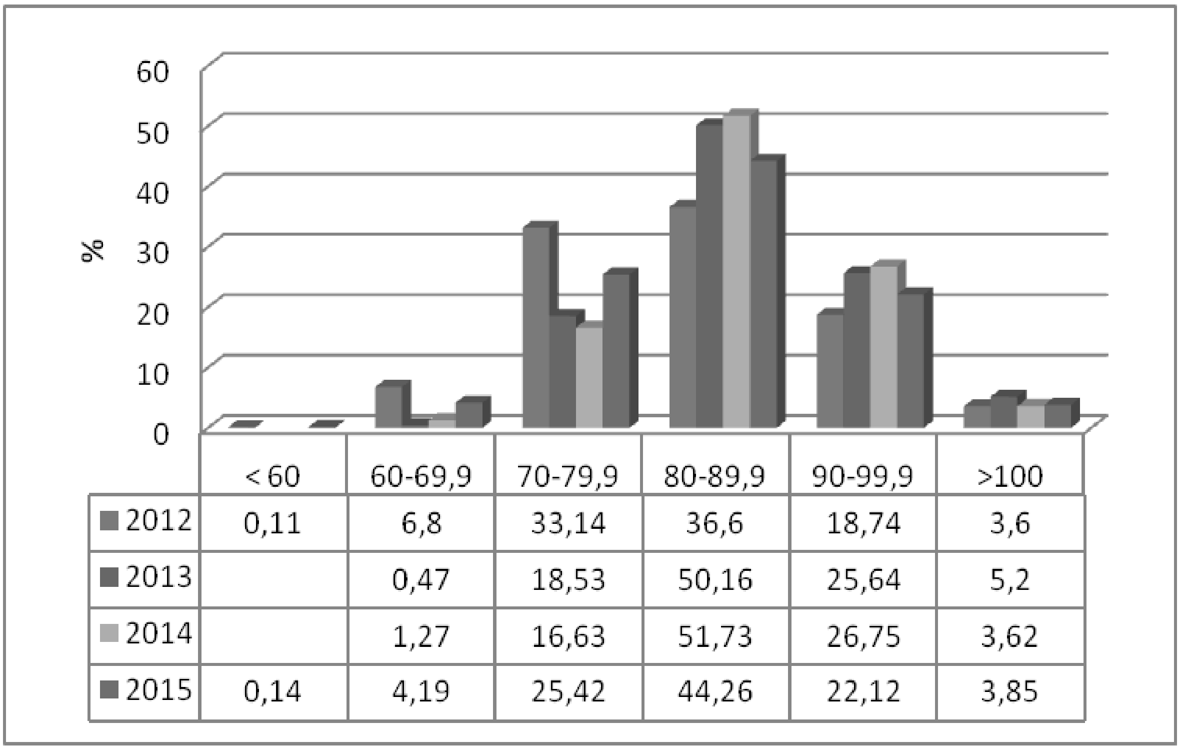
Table 8. Weight and content of lean meat in carcasses of different weight classes

Class			No.	Chilled carcass, kg			Lean meat content, %			
			n	$\bar{x}$	C	E	$\bar{x}$	C	E	t-test
Weight class, kg	1	< 60	264	57,893	3,63	0,22	57,28	3,3	0,21	1-2* 1-[3;4;5;6]*** 2-[3;4;5;6]*** 3-[4;5;6]*** 4-[5;6]*** 5-6***
	2	60-69,9	7819	67,059	3,56	0,04	57,03	3,5	0,04	
	3	70-79,9	47336	75,842	3,63	0,02	56,54	3,5	0,02	
	4	80-89,9	82419	85,028	3,29	0,01	55,98	3,4	0,01	
	5	90-99,9	51198	93,853	2,87	0,01	55,49	3,7	0,02	
	6	>100	7175	104,11	3,67	0,04	54,73	4,3	0,05	
Total			186211	84,588	10,2	0,02	56,01	3,6	0,01	

System graded (S) EUROP carcasses weighing up to 99.9 kg are graded E, with the percentage of lean meat decreasing from 57.28% (< 60 kg) to 55.49% (90-99.9 kg).

Distribution of carcasses by weight classes by year (Graph 3) shows a tendency to increase carcasses in weight classes 80-89.9 kg. and 90-99.9 kg. for the period 2012-2014. For the entire period of the study, the weight class 80-89.9 kg occupies 44.26% and together with the classes- 70-79.9 kg (25.42%) and 90-99.9 kg (22.12%), represent 91.8% of the studied sample.

The results of another study of the main quality characteristics of pig carcasses established for the period 2016-2019 are shown in table 9. The analysis of the quality characteristics in different weight classes of the studied sample for the entire period does not show significant differences in the weight of the carcasses within the class. The coefficient of variation ranges from 2.85% to 4.02%. Graded carcasses of all weight classes are graded E, with 14 percent lean meat decreasing from 56.42% (60-69.99) to 55.30% in the highest grade (>100).



Graph 3. Distribution of carcasses by weight classes - by years.

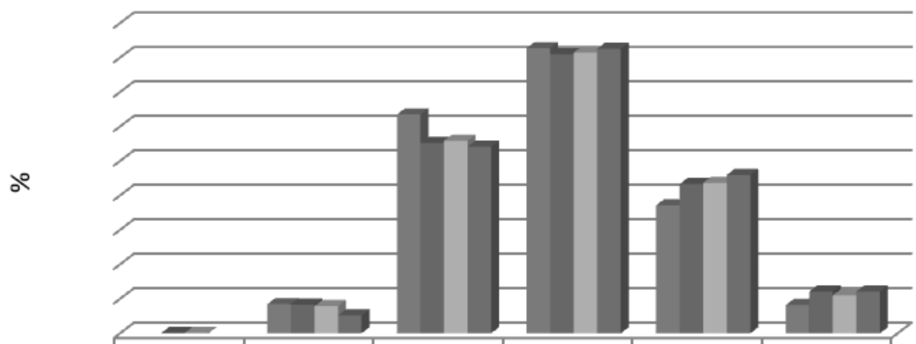
Table 9. Weight and lean meat content in slaughter carcasses from different classes

Class			Number	Chilled carcass, kg			Lean meat content, %			
			n	$\bar{x}$	sd	C	$\bar{x}$	sd	C	t-test
Weight class, kg	1	<60	110	58.133	1.65	2.85	56.42	1.69	3.00	1-2* 1-[3;4;5;6]*** 2-[3;4;5;6]*** 3-[4;5;6]*** 4-[5;6]*** 5-6***
	2	60-69,9	12069	67,274	2.17	3.23	56.50	1.67	2.97	
	3	70-79,9	85772	75.830	2.71	3.58	56.18	1.95	3.46	
	4	80-89,9	122940	84.754	2.83	3.34	56.32	2.59	4.01	
	5	90-99,9	63539	93.985	2.57	2.93	55.96	2.58	4.61	
	6	>100	16193	104.53	4.20	4.02	55.30	2.36	4.26	
Total			300623	84,51	2.70	3.38	56,25	2.12	3.99	

*P<0.05; ** P<0.01; ***P<0.001.

In the individual weight classes, a decrease in the relative share of carcasses weighing less than 80 kg was found (Graph 4).

During the studied period, a relatively equal percentage of the 80-89.9 kg class was preserved and a permanent tendency to increase carcasses over 90 kg by 4.41% (90-99.9 kg) and 1.98% (>100) respectively.



	< 60	60-69,9	70-79,9	80-89,9	90-99,9	>100
2016		4,23	31,75	41,36	18,57	4,09
2017	0,05	4,14	27,62	40,48	21,66	6,05
2018	0,06	3,94	27,93	40,72	21,83	5,51
2019		2,59	27,07	41,28	22,98	6,07

Graph 4. Distribution of carcasses by weight classes - total 2016-2019.

5.2. Influence of the year and the season on the quality characteristics of the carcass.

The average lean meat percentage (LMP) was 56.34% and the slaughter weight of the slaughtered pigs was 85.00 kg (Table 10). The results for LMP are close, and the carcass weight is significantly higher compared to those found in our previous study (Nakev 2010), (LMP - 56.72%, 76.80 kg), conducted with the carcasses of 100762 animals. pigs, in 2009.

Table 10. Mean, standard deviation (SD), coefficient of variation (CV), minimum and maximum values for percent lean meat, carcass weight, fat thickness, and m LT thickness

Indicator	Lean meat, %	Carcass weight, kg	Fat X_1, mm	Дебелина на сланината X_2, mm	m. LT X_3, mm
Average	56.34	85.13	18.59	15.14	58.28
SD	1.85	8.44	3.61	3.18	8.89
CV, %	3.28	9.91	19.43	21.01	15.25
Minimum	36.6	49	7	7	7
Maximum	63.1	132.01	47	51	92

The highest variability between the analyzed traits was found in the back fat. Depending on the measurement point, it varies from 19.43% to 21.01%. The coefficients of variation for the carcass weight and MLD height traits were 9.88% and 15.25%, respectively. Deviations from the average value for LMP do not exceed 3.3%.

The ANOVA results showed that, apart from the significant effect of year and season of slaughter, both factors interacted significantly (Table 11).

The present study shows significant differences in the dynamics of changes in carcass characteristics are affected by the season and year of slaughter. The highest percentage of lean meat was found in animals, slaughtered during the summer (56,48%), followed by those slaughtered in the spring (56,34%), autumn (56,29%) and winter (56,10%).

Pigs slaughtered in winter had the highest carcass weight and back fat thickness X1 and X2.

Table 11. Results of ANOVA test for the effect of year, season and their effects on carcass traits

Source	Lean meat percentage			
	df	MS	F	Sig.
Year	1	960.69	285.35	***
Season	3	531.45	157.45	***
Effect	3	415.02	123.27	***
Error	106020			
	Carcass weight			
	df	MS	F	Sig.
Year	1	119323.69	1745.49	***
Season	3	23854	348.94	***
Effect	3	17693.44	258.82	***
Error	106020			
	Fat thickness X_1			
	df	MS	F	Sig.
Year	1	9515.68	752.03	***
Season	3	2595.77	205.14	***
Effect	3	5113.59	404.13	***
Error	106020			
	Fat thickness X_2			
	df	MS	F	Sig.
Year	1	104.18	10.39	**
Season	3	1122.95	111.45	***
Effect	3	341.58	33.90	***
Error	106020			
	Thickness of m. LD X_3			
	df	MS	F	Sig.
Year	1	8786.83	113.08	***
Season	3	22757.96	292.89	***
Effect	3	12809.82	164.86	***
Error	106020			

** $P<0.01$; *** $P<0.001$

Analysis of variance showed a highly significant effect of year, season and interaction of both factors for all traits studied. It was found that, in 2015, compared to 2014, slaughtered pigs had lower carcass weight, MLD height and back fat thickness in X1. The lean meat percentage (LMP) of animals slaughtered in 2015 was 56.4% and was 0.19 percentage points higher than those slaughtered in 2014.

The production obtained in autumn had the lowest carcass weight. The percentage of lean meat (LMP), depending on the time of year, varies in a narrow range from 56.10% to 56.48%. The highest value of this trait is found in pigs slaughtered in summer, followed by spring, autumn and winter.

5.3.1. Quality of meat in carcasses in different classes according to the EUROP system.

From the values of the variables, weight and percentage of lean meat shown in Table 12, it is clear that the carcasses from group II have thinner fat in the points x1 and x2 compared to group I with 3.49 and 3.08 mm, respectively (P <0.01).

Table 12. Variable values, carcass weight and percentage of lean meat in the studied sample

Indicators	I group (LxLW)xD			II group (LxLW)xD			Total		
	$\bar{x}$	C	E	$\bar{x}$	C	E	$\bar{x}$	C	E
Carcass weight, kg	98.83	3.01	1.06	99.79	3.43	0.99	99.41	3.23	0.72
x_1, mm	21.00 b	9.52	3.36	17.75 b	11.79	3.40	19.05	13.57	3.03
x_2, mm	18.25 b	10.45	3.69	15.16 b	10.45	3.02	16.40	13.90	3.11
x_3, mm	59.00	10.33	3.65	61.58	11.02	3.18	60.55	10.71	2.39
% LM	54.40	1.04	0.44	56.68	1,55	0.45	55.77	2.46	0.55

Values, different from significant are marked with the following letters: *a:a P≤0.05; b:b P≤00.01; A:A P≤00.001*

Table 13. Physicochemical characteristics of m. Longissimus thoracis

Indicators	I group (LxLW)xD			II group (LxLW)xD		
	$\bar{x}$	C	E	$\bar{x}$	C	E
Water, %	71.66	1.23	0.43	72.32	0.96	0.27
Fats, %	2.38	29.35	10.37	2.00	15.54	4.48
Mineral substances , %	1.29	9.79	3.45	1.31	9.41	2.97
Protein, %	24.65	3.79	1.34	24.36	3.03	0.87
Water retention, %	32.02	5.71	2.02	33.02	5.02	1.45
pH45 min p.m.	6.17	1.00	0.35	6.16	1.41	0.40
pH24 h p.m.	5.94	1.51	0.53	5.91	2.20	0.63
Color,525 nm	20.42	7.14	2.52	22.68	20.37	5.85
Loss when boiling, %	44.37	7.22	2.55	44.66	7.14	2.55
Loss when baking, %	48.75	9.09	3.21	46.66	13.18	3.80
Thickness of muscle fibers, µm	43.33	12.12	4.28	42.29	6.81	1.97

The established relatively low coefficients of variation for the weight of the cold carcass in the groups are indicative of a good leveling of the animals, and the differences between the two groups are insignificant. Similar are the results for varying the percentage of lean meat.

No significant differences were found between the two groups for some of the indicators characterizing the physicochemical composition of m. Longissimus thoracis –

moisture, protein, fat and ash (Table 13). In the first group, a tendency was found for less moisture (0.66%) and more protein (0.29%) and fat (0.38%) compared to the second group.

5.3.2. Meat quality characteristics of two- and three-breed crosses (2010).

The results of the study of the chemical composition of m. Longissimus thoracis (Table 14) show that there are no significant differences between the studied origins, except for crosses with father Duroc.

They have a relatively lower proportion of water and a higher proportion of fat and protein, which makes the meat extremely suitable for fresh consumption, followed by GBhL, crosses with father Pietrain and line 337.

The values of the pH2 trait show that in crosses with Pietrain and line 337, the probability of appearance of pigs with reduced meat quality is higher. This is determined by the variation in the pH2 indicator, which is an indicator of the speed of the glycolysis process. Summarized data by sex show that there is a tendency for a higher proportion of fat (0.5%) and protein (0.36%) in male compared to female pigs. An exception is found in Landrace x Large White crossbred pigs.

According to the indicators characterizing the technological properties, no significant differences were found.

Table 14. Results of the research on the qualitative characteristics of meat from different origins.

Origin	**Sex**	Water		Fats		Protein		Mineral substances		Water retention		pH45 min p.m.		pH24 h p.m.		Color		Boiling		Baking	
		x	**C**	**x**	**C**	**x**	**C**	**x**	**C**	**x**	**C**	**x**	**C**	**x**	**C**	**x**	**C**	**x**	**C**	**x**	**C**
(LxLW)xD	♂	69.92	1.89	4.57	22.74	24.22	2.79	1.29	3.37	29.39	3.91	6.42	3.25	6.11	1.28	24.26	4.84	48.60	4.51	50.60	4.76
	♀	71.87	2.43	3.87	31.91	22.99	3.54	1.27	4.98	29.85	1.63	6.34	1.23	6.06	0.91	24.34	8.73	46.80	2.78	51.80	3.95
	total	70.89	2.48	4.22	26.94	23.61	4.06	1.28	4.07	29.62	3.91	6.53	2.85	6.09	1.13	24.31	6.66	47.70	4.08	51.20	4.29
(LxLW)xP	♂	72.67	2.14	2.81	28.54	23.27	3.60	1.24	4.23	31.01	1.83	6.05	5.75	5.90	3.95	23.58	7.88	47.40	4.11	51.00	4.38
	♀	73.12	1.93	2.66	21.68	22.96	3.56	1.25	4.97	28.39	2.65	5.99	2.97	5.91	2.95	25.54	3.94	47.60	4.83	52.40	3.19
	total	72.90	1.95	2.73	24.24	23.12	3.45	1.25	4.38	29.70	8.59	6.03	4.35	5.90	3.28	24.56	7.11	47.50	4.24	51.70	3.87
(LxLW)x**337**	♂	72.10	2.16	2.95	23.92	23.68	4.16	1.26	6.52	28.91	5.64	6.12	0.94	5.92	0.89	25.08	8.95	47.20	4.07	52.20	4.36
	♀	73.63	1.93	2.40	13.11	22.73	5.13	1.22	7.85	29.98	6.21	6.20	5.95	5.97	4.66	24.71	10.74	45.60	8.43	51.60	1.73
	total	72.86	2.25	2.68	22.11	23.21	4.88	1.24	6.95	29.44	5.92	6.10	4.39	5.95	3.21	24.89	9.34	46.40	6.44	51.90	3.20
LxLW	♂	72.91	3.60	2.86	20.65	22.94	9.18	1.28	5.27	30.09	5.94	6.54	3.38	6.08	1.31	23.76	3.67	46.80	6.30	51.40	4.26
	♀	71.72	2.05	2.98	27.74	24.02	2.95	1.28	5.62	29.67	3.43	6.17	4.98	6.02	1.51	25.06	10.74	46.60	4.94	53.00	3.77
	total	72.32	2.90	2.92	23.31	23.48	6.75	1.28	5.14	29.88	4.65	6.35	5.06	6.06	1.44	24.41	8.21	46.70	5.34	52.20	4.12

5.3.3. Qualitative characteristics of meat in two hybrid combinations raised under industrial conditions.

No significant differences were found between the two groups for some of the indicators characterizing the physicochemical composition of m. Longissimus thoracis – moisture and mineral substances (Table 15).

Table 15. Physicochemical composition and quality characteristics of m. Longissimus thoracis

Groups		I group (LxLW) x P	II group (L x D) x P
Water	$\bar{x}$	71,38	71,60
	$S\bar{x}$	0,29	0,27
Fats	$\bar{x}$	2,42a	2,99a
	$S\bar{x}$	0,09	0,25
Protein	$\bar{x}$	24,83	24,16
	$S\bar{x}$	0,27	0,26
Mineral substances	$\bar{x}$	1,37	1,35
	$S\bar{x}$	0,02	0,02
Water retention	$\bar{x}$	31,13	31,12
	$S\bar{x}$	0,34	0,33
pH45 min p.m.	$\bar{x}$	6,27	6,28
	$S\bar{x}$	0,05	0,04
pH24 h p.m.	$\bar{x}$	5,90	5,90
	$S\bar{x}$	0,01	0,03
Color	$\bar{x}$	21,73	20,84
	$S\bar{x}$	0,62	0,45

Values, different from significant are marked with the following letters: *a:a P≤0.05; b:b P≤00.01; A:A P≤00.001*

In the first group, there is a tendency for less moisture (0.22%) compared to the second group, and in the mineral composition the difference between the two groups is minimal (0.02%). In the hybrid combination with the participation of the Duroc breed (II group), the established amount fat in was higher by 0.57% ($P \leq 0.05$). This shows that the participation of the Duroc breed has a beneficial effect on the phenotypic manifestation of this trait. The results of our study show no deviation from the parameters of "normal" meat (Warriss, 2000). In both groups, the values of pH1 (6.27, 6.28), pH2 (5.90, 5.90) and BZS (31.13, 31.12) did not differ significantly. In pigs from the II group, the reflection remission was 0.89% lower compared to that of the I group, but the difference was not statistically proven. In pigs from the II group, the reflection remission was 0.89% lower compared to that of the I group, but the difference was not statistically proven.

5.3.4. Determination of the values of the percentage of lean meat, carcass weight and quality characteristic traits of m. Longissimus thoracis in purebred pigs.

The results of the in vivo measurements with the PIGLOG-105 device show that the breeds used in the maternal position in the hybridization schemes (Landrace and Large White) do not differ reliably from those in the paternal position Pietrain and Duroc.

We found almost identical values for the trait percentage of lean meat in Landrace (56.26%) and Pietrain (56.27%), and a peak value for the studied trait in the Large White (57.58%). The percentage of lean meat in the Duroc breed is 56.06%.

In the case of the Duroc breed (table 16), the amount of fat found is higher compared to the other breeds subject to research ($P \leq 0.05$). Compared to the Large White pigs, the intramuscular fat in the Landrace and Pietrain groups was in greater quantity - by 0.53 and 0.52%, respectively. Moisture content was higher in Pietrain and Landrace compared to Duroc and Large White but the differences were not statistically proven. The amount of protein is highest in Large White.

Table 16. Physicochemical composition and quality characteristics of m. Longissimus thoracis

Indicators	Landrace	Pietrain	Duroc	Large White	SEM	Sig.
pH45 min p.m.	6.18	6.24	6.24	6.17	0.02	NS
pH24 h p.m.	5.85	5.84	5.87	5.87	0.01	NS
WHC	30.61	30.93	29.83	30.82	0.78	NS
Color	22.98	23.09	22.37	20.08	0.47	0.07
Fats	2.23ab	2.22ab	2.81b	1.70a	0.12	**
Protein	22.23	21.68	23.20	23.80	0.38	NS
Moisture	74.49	75.09	72.83	73.83	0.40	NS
Ash	1.04ab	1.01a	1.16b	1.12ab	0.02	*

Mean values associated with different letter designations differ significantly at $P<0.05$.

The results of the research show that one of the main factors underlying the variation in the quality characteristics of pork is the breed.

5.3.5. Fatty acid profile of back fat m. Longissimus thoracis in purebred fattening pig carcasses.

According to Table 17, 9 fatty acids were identified in the two layers of the back fat in the 4 breeds studied, with the highest content being C18:1n-9, followed by C16:0 and C18:2n-6. Differences between breeds were found only for C18:1n-9, which showed higher levels in the inner layer of fat in the Duroc breed ($P<0.05$) compared to the other breeds. In general, no strong effect of breed on the fatty acid composition of back fat was found.

The differences between the inner and outer layers of the back fat in the breeds are marked to a much greater extent. Saturated fatty acids in both layers include C14:0, C16:0, and C18:0. The latter differed significantly between the layers at Landrace ($P<0.001$) and Duroc ($P<0.05$), showing a higher content in the inner layer. This was also found in the pigs of the Pietren breed, where the content of C14:0 and C16:0 showed a tendency to increase in the inner layer by 18.52% and 11.42%, respectively. trends towards higher C14:0 and C16:0 contents in the inner layer were found in Landrace.

Table 17. Fatty acid composition of inner and outer layers of back fat

Fatty Acids	Landrace		Duroc		Pietrain		Large White	
	Inner	Outer	Inner	Outer	Inner	Outer	Inner	Outer
C14:0	1.90±0.07	1.76±0.06	1.84±0.12	1.73±0.11	1.89±0.10	1.55±0.14	1.80±0.13	1.57±0.13
C16:0	23.77±0.29	22.87±0.37	23.80±1.14	23.06±0.80	24.61±1.38	21.80±1.07	24.17±0.99	23.10±1.10
C16:1n-7	1.94±0.05	2.14±0.10	1.81±0.22	1.85±0.19	1.77±0.12	1.74±0.09	1.83±0.47	1.85±0.15
C18:0	11.72±0.26***	9.93±0.26	11.84±0.33*	10.59±0.30	11.19±0.86	9.63±0.58	11.18±0.41	10.65±0.41
C18:1n-9	35.77±0.94^{ab}	35.47±0.58	37.14±1.39^{a}	36.20±0.61	32.96±1.13^{b}	34.88±1.98	34.29±0.93^{ab}	36.11±0.70
C18:2n-6	21.80±0.75*	24.08±0.18	20.24±2.08	22.96±1.36	23.91±2.69	26.36±2.78	23.04±0.94	23.10±1.01
C18:3n-3	1.99±0.06**	2.28±0.03	1.75±0.17	2.02±0.13	2.02±0.27	2.30±0.26	2.11±0.11	2.11±0.13
C20:2n-6	0.84±0.03	0.85±0.04	0.93±0.11	0.93±0.06	0.99±0.08	1.04±0.08	0.96±0.07	0.91±0.06
C20:4n-6	0.57±0.03	0.62±0.01	0.65±0.05	0.66±0.03	0.66±0.05	0.70±0.07	0.62±0.04	0.60±0.03

Differences between inner and outer layers are significant *P<0.05; **P<0.01 and***P<0.001; Between the breeds the differences are reliable, if values are associated with different letters (P<0.05)

Significant differences between breeds were also found in a large part of fatty acids in m. LT (Plate 18).

Similar to core intramuscular lipids, Duroc pigs showed the highest levels of C14:0 ($P<0.05$) compared to Pietrain and Large White. The latter show a tendency towards the lowest amount of C14:0 of all breeds. This was not observed with respect to C18:0 in m. LT, where Duroc and Pietrain showed lower levels of this fatty acid compared to Landrace and Large White ($P<0.05$).

Table 18. Fatty acid content of m. Longissimus thoracis in different breeds

Fatty Acids	Landrace	Pietrain	Duroc	Large White	SEM	Sig.	rIMF
C14:0	1.57ab	1.54b	2.04a	1.49b	0.07	*	0.673***
C16:0	24.14	24.74	25.04	24.16	0.42	NS	0.231
C16:1n-7	3.03	3.01	3.40	2.68	0.10	P=0.1	0.491*
C18:0	12.71a	11.90b	11.84b	12.77a	0.12	***	-0.396
C18:1n-9	34.27ab	31.93b	40.22a	29.36b	1.09	***	0.727***
C18:2n-6	18.01a	19.41a	13.03b	21.09a	0.89	**	-0.717***
C18:3n-3	0.84	0.96	0.86	0.95	0.04	NS	-0.217
C20:2n-6	0.45	0.54	0.48	0.58	0.02	NS	-0.258
C20:3n-6	0.44bc	0.47ab	0.30c	0.63a	0.03	***	-0.704***
C20:4n-6	3.80b	4.52ab	2.30c	5.12a	0.30	***	-0.758***
C20:5n-3	0.14ab	0.18ab	0.09b	0.22a	0.01	*	-0.527**
C22:5n-3	0.52bc	0.71ab	0.34c	0.88a	0.05	***	-0.699***
C22:6n-3	0.08	0.09	0.06	0.07	0.01	NS	-0.104

*P<0.05; **P<0.01; ***P<0.001, ns- Values associated with different letters differ significantly (P<0.05).

5.3.5. Establishing the values of the signs percentage of lean meat, carcass weight and quality characteristics of m. Longissimus thoracis in two crossbreeds.

The results of the in vivo measurements with the PIGLOG-105 device show that both crosses do not differ significantly in terms of percentage of lean meat in the carcass and 24 are classified in class E according to the SEUROP system. The obtained results are completely logical, against the background of practically identical values for the sign, percentage of lean meat found by us in purebred pigs - Landrace (56.26%), Pietrain (56.27%), Large White (57.58%) and Duroc is 56.06%.

The results of the study (Table 19) show no deviation from the parameters of "normal" meat (Warriss, 2000). In both groups, the values of pH1 (6.18, 6.16), pH2 (5.86, 5.85) and water retention (25.23, 24.98) did not differ significantly. In pigs from the II group, the reflection remission was 0.72% lower compared to that of the I group, but the difference was not statistically proven.

In the cross with the participation of the Duroc breed, the amount of fat found was higher compared to the second group. This shows that the participation of the Duroc breed in the maternal position in the crossbreeding schemes has a favorable influence on the phenotypic manifestation of this indicator.

Table 19. Physicochemical composition and quality characteristics of m. Longissimus thoracis

Groups / Indicators	I group D x L			II group P x L		
	$\bar{x}$	SE	C	$\bar{x}$	SE	C
pH45 min p.m.	6.18	0.03	1.65	6.16	0.02	1.16
pH24 h p.m.	5.86	0.02	1.39	5.85	0.02	1.00
Color	25.29	0.60	7.15	24.57	0.86	10.55
Water retention	25.23	0.54	6.53	24.98	0.70	8.47
Dry matter	26.54	0.67	7.65	27.14	0.72	8.02
Protein	23.40	0.58	7.50	24.20	0.72	9.04
Fat	1.98	0.14	21.34	1.79	0.16	27.79
Mineral substances	1.12	0.03	8.91	1.15	0.04	10.91

The obtained results show that the intramuscular fat tissue is the most variable component of the meat. The coefficients of variation of fat are several times higher than those of other meat components 21.34% and 27.79%. The moisture content was higher and the protein lower in pigs from the DxL cross compared to PxL, but the differences were not statistically proven.

5.3.6. Fatty acid content in two crossbreeds

The results of the study show significant differences between the breeds and the crosses in terms of fatty acids in m. LT (table 20). The highest C14:0 content was found in Duroc, while the amount of C18:0 was highest in Duroc x Landrace animals. The studied groups did not differ in the content of the main saturated fatty acid - C16: 0. The amount of C16: 1n-7 was lower in the crosses, with Duroc pigs reaching the highest content of 3.40%.

C18:1n-9 levels were higher in Duroc and Duroc x Landrace compared to the other groups. These two groups have lower levels of C18:2, C20:3n-6 and C20:4n-6. The highest amounts of these fatty acids were observed in Pietrain, Pietrain x Landrace and Landrace. Compared to the other groups, Pietrain pigs had a higher amount of C22:5n-3. Total monounsaturated fatty acids (MUFA) were higher in Duroc pigs, but this group had lower polyunsaturated fatty acids (PUFA) along with Duroc x Landrace.

Table 20. Fatty acid content in m. Longissimus thoracis in breeds and crossbreeds.

Fatty acids	Landrace	Pietrain	Duroc	Duroc x Landrace	Pietrain x Landrace	SEM	Sig.
C14:0	1.57a	1.54a	2.04b	1.53a	1.47a	0.06	**
C16:0	24.12	24.75	25.03	24.88	25.08	0.33	ns
C16:1n-7	3.03ab	3.01ab	3.40a	2.72b	2.47b	0.08	**
C18:0	12.71b	11.90c	11.84c	13.90a	12.98b	0.15	***
C18:1n-9	34.27b	31.93b	40.22a	37.16a	31.93b	0.82	***
C18:2n-6	18.01ab	19.40a	13.03b	15.23ab	19.66a	0.68	**
C18:3n-3	0.85	0.96	0.86	0.92	0.91	0.03	ns
C20:2n-6	0.45	0.54	0.49	0.48	0.54	0.02	ns
C20:3n-6	0.44ab	0.47a	0.30bc	0.28c	0.47a	0.02	***
C20:4n-6	3.79ab	4.52a	2.31c	2.48bc	3.93a	0.21	***
C20:5n-3	0.16	0.18	0.09	0.06	0.10	0.01	0.06
C22:5n-3	0.52ab	0.71a	0.34b	0.33b	0.46b	0.03	***
C22:6n-3	0.08	0.09	0.05	0.03	0	0.01	ns
UFA	38.40	38.19	38.91	40.31	39.53	0.40	ns
MUFA	37.30b	34.94b	43.62a	39.88ab	34.40b	0.86	***
PUFA	24.30ab	26.87a	17.47c	19.81bc	26.07ab	0.96	***

Sig. **P<0.01; ***P<0.001, ns – insignificant

Table 21. Fatty acid content of the inner layer of back fat in different breeds and crossbreeds.

Fatty acids	Landrace	Pietrain	Duroc	Duroc x Landrace	Pietrain x Landrace	SEM	Sig.
C14:0	1.92	1.91	1.82	1.75	1.80	0.04	ns
C16:0	23.76	24.00	23.77	24.46	24.34	0.39	ns
C16:1n-7	1.93	1.72	1.81	1.75	1.88	0.06	ns
C18:0	11.72ab	10.49b	11.84ab	12.39a	11.41ab	0.19	*
C18:1n-9	35.47ab	32.00b	37.14a	35.24ab	36.22ab	0.56	*
C18:2n-6	21.80	25.92	20.33	21.31	21.05	0.72	ns
C18:3n-3	1.99	2.20	1.75	1.95	1.89	0.06	ns
C20:2n-6	0.84	1.06	0.93	0.80	0.86	0.03	ns
C20:4n-6	0.57b	0.70a	0.65ab	0.35b	0.55b	0.02	*
UFA	37.40	36.40	37.39	38.60	37.55	0.54	ns
MUFA	37.40ab	33.72b	38.95a	36.99ab	38.10ab	0.59	*
PUFA	25.20	29.88	23.66	24.41	24.35	0.82	ns

*P<0.05; ** P<0.01; ***P<0.001. Values, connected with different letters have significant differences.

Contrary to the lipid profile of muscle tissue, the differences between breeds and crosses found in back fat were significantly smaller. In the inner layer, there are discrepancies in the content of C18: 0, C18: 1n-9, C20: 4n-6 and the total amount of MUFA (Table 21).

Both C18:0 and C18:1n-9 are lower in Pietrain compared to Duroc x Landrace and Duroc. The total amount of MUFA significantly differed between Pietrain and Duroc, showing a lower content in Pietrain. This breed shows a higher C20:4n-6 content compared to the Landrace and both crosses.

5.4.1 Slaughter qualities of pigs from the Danube White breed. Physicochemical composition of m. Longissimus thoracis.

Pigs from groups R2 and D2 were classified in class E, and those from the other three groups - in class U according to the SEUROP system. On the other hand, the deviations in the content of lean meat are not significant and vary between 52.83 - 55.07% (Table 22).

Table 22. Measurement values and percentage of lean meat measured post mortem with the UltraFom 200 device

Indicators	Group				
	Control (C)	Experimental (D1)	Experimental (D2)	Experimental (R1)	Experimental (R2)
Live weight, kg	105,00±4,26ab	114,50±2,57a	109,00±2,45	109,88±2,79	113,13±1,55b
Carcass weight, kg	74,20±3,42a	81,77±2,01ab	75,97±1,99b	77,55±1,87	79,14±1,36
X1, mm	23,37±2,53	24,25±1,46a	19,75±0,62a	22,37±2,17	17,50±2,46
X2, mm	18,37±2,75	19,37±2,17	17,12±1,65	17,62±2,22	17,35±1,77
X3, mm	51,00±1,44a	58,87±2,17a	54,62±2,47	53,37±2,47	53,00±1,62
LM, %	53,39±1,76	52,83±1,24	55,07±0,65	54,03±1,28	55,01±1,00

- Significant differences are marked with the same letters, a-p<0,05.

The results obtained for the measured pH of m. Longissimus thoracis from steamed pigs in the early post mortem period (45 min post mortem) did not show statistically significant differences between the five studied groups. (Table 23). In the meat cooled to 0 - 4°C at 24 h post mortem, statistical differences ($p < 0.05$) were found in the pH values of the studied groups of meat. Statistically significant ($p < 0.05$) lowest pH values were found in experimental samples (R2), (D1) and (R1). The highest pH was in the control group (C). The difference in average values between the lowest and the highest pH level was found to be only 2.5% or 0.15 units, which did not significantly affect the quality characteristics of m. Longissimus thoracis.

Table 23. pH of m. Longissimus thoracis from steamed pigs during the early post-mortem period and during seven days cold storage at 0 - 4°C

Indicators	Groups					Significance
	Control (C)	**Experimental (D1)**	**Experimental (D2)**	**Experimental (R1)**	**Experimental (R2)**	
pH_1 (45 min)	6,25±0,02	6,21±0,02	6,19±0,04	6,15±0,04	6,28±0,05	N.S.
pH_2 (24 h)	6,00±0,05	5,88±0,01*	5,92±0,01	5,89±0,01*	5,85±0,02*	$p < 0,01$

The quality of meat and its nutritional value depend on the ratio of its individual ingredients (Culioli, et al., 2003). The results show that in all five groups of animals studied, the content of lipids in m. Longissimus thoracis does not differ significantly (Table 24).

Table 24. Physicochemical content of m. Longissimus thoracis 24h post mortem (0-4 ^{0}C)

Groups	**Water content, g/100 g**	**Dry matter, g/100 g**	**Protein, g/100 g**	**Lipids, g/100 g**	**Mineral salts, g/100 g**
Control (C)	71,18±0,72	28,81±0,72	22,30±0,61	5,43±0,76	1,09±0,03
Experimental (D1)	71,72±1,55	28,27±1,55	21,94±0,95	5,27±0,67	1,06±0,04
Experimental (D2)	72,29±0,40	27,71±0,40	20,91±0,28	5,76±0,43	1,04±0,02
Experimental (R1)	71,37±1,05	28,62±1,05	21,89±0,72	5,68±0,55	1,06±0,03
Experimental (R2)	72,07±1,19	27,92±1,19	22,04±1,14	5,12±0,24	1,06±0,05
Significant differences	NS	NS	NS	NS	NS

The values found for this trait are higher than those recommended by Verbeke et al. (1999) - from 2 to 4%, Fernandez et al. (2000) - 2.5 - 3.5%, Obadálek (1999) - 1.6 - 2.0%.

In our opinion, this is due to the peculiarities of the Danube White breed. The established higher lipid content is a prerequisite for good tenderness and contributes to an increase in the taste qualities of the meat. The highest content of total lipids was found in the meat of pigs from the third experimental group (D2) (5.76%). The high level of total lipids in the meat of this group of pigs had an adverse effect on the protein content, which was the lowest among the five groups of samples compared. No significant differences were found in protein levels.

5.4.2 Influence of the raising method on fat thickness and lean meat percentage in female pigs of the Danube White and Landrace breeds

The results of the study (Table 25) show that in pigs of the Landrace breed, fat thickness measured with Pig log 105 at point x1 is in the range of 20.8-26.6 mm. The fat thickness at point x2 is the lowest in animals from group III – 19.8 mm, and the highest in group I – 25.2. The fat thickness at point x2 is the lowest in animals from group III – 19.8 mm, and the highest in group I – 25.2 mm. The results are identical for the Danube White breed - the phenotypic values of the fat thickness trait in items x1 and x2 are the highest in pigs raised in pens with straw bedding. In both breeds, pen-housed animals have the greatest thickness of MLT (x3), which together with the relatively thin fat explains the high percentage of lean meat.

Table 25. Fat thickness and lean meat percentage in different types of raising.

Traits	Landrace						Danube White					
	I group		II group		III group		I group		II group		III group	
	$\bar{x}$	C	$\bar{x}$	C	$\bar{x}$	C	$\bar{x}$	C	$\bar{x}$	C	$\bar{x}$	C
x_1, mm	26.6	12.6	20.8	22.82	22.3	18.64	22.1	34.71	18.2	20.65	24.5	18.89
x_2, mm	25.2	9.87	20.2	17.25	19.8	15.07	24.7	27.72	16.8	23.79	25.1	19.54
MLT, mm	41.0	9.75	42.6	17.50	37.3	9.69	39.0	14.35	45.0	8.77	41.5	13.81
LM, %	44.2	4.37	50.3	8.63	48.4	7.75	47.2	14.55	52.1	5.32	45.5	5.12

Table 26 shows the influence of the raising method on the fat thickness and the percentage of lean meat in total for both breeds. The results show that pigs raised in pens with open space for walking have the thinnest back fat at point x1 – 19.6 mm.

The fat thickness measured at the same point in pigs reared in a pen with bedding (group III) and pigs reared on a solid brick floor (group I) was 3.84 mm and 4.78 mm greater, respectively, compared to animals in group II ($P \leq 0.05$).

Table 26. Influence of the method of raising on the fat thickness and the percentage of lean meat

Traits	I group		II group		III group		t-test
	$\bar{x} \pm S\bar{x}$	C	$\bar{x} \pm S\bar{x}$	C	$\bar{x} \pm S\bar{x}$	C	
Live weight, kg	88.85±2.8	12.9	84.45±2.84	13.8	90.85±2.5	11.50	n.s
x_1, mm	24.38±1.5	25.3	19.56±1.09	22.3	23.44±1.0	18.76	I-II-* II-III-*
x_2, mm	25.00±1.2	19.9	18.56±1.01	21.7	22.50±1.2	19.97	I-II-*** II-III-*
MLD, mm	43.00±1.3	12.9	40.81±1.48	14.4	39.44±1.2	12.93	n.s.
LM, %	45.74±1.2	11.1	51.21±0.91	7.11	46.97±0.8	7.17	I-II-** II-III-**

Significance *P<0.05; **P<0.01 and ***P<0.001

The trend for thinner back fat in group II pigs is also maintained at point x2. The animals raised in a pen with straw bedding have 3.94 mm ($P \leq 0.05$) and those of the I group with 6.44 mm ($P \leq 0.001$) thicker fat compared to the pigs of the II group.

The thickness of m. longissimus dorsi is the largest in pigs from the control group - 43.00 mm, and we found a minimum value for the investigated trait in 29 animals raised on straw bedding. Group II pigs raised in pens with open space occupy an intermediate position with 40.81 mm. In all three groups, the differences are small and insignificant.

The percentage of lean meat varies between 45% - 51%, being the highest in animals from group II - 51.21%, followed by those from group III - 46.97% and pigs from group I - 45.74%, which is in line with the previously mentioned results on the effect of the possibility of movement. Differences between groups were statistically significant ($P \leq 0.01$).

From the results obtained by us, it is evident that the breed did not have a significant influence on the studied traits. At point x1, a thinner (by 1.66 mm) and at point x2 thicker back fat (by 0.46 mm) was found in the Danube White breed compared to the Landrace breed.

5.4.2. East Balkan swine breed

5.4.2.1. Slaughter qualities of East Balkan swine breed in one weight class raised in different regions of the country.

It is evident from the slaughter indicators shown in Table 27 that there is a tendency for a higher slaughtering output in pigs from II group (Tsonevo village, Varna region), regardless of their lower slaughter weight.

Table 27. Slaughter qualities of pigs of the East Balkan breed in one weight class raised in different regions of the country.

Groups / Traits	I group			II group		
	№ 7			№ 10		
	$\bar{x}$	E	C	$\bar{x}$	E	C
Live weight - kg	91.14	1.66	5.20	87.70	4.95	15.65
Carcass weight - kg	51.44	2.47	6.53	50.15	5.47	18.17
Carcass weight - %	56.45	2.07	4.38	57.06	1.50	4.75
Lard - kg	1.34	7.15	18.19	1.38	10.88	34.42
Loin - kg	0.33	14.85	5.61	0.25	8.43	26.66
Small length – cm	69.86*	1.01	2.66	73.20*	1.30	4.11
Large length – cm	86.14*	0.82	2.16	89.60*	1.41	4.47
Shoulder – mm	34.43	6.49	17.17	33.80	5.57	17.63
Back - mm	25.14	7.88	20.84	24.20	10.91	34.50
Stook L_1 - mm	23.29	3.59	9.51	26.50	8.97	28.36
Stook L_2 - mm	21.43	3.35	8.87	23.00	9.28	29.34
Stook L_3 - mm	28.14	4.06	10.74	28.90	8.29	26.28
C - mm	16.86	5.40	14.29	19.80	8.63	27.33
K - mm	19.43	4.61	12.20	21.80	8.02	25.38
Total CKL_2 - mm	57.71*	3.56	9.42	64.60*	8.11	25.65
Area MLD – cm^2	24.47	3.55	9.39	23.91	3.71	11.48
Length back ham - cm	44.71	0.63	1.69	45.80	1.29	4.09
Back ham index - cm	41.14	1.96	5.20	41.10	2.03	6.42
Index - %	94.24*	1.79	4.73	89.68*	1.03	3.27

*P<0.05; **P<0.01; ***P<0.001. The values associated with different letters are significantly different (P<0.05)

Pigs from the Varna region are characterized by longer carcass length ($P \leq 0.05$) and thicker fat in all points except the shoulder and back. The fat thickness sum CKL2 in them is 64.6 mm, and in those grown in the Shumen region (I group) – 57.71 mm ($P \leq 0.05$). Palova (2006) found that pigs were slaughtered at 86.12 kg. and 84.62 kg amount CKL2 respectively-

74.50 and 65.75%. No significant difference was observed between the groups in terms of MLD area. Back thigh length in pigs from group II had a negative effect on the index, which was 4.56% (P ≤ 0.05) lower compared to that of group I.

The results of the study of the quality characteristics of the individual parts of the carcass show that there are no significant differences in the weight of the individual parts of the carcass in the two groups.

The data characterizing the fat thickness (table 27) explain the higher relative share of meat in all parts of the carcass in the pigs raised in the area of the village of Veselinovo. The most significant differences were found (graph 5) in the actual leg (5.51%, P ≤ 0.01), loin part (6.52%, P ≤ 0.01) and neck steak (4.36%, P ≤ 0.01).

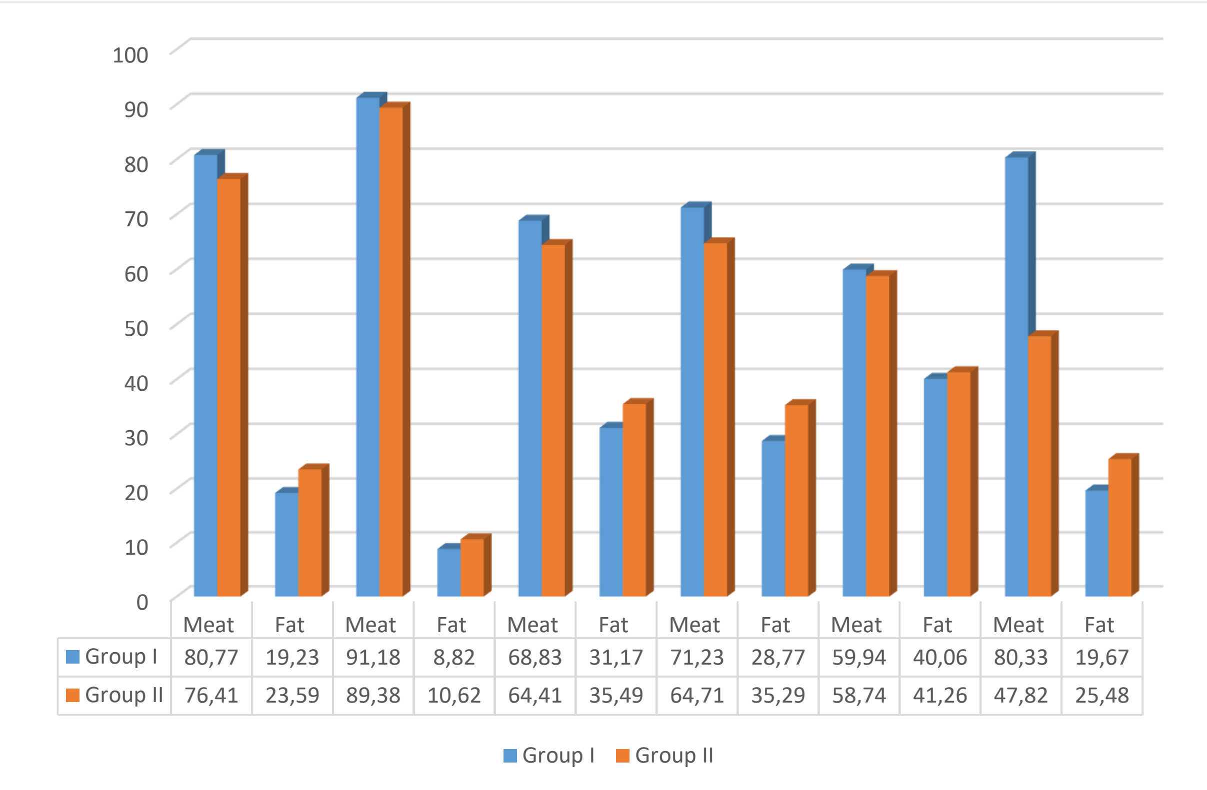


Figure 5. Composition of the main parts of pigs of the East Balkan swine breed in one weight class grown in different regions

5.4.2.2. Slaughter qualities of the East Balkan swine breed in different weight classes.

The results showed that an increase in slaughter weight from 91.14kg to 101.10 resulted in an increase in carcass weight and length (table 28).

It is noteworthy that no significant difference was found between the two groups in terms of slaughter efficiency. Quite logically, a tendency for thicker fat was observed in the pigs of the II group, and reliable differences were found in the amount of CKL2. Values for the area of MLD trait in the two groups show that the increase in slaughter weight for the East Balkan swine breed by 10 kg (from 90 to 100kg) does not affect MLD growth.

Table 28. Slaughter qualities of East Balkan swine from different weight classes

Traits \ Groups	I group			II group		
	n - 7			n - 10		
	$\bar{x}$	E	C	$\bar{x}$	E	C
Live weight - kg	91.14	1.66	5.20	101.10	1.92	6.08
Carcass weight - kg	51.44	2.47	6.53	56.69	1.69	5.34
Carcass weight - %	56.45	2.07	4.38	56.21	2.07	6.55
Lard - kg	1.34	7.15	18.19	1.52	4.68	14.10
Loin - kg	0.33	14.85	5.61	0.31	3.68	11.63
Small length – cm	69.86	1.01	2.66	75.90	1.38	4.36
Large length – cm	86.14	0.82	2.16	93.20	3.06	1.14
Shoulder – mm	34.43	6.49	17.17	38.10	3.39	10.74
Back - mm	25.14	7.88	20.84	26.20	5.34	17.19
Stook L_1 - mm	23.29	3.59	9.51	26.80	4.61	14.59
Stook L_2 - mm	21.43	3.35	8.87	23.50	7.45	23.58
Stook L_3 - mm	28.14	4.06	10.74	29.00	6.56	20.73
C - mm	16.86	5.40	14.29	20.70	5.53	17.50
K - mm	19.43	4.61	12.20	24.10	6.98	22.08
Total CKL_2 - mm	57.71*	3.56	9.42	68.50*	5.68	17.97
Area MLD – cm^2	24.47	3.55	9.39	27.48	2.94	9.31
Length back ham - cm	44.71	0.63	1.69	45.70	1.26	4.00
Back ham index - cm	41.14	1.96	5.20	41.85	0.56	1.78
Index - %	94.24	1.79	4.73	91.69	1.28	4.06

The qualitative characteristics of the individual parts of the carcass show that the weight of the waist and abdominal parts of pigs from the II group is 0.43kg ($P \leq 0.01$) and 0.76kg ($P \leq 0.001$) higher than that of the pigs from the I group.

The difference in the weight of the shoulder (0.43kg) compared to the weight of the meat with bone (0.14kg) shows that the increased weight is due to the layering of more fat in it. The results show that the percentage of meat with bone in pigs from the low weight class was 5.52% ($P \leq 0.01$) higher than those in the high weight class.

5.4.2.3. Slaughter qualities of "heavy" pigs of the East Balkan breed.

Table 29 shows some of the main slaughterhouse indicators characterizing the quality of the carcass in the two weight classes. The increase in pre-slaughter weight from 91.14 to

124.10 kg leads to an increase in carcass weight and slaughter output, respectively, by 19.62 kg (0.63%).

The analysis of the results for the fat thickness shows that with an increase in live weight, the thickness of the fat layer increases, with the most intense fat layering laterally above the last rib (points C and K), followed by the accumulation of fatty tissue in the region of the stook (m. Medius, point L1, L2 and L3).

Table 29. Slaughter qualities of East Balkan swine from the high weight class

Traits / **Groups**	**I group – heavy pigs**			**II group – light pigs**		
	№ 11			**№ 7**		
	$\bar{x}$	E	C	$\bar{x}$	E	C
Live weight - kg	124.10	1.82	6.06	91.14	1.66	5.20
Carcass weight - kg	70.76	1.84	6.11	51.44	2.47	6.53
Carcass weight - %	57.08	1.41	4.68	56.45	2.07	4.38
Loin - kg	0.314	4.01	13.32	0.300	14.8	5.61
Small lenght – cm	74.73	0.72	2.40	69.86	1.01	2.66
Large length – cm	90.91	0.79	2.62	86.14	0.82	2.16
Shoulder – mm	39.82	5.44	18.07	34.43	6.49	17.17
Back - mm	30.27	4.47	14.85	25.14	7.88	20.84
Stook L_1 - mm	34.18*	3.02	10.03	23.29*	3.59	9.51
Stook L_2 - mm	29.82**	3.64	12.07	21.43**	3.35	8.87
Stook L_3 - mm	35.27*	3.13	10.38	28.14*	4.06	10.74
C - mm	29.73**	4.00	13.29	16.86**	5.40	14.29
K - mm	34.54**	3.69	12.24	19.43**	4.61	12.20
Total CKL_2 - mm	94.09***	3.43	11.40	57.71***	3.56	9.42
Area MLD – cm^2	28.19	3.72	12.36	24.47	3.55	9.39
Length back ham - cm	44.27	1.06	3.51	44.71	0.63	1.69
Back ham index - cm	46.45	1.31	4.34	41.14	1.96	5.20
Index - %	104.97*	1.27	4.22	94.24*	1.79	4.73

*P<0.05, ** <0.01, ***P<0.001

The differences in the fat thickness measured at the shoulder and the back in both groups were the smallest, indicating that with increasing weight, the accumulation of fat in these points was of the lowest intensity. Heavy pigs from group I, at points C, K and L2 with 12.87, 15.11 and 8.39 mm., had thicker fat compared to group II ($P \leq 0.01$). Quite logically, we also establish a highly reliable difference for the CKL2 sum trait. Higher pre-slaughter weight increased carcass length, ham index and MLD area measured above the last rib.

The obtained results characterizing the composition of the carcass show an increase in the weight of the individual parts in the pigs of the I group varying from 0.11 kg. for the shin up to 2.72 kg. for the abdominal area. The increase in pre-slaughter weight also affected the ratio of meat with bone and fat. Pigs from the high weight class are characterized by a higher relative proportion of fat in all parts of the carcass ($P \leq 0.01$, 0.001) except for the shoulder. In the waist region, we found a difference of 12.63% between the groups, which is a consequence of the differences in fat thickness in points C, K and L2 (Table 38). There is a significant amount of fat in the abdominal part in both groups, respectively - 43.10% for I group and 40.06% for II group.

The percentage of meat with bone in pigs of group I was 70.11%, which was 1.87% less than in those of group II.

5.4.2.4. Physicochemical composition and technological characteristics of meat from East Balkan swine.

To establish the physicochemical composition of m. LT we conducted a survey with 16 pigs from the East Balkan breed (8 females and 8 males castrated pigs), negative for porcine stress syndrome (PSS) bred in the village of Veselinovo, Shumen region (Table 30).

Table 30. Physicochemical properties of m. LT of pigs of the East Balkan breed (n=16)

Groups / Indicators	pH > 6.00 (n = 11)			pH < 6.00 (n = 5)			Sign. t
	$\overline{x}$	$S\overline{x}$	CV	$\overline{x}$	$S\overline{x}$	CV	
pH 45 min p.m.	6.24	0.03	1.53	5.94	0.01	0.41	***
pH 24 h p.m.	5.74	0.04	2.41	5. 66	0.09	3.80	n. s.
Color, (R/525 nm)	28.62	0.77	6.04	30.77	0.62	3.48	n. s.
Water retention, %	38.40	0.48	2.81	41.41	0.20	0.83	**
Moisture, %	74.17	0.43	1.83	74.29	0.50	1.66	n. s.
Myoglobin, mg/g	1.59	0.10	20.72	1.60	0.18	27.05	n. s.
Fats, %	3.24	0.32	31.24	3.83	0.45	28.75	n. s.
Protein, %	20.44	0.28	4.28	19.84	0.32	3.96	n. s.
Ash, %	1.09	0.06	17.76	1.06	0.02	3.67	n. s.

Significance of the results measured between the groups: p < 0.01 - **; p < 0.001 - ***

We divided the animals into two groups according to the upper limit for PSE meat (pH ≤ 6.00), according to the research of Drbohlav and Stancheva (1983), who came to the conclusion that at pH1 lower than 5.8-6 conditions are created for the formation of PSE meat. The authors consider that the pH1 value of normal meat should be above 6.00. The results show a tendency to obtain PSE meat in 5 animals (31.2%) from the studied samples. Changes in meat pH are the result of post mortem metabolism in muscle tissue and the conversion of glycogen to lactic acid. The sharp drop in pH at a still high carcass temperature leads to denaturation of muscle proteins, which is associated with a reduction in water retention and a lighter meat color. The differences between the groups for this indicator are reliable (P<0.001) and sufficient to show a significant effect for a decrease in water retention (P<0.05) and a trend for a lighter color of the m. LT. The close values for fat and myoglobin content between groups indicate that the trend for lighter muscle color is a result of changes in pH 45 min p.m. The indicators pH 24 h p.m., protein content and ash are within normal limits for this type of meat.

The obtained results for the physicochemical composition of m. LT show that there are conditions for the formation of PSE meat in some animals, and the reasons for this do not have a genetic nature.

5.4.2.5. Fatty acid composition of different fat depots in pigs of the East Balkan breed.

The type of fatty tissue – subcutaneous or intramuscular shows significant differences in the content of individual fatty acids (Table 31). The C16:0 content is lower in both layers of the dorsal fat than in m. LT (P < 0.001). No differences were observed between the inner and outer layers. Subcutaneous fatty tissue showed significantly lower C18:0 content compared with 34 intramuscular fatty tissues (P < 0.001), but a further decrease in this fatty acid was observed in the outer layer. A significant difference was found between tissues in terms of C18:1 levels.

Table 31. Fatty acid composition of back fat layers and intramuscular fat in Eastern Balkan pigs

Fatty acids,%	Back fat		intramuscular fat (m.LT)	SEM	Sign. t
	Outer layer	Inner layer			
C14:0	1.20	0.95	1.08	0.087	NS
C16:0	17.47^{a}	16.84^{a}	20.35^{b}	0.47	***
C16:1	1.81^{a}	1.22^{b}	3.58^{c}	0.17	***
C18:0	3.25^{a}	4.41^{b}	5.79^{c}	0.26	***
C18:1	52.79^{a}	53.66^{a}	49.81^{b}	0.79	**
C18:2	20.27^{a}	20.13^{a}	14.36^{b}	0.61	***
C18:3	2.28^{a}	1.84^{b}	1.14^{c}	0.08	***
C20:2	0.44^{a}	0.42^{a}	0.34^{b}	0.02	**
C20:3	0.10^{a}	0.08^{a}	0.17^{b}	0.01	***
C20:4	0.09^{a}	0.20^{a}	2.77^{b}	0.23	***
C20:5	0.07^{a}	0.07^{a}	0.23^{b}	0.02	***
C22:5	0.20^{a}	0.15^{a}	0.37^{b}	0.02	***
UFA[1]	21.93^{a}	22.20^{a}	27.22^{b}	0.55	***
MUFA	54.61	54.89	53.39	0.82	NS
PUFA	23.46^{a}	22.90^{a}	19.38^{b}	0.81	**
PUFA/UFA	1.08^{a}	1.04^{a}	0.72^{b}	0.04	***
n-6/n-3	8.31^{a}	10.16^{b}	10.21^{b}	0.38	***
C16:1/C16:0	0.10^{a}	0.07^{b}	0.17^{c}	0.008	***
C18:1/C18:0	16.61^{a}	12.56^{b}	8.89	0.73	***

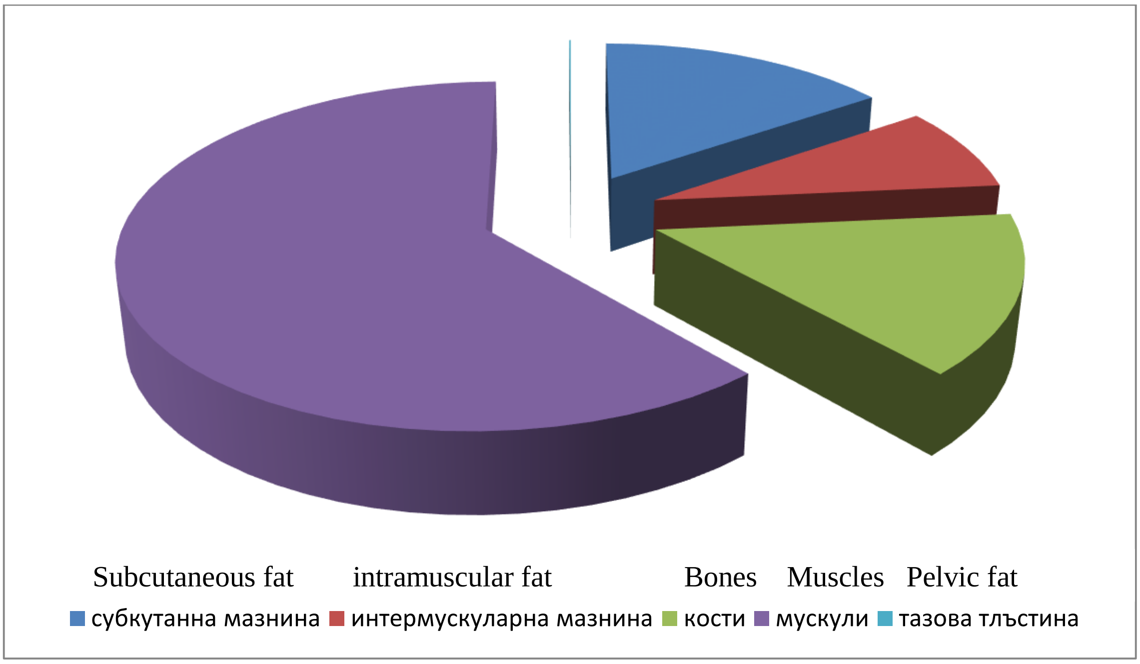
*P<0.05; **P<0.01; ***P<0.001. Values associated with different letters are significantly different (P<0.05)

Pork fat is characterized by a high content of linoleic fatty acid (C18:2). The type of fat depots affected the content of C18:2 (P < 0.001), which was at a lower level in intramuscular fatty tissue compared to subcutaneous fatty tissue. The same regularity is observed with regard to the content of linolenic (C18:3) acid. The study showed greater deposition of these polyunsaturated fatty acids in the back fat, with significant differences between the layers.

5.6. Development of methods for evaluating the meat productivity of fattened pigs.

5.6. 1. Establishing the slaughter qualities and morphological components in the carcass and its separate parts in skinned pigs.

The average weight of the chilled carcass was 31,696 kg, with the relative proportion of muscle tissue being the highest, followed by fat and bone (Chart 6). In this study, the higher muscle content (61.47%) was due to the skinned carcasses, without skin, head and feet, and therefore the weight was lower and the percentage of meat in it was accordingly higher.



Subcutaneous fat, %	15,41
intramuscular fat, %	8,1
Bones, %	14,94
Muscles, %	61,47
Pelvic fat, %	0,08

Graph 6. Content of the individual tissues in half a carcass, %

5.6.2. Dependencies between the morphological components in the carcass and its individual parts in skinned pigs.

The coefficients of phenotypic correlation (Table 32) between the absolute share of muscles in the carcass and the amount of subcutaneous fat in individual parts and in the whole carcass are low and statistically insignificant.

Table 32. Phenotypic correlation coefficients between the amount of muscle in ½ carcass (kg and %) and the content of subcutaneous and intramuscular fat.

Dependencies:		Musculature, kg		Musculature, %	
		r_p	Sr	r_p	Sr
Subcutaneous fat, kg	Total	0,055	0.12	-0,851+++	0.06
	Ham	0,231	0.11	-0,680+++	0.08
	Fillet	-0,097	0.12	-0,775+++	0.07
	Shoulder blade	-0,074	0.12	-0,807+++	0.07
	Breast	0,084	0.12	-0,649+++	0.09
	Neck chop	-0,242	0.11	-0,313++	0.11
	Stomach	0,010	0.12	-0,518+++	0.10
	Front shin	0,082	0.12	-0,198	0.11
	Back shin	0,299	0.11	-0,416+++	0.11
Intramuscular fat, total, kg		-0,197	0.12	-0,779+++	0.07

The relationships between the relative share of muscles in the carcass and the amount of subcutaneous fat (Table 29) in the shoulder, chest, ham are respectively - Rp = - 0.807, -0.775, -0.680 (P≤0.001). The correlations between the percentage of musculature and the total amount of subcutaneous fat (Rp = - 0.851, P≤0.001) and intramuscular fat (Rp = -0.779, P≤0.001) in the carcass are also high in value and negative.

5.6.2. Dependencies between morphological components and some dimensions of the carcass and its individual parts.

Phenotypic correlation coefficients (Table 33) between fat thickness and the amount of subcutaneous and intramuscular fat were positive, medium to high in value (P≤0.001), except for the relation between fat thickness measured between 3-4 ribs and the amount of subcutaneous fat in the carcass.

Fat thickness is negatively related to the amount of musculature and to a higher degree determines the relative share of musculature in the carcass. (P≤0.01; P≤0.001). MLD thickness measured from the cranial end of the m. Glut. medius to the dorsal end of the canal rachidien, carcass and ham lengths were positively correlated with the amount of musculature in the carcass.

Table 33. Phenotypic correlation coefficients between the content of the morphological constituents of the carcass half and some dimensions found at dissection

Dependencies:		Musculature, kg		Subcutaneous fat, kg		intramuscular fat, kg		Musculature, %	
		r_p	Rxy	r_p	Rxy	r_p	Rxy	r_p	Rxy
Fat thickness, mm	Last rib	-0.038	-0.021	0.616^{+++}	0,254	0.638^{+++}	0,098	-0.572^{+++}	-0,759
	¾ rib	-0.238	-0,094	0.299^{+}	0,056	0.440^{+++}	0,047	-0.324^{++}	-0,298
	L_1	-0.194	-0,109	0.621^{+++}	0,236	0.655^{+++}	0,093	-0.640^{+++}	-0,782
	L_2	-0.105	-0,056	0.766^{+++}	0,297	0.626^{+++}	0,090	-0.720^{+++}	-0,898
	L_3	-0.150	-0,060	0.749^{+++}	0,218	0.682^{+++}	0,074	-0.722^{+++}	-0,677
	loin	-0.161	-0,057	0.598^{+++}	0,154	0.560^{+++}	0,054	-0.564^{+++}	-0,468
M, mm		0.250^{+}	0,113	0.224	0,074	0.112	0,014	-0.105	-0,111
F, mm		0.526^{+++}	0,137	0.155	0,030	-0.017	-0,001	0.072	0,044
MLD last rib, mm		$0,612^{+++}$	0,161	0,028	0,005	-0,270	-0,019	0,228	0,140
MLD 3^{rd}- 4^{th} rib, mm		$0,578^{+++}$	0,129	0,130	0,019	-0,114	-0,007	0,140	0,073
Large length, cm		0.434^{+++}	0,250	0.454^{+++}	0,190	0.229	0,036	-0.165	-0,222
Small length, cm		0.311^{++}	0,236	0.406^{+++}	0,223	0.242^{+}	0,050	-0.218	-0,385
Ham length, cm		0.270^{+}	0,193	0.218	0,113	0.078	0,015	-0.105	-0,175
Ham index, cm		0.369^{++}	0,090	0.327^{++}	0,058	0.050	0,003	-0.188	-0,107

5.6.4. Possibilities of using some dimensions found at dissection in the development of methods for carcass quality assessment in skinned pigs.

The model using fat thicknesses at point L2 and MLD measured from the cranial end of the m. Glut. medius to the dorsal end of the canal rachidien (ZP method) determined 55% of the lean meat in the skinned carcasses, subject to the study (table 34).

Table 34. Predictive models developed based on the results of carcass measurements in dissection

FORECASTING MODELS	Mult, R	R^2	SE
1. LM= 63,40 - 0,925 X_6 + 0,1028 F	0,74	0,55	3,14
2. LM = 64,2 – 0,75X_1 + 0,02 X_2 + 0,11X_3 + 0,01X_4	0,60	0,36	3,99
3. LM= 70,70 - 0,1650 X_8 - 0,071 X_5 - 0,378 X_6 - 0,315 X_7 + 0,0784 F	0,78	0,62	2,95
4. LM= 71,11 - 0,1510 X_8 - 0,027 X_5 - 0,423 X_6 - 0,317 X_7- 0,0889 M + 0,0905 F	0,79	0,63	2,95
5. LM = 72,69 - 0,193 X_8 - 0,059 X_5 - 0,504 X_6 - 0,231 X_7 - 0,099 M + 0,0868 F + 0,047 X_2- 0,0101 X_4	0,77	0,60	3,33
6. LM = 72,33 - 0,189 X_8 - 0,082 X_5 - 0,525 X_6 - 0,178 X_7 + 0,0450 F + 0,001 X_1+ 0,0129 X_3	0,77	0,60	3,32
7. LM= 79,7 - 0,1936 X_8 - 0,058 X_5 - 0,422 X_6 - 0,262 X_7- 0,0563 M + 0,0824 F + 0,227 X_9- 0,376 X_{10}	0,80	0,64	2,93
8. LM= 79,6 - 0,2403 X8- 0,081 X5 - 0,242 X6- 0,332 X7- 0,0034 M + 0,1119 F + 0,249 X9- 0,331 X10- 0,034 X11- 0,1049 X12	0,81	0,66	2,90

LM – musculature, %
Musculus longissimus dorsi, mm
X_1- fat thickness at 7cm at the last rib, mm
X_2- fat thickness at 7cm at 3^{rd} / 4^{th} rib, mm
X_3- MLD thickness at 7cm at the last rib, mm
X_4 - MLD thickness at 7cm at the 3^{rd} / 4^{th} rib, mm
X_5- fat thickness L_1, mm
X_6- fat thickness L_2, mm
X_7- fat thickness L_3, mm
X_8- fat thickness, loin, mm
X_9 – Large length of the carcass, cm
X_{10}- Small length of the carcass, cm
X_{11}-Ham length, cm
X_{12} –Ham index, cm
F –MLD thickness, measured from the cranial end of m.Glut.medius to the dorsal end of canal rachidien, mm
M - m Glutenus medius thickness in point L_2, mm

The inclusion in the two-point model for the thicknesses of the shoulder, L1 and L3 (model 3) and m Glutenus medius thickness at point L2 (model 4) increased the prediction accuracy by 7% (R2=0.62) and 8% (R2=0.62) respectively. R2=0.63). Our results outline a trend of increasing prediction accuracy with increasing parameters used.

4.6.5. Possibilities of using the results of dissection in the development of methods for evaluating meat productivity of skinned pigs.

The absolute values for the amount of fat and intramuscular fat in the carcass (models 1 and 2) determine respectively 73% and 61% of the phenotypic trait % musculature in the carcass (Table 35). Using the absolute proportion of fat in the shoulder (model 8), loin (model 7), and leg (model 6) provided prediction accuracies of 65%, 60%, and 46%, respectively.

Table 35. Predictive models using the absolute values of the amount of fat and intramuscular fat in the carcass and its individual parts

FORECASTING MODELS	Mult, R	R^2	SE
1. LM = 74,96 - 0,002736 A_1	0,85	0,73	2,40
2. LM = 78,85 - 0,006725 A_8	0,78	0,61	2,87
3. LM = 72,93 - 0,00654 A_7	0,41	0,17	4,16
4. LM = 54,77 + 0,001645 A_5	0,31	0,10	4,34
5. LM = 68,22 - 0,00817 A_6	0,65	0,42	3,48
6. LM = 70,46 - 0,006674 A_2	0,68	0,46	3,35
7. LM = 70,601 - 0,009366 A_4	0,77	0,60	2,89
8. LM = 73,13 - 0,01539 A_3	0,81	0,65	2,70

A_1- Subcutaneous fat, total, g
A_2- Subcutaneous fat, ham, g
A_3- Subcutaneous fat, shoulder, g
A_4- Subcutaneous fat, fillet, g
A_5- Subcutaneous fat, neck chop, g
A_6- Subcutaneous fat, breast, g
A_7- Subcutaneous fat, stomach, g
A_8- intramuscular fat, g

The predictive models using the relative values of the amount of subcutaneous and intramuscular fat in the carcass and its individual parts are shown in (Table 32). In the predictive value of the models using the percentage of subcutaneous fat in one part, the maximum accuracy was found in model 13 using the shoulder dissection (R2= 0.78; SE=2.14). Higher accuracy was found when using the relative proportion of musculature in two parts - chest and ham.

Table 32. Predictive models using the absolute values of the amount of fat and intramuscular fat in the carcass and its individual parts

FORECASTING MODELS	Mult, R	R^2	SE
9. LM = 79,305 - 1,1611 A_1	0,95	0,90	1,48
10. LM = 77,83 - 2,003 A_8	0,70	0,49	3,27
11. LM = 74,30 - 0,8529 A_2	0,83	0,69	2,55
12. LM = 73,14 - 0,6750 A_4	0,81	0,65	2,71
13. LM = 76,456 - 0,8945 A_3	0,88	0,78	2,14
14. LM = 70,26 - 0,4961 A_6	0,60	0,36	3,66
15. LM = 69,01 - 0,856 A_5	0,54	0,30	3,84
16. LM = 77,705 - 0,4115 A_2 - 0,6006 A_3	0,93	0,86	1,75

A_1- Subcutaneous fat, total, g
A_2- Subcutaneous fat, ham, g
A_3- Subcutaneous fat, shoulder, g
A_4- Subcutaneous fat, fillet, g
A_5- Subcutaneous fat, neck chop, g
A_6- Subcutaneous fat, breast, g
A_7- Subcutaneous fat, stomach, g
A_8- intramuscular fat, g

CONCLUSIONS

Study of some quality characteristics of domestically produced pig carcasses.

- The results of the examination of the main characteristics of pig carcasses show a high degree of repeatability. For the two studied periods (2012-2015 and 2016-2019), the established difference in the relative share of lean meat was 0.24% at practically the same weight.

- According to the SEUROP classification system, the pig carcasses subject to our study are classified in the lower half of class E.
- Slaughter carcasses classified in class S occupy a very low share in the studied sample, and a permanent tendency for their reduction was established.
- Slaughter carcasses with a high content of lean meat in the carcass are characterized by a lower carcass weight.
- Significant differences in the dynamics of changes in carcass characteristics were found for those affected by the season and year of slaughter, as well as the interaction between them.

Quality of meat in carcasses in different classes according to the EUROP system.

- No reliable differences were found between the quality characteristics of the meat in three-line crossbred pigs (L x LW) x D classified in different classes of the SEUROP system - respectively in class U (54.4% lean meat) and class E (56.68% lean meat).

Quality characteristics of meat in carcasses of purebred, two- and three- crossbreeds.

- The higher variation of the pH2 trait in the crosses (L x LW) x P (C=3.28%) and (L x LW) x line 337 (C=3.21%) is an indication of a different speed of the glycolysis process in comparison with the crosses L x LW (C=1.44%) and (LxLW) x D (C=1.13%).
- Pigs from the hybrid combination (LxD)xP have a higher level of intramuscular fat in the m. Longissimus thoracis (0.57%), compared to the (LxLW)xP combination.
- In the Duroc breed, the established amount of fat in m. Longissimus thoracis is higher compared to other breeds. There is a tendency for a greater amount of intramuscular fat in the Landrace and Pietrain warblers compared to the Large White.
- In the two layers of back fat, differences between breeds were found only with respect to C18:1n-9, which showed higher levels in the inner layer of fat in the Duroc breed compared to the Landrace, Pietrain and Large White breeds.
- The content of the majority of polyunsaturated fatty acids in m. Longissimus thoracis, shows considerable variation between breeds. Duroc pigs showed the lowest levels of C18:2n-6, C20:3n-6, C20:4n-6, C20:5n-3 and C22:5n-3, the differences being particularly pronounced compared to Large White.
- No significant differences were found for the fat thickness trait, m. Longissimus thoracis and percentage of lean meat measured in vivo with a PIGLOG-105 between two-crossbreeds DxL and PxL.
- The analysis of the fatty acid profile of in m. Longissimus thoracis and intramuscular lipids showed significant differences between the Duroc, Landrace, Pietrain and Large White breeds and their crosses.
- Slaughter carcasses of the Danube white breed are classified in the upper half of class U (53-55% lean meat) according to the SEUROP system and the amount of fat in m. Longissimus thoracis is over 5%
- The method of raising significantly affected fat thickness and the percentage of lean meat, expressed by thinner fat and a higher percentage of lean meat in the carcass (Danube white - 52.1% and Landrace - 50.3%) in pen-raised female pigs with an open space for walking.

- The breed had no influence on fat thickness, m. Longissimus thoracis and percentage of lean meat in female pigs of the Danube White and Landrace breeds.

Quality characteristics of the carcass and meat of pigs from the East Balkan breed

- Studies of carcasses from the East Balkan breed show significant phenotypic diversity in carcass length (small and large), ham index, relative proportion of meat in the actual ham, loin and neck chop.
- Conditions for the formation of PSE meat have been noted at the upper critical limit for PSE meat pH1 ≤ 6.00, in 31.2% of the examined samples of m. Longissimus thoracis in East Balkan pigs. The pH2, protein and ash content are within normal limits for this type of meat.
- In the intramuscular fatty tissue of pigs of the East Balkan breed, there is a significantly higher content of saturated C16:0 and C18:0, as well as C16:1 than subcutaneous fat. Significant differences were found between the outer and inner layers of back fat for C16:1, C18:0 and C18:3.
- Correlation coefficients between the main fatty acids deposited in subcutaneous and intramuscular fatty tissue are indicative of different fatty acid metabolism in the different fat depots in pigs of the East Balkan breed.

Development of models for evaluation of meat productivity of skinned pigs

- Phenotypic correlation coefficients between fat thickness and the amount of subcutaneous and intramuscular fat were positive, medium to high in value except for the relation between fat thickness measured between 3-4 rib and the amount of subcutaneous fat in the carcass.
- Fat thickness is negatively related to the amount of musculature and to a higher degree correlates with the relative share of musculature in the carcass. The amount of lean meat (%) increased to the highest degree with decreasing fat thickness at point L2 (Rxy = - 0.898), L1 (Rxy = - 0.782) and last rib (Rxy = - 0.759)
- The correlations between the percentage of musculature and the total amount of subcutaneous fat (Rp = -0.851) and intramuscular fat (Rp = -0.779) in the carcass are also high in value and negative.
- The Zp method provides forecast accuracy – 55% (R^2=0.55). Inclusion in the two-point model of the thicknesses of the shoulder, L1 and L3, and m Glutenus medius thickness at point L2 increased the accuracy of prediction by 7% (R^2=0.62) and 8% (R^2=0.63), respectively.
- The models for meat productivity evaluation, developed on the basis of the content of subcutaneous and intramuscular fat in the carcass and its separate parts show a higher accuracy when using the relative compared to absolute values.
- The absolute share of subcutaneous fat and intramuscular fat in the carcass determines the phenotypic manifestation of the trait 73% and 61%, respectively, % musculature in the carcass.
- The relative content of intramuscular fat in the carcass, included in a predictive model, determines to a high degree the percentage of musculature (R^2=0.90).
- Increasing the number of variables used in the models increases the accuracy of the forecast, but leads to higher costs.

Recommendations

- The implementation of the system for the quality of pig carcasses (SEUROP) has contributed to the improvement of the quality of carcasses. To ensure the maximum accuracy of the system, we recommend continuing the monitoring of carcasses.
- Minimizing the effects of pre-slaughter stress factors, control and analysis of the results from the pH measurement after slaughter are needed for assuring quality production in swine breeding. The obtained information is the basis for the detection of carcasses with deteriorated meat quality at an early stage in meat production.
- In order to standardize the carcasses of pigs of the East Balkan breed, we recommend to continue the studies of the slaughter traits until covering the entire population of the breed. The obtained information can be used to typify the investigated characteristics of the pigs by regions and herds and will be a good basis for updating the Breeding Program of the breed.
- The use of the methodology for slaughter analysis described in the Regulations for assessment of the breeding value, production and classification of pigs for breeding, underestimates or overestimates some parts of the carcass, compared to other methodologies, and this does not ensure comparability of the results. In this regard, we consider that it is morally outdated and it is necessary in the selection and scientific activity in pig breeding to be replaced by the reference methodology for dissection in the EU (Scheper and Scholz, 1985).
- From the developed models for evaluating the meat productivity of skinned pigs, in scientific activity and in the assessment of progeny, we recommend using the model LM = 79.305 - 1.1611% fat in the carcass (R2=0.90). Its advantage over other models is the high accuracy and the fact that establishing the magnitude of the variable is a routine activity that does not require time and resources.

CONTRIBUTIONS

- In connection with the evaluation of the quality characteristics of pig carcasses produced in the northeastern part of the country:
- The information on the indicators included in the system (SEUROP) for harvested pork in the eastern part of the country (Shumen, Varna, Burgas and Ruse regions) for the period 2012-2019 has been systematized. Carcasses with a high content of lean meat were found to be characterized by lower weight. Trait values, percentage of lean meat and carcass weight showed a high degree of repeatability. A contribution of a scientific and applied nature. (2,3,4,7)
- The study of the seasonal and annual dynamics of variation of the indicators included in the system (SEUROP) is directly related to the precise planning of production in pig breeding. An original contribution of a theoretical and scientifically applied nature. (13)
- The physicochemical parameters and fatty acid composition of m. Longissimus thoracis and back fat in purebred pigs (L, LW, D and P) as well as two and three crossbreeds of the above breeds were studied. The obtained information is of essential importance when making decisions about the breeding policy by the producers. A contribution of a scientific and applied nature. (5, 6 16, 17,18,19)
- The phenotypic values of the traits, the percentage of lean meat (measured post mortem) and the quality characteristics of the meat in carcasses of the Danube White breed were analyzed. A higher level of intramuscular lipids (over 5%) was found in m. Longissimus thoracis compared to that of purebred pigs (L, LW, D and P) as well as two- and three-crossbreeds between them. A contribution of a scientific and applied nature. (8)
- It was found that the method of raising significantly affected fat thickness and the percentage of lean meat, expressed by thinner fat and a higher percentage of lean meat in the carcass (Danube white - 52.1% and Landrace - 50.3%) in female pigs, grown in pens with open space. A contribution of a scientific and applied nature. (9)
- The quality characteristics of the carcass and the meat of the East Balkan breed were studied. Significant phenotypic diversity was found in some slaughter traits: carcass length (small and large), ham index, relative proportion of meat in the actual ham, loin and neck chop. In 31.2% of the studied samples of m. Longissimus thoracis for East Balkan swine, there are conditions for the formation of PSE meat. An original contribution with practical significance. (10, 1)
- The fatty acid composition of back fat and intramuscular lipids in m. Longissimus thoracis in the East Balkan breed, tissue differences were established and scientific evidence was obtained for the healthy lipid profile of fat. An original contribution of scientific and applied importance. (11)
- The possibilities of developing models for the assessment of meat productivity by using slaughter measurements and the results of the complete dissection of carcasses of skinned pigs were investigated. It is recommended that, of the models developed for the evaluation of skinned carcasses in scientific activity and in progeny evaluation, a model with one variable (% fat in the carcass) should be used. Carcass quality is determined by the formula: LM = 79.305 - 1.1611 x % fat in the carcass (R2=0.90). An original contribution of a scientifically applied nature. (12,14,15)

LIST OF PUBLICATIONS RELATED TO THE DISSERTATION

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Abstract

Pork occupies a dominant share in the production of red meat in the country - 71% of total production in 2016. Without neglecting the importance of eating habits, the more affordable prices in relation to household incomes compared to beef determine its leading position and in terms of consumption.

Qualification of pig carcasses according to the SEUROP system in the country has been carried out since 2005. We believe that this is a sufficient enough period to analyze the effect of the application of the system.

In the present paper we present an analysis of the results of the application of the SEUROP system in pig breeding in the Northeastern part of Bulgaria. In terms of the requirements of the system, we have considered some features that determine the quality of the carcass (percentage of lean meat, physico-chemical composition of the meat, fatty acid composition) in the commercial population of fattened pigs. In this section we analyze the features of carcasses of Danube white pigs.

We have paid special attention to the characteristics of the carcass of the only domestic aboriginal breed of pigs - the Eastern Balkan pig. The impossibility of using the SEUROP system in aboriginal pigs led us to use the approach to analyze the results of carcass dissection in exact studies for different purposes. We believe that this approach provides maximum variability of the studied features, which provides opportunities for more objective analysis.

The way the carcass is presented (skinned or steamed) affects the trade relations and the cost of production. Legislation in the country allows the use of the SEUROP system only on steamed carcasses. Guided by the experience in Greece (the only country in the EU to use the classification of skinned carcasses), we also present our vision of the possibilities for predicting the composition of skinned carcasses.