



## Physicochemical properties and chemical composition of muscle tissue of young pigs of large white breed and their correlation with some serum enzymes

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### Contents

1. Introduction .....	34
2. Materials and methods .....	35
3. Results and discussion .....	35
4. Conclusions .....	37
References .....	37

### Abstract

The aim of the study was to investigate the biochemical parameters of blood serum, physicochemical properties and chemical composition of muscle tissue of young white pigs of English origin, as well as to calculate the level of correlations between the main quantitative traits. The experimental part of the work was carried out in LTd "AF" Dzerzhynets" Dnipropetrovsk region, Research Center for Biosafety and Environmental Control of Agricultural Resources Dnipro State Agrarian and Economic University, Ltd "Globinsky Meat Plant" Poltava region, laboratory of zootechnical analysis of the Institute of Pig Breeding and Agriculture and livestock laboratories of the Institute of Cereals NAAS. Blood sampling for biochemical studies was performed in 5-month-old animals, serum activity of aspartate aminotransferase (AST), alanine aminotransferase (ALT), alkaline phosphatase and  $\alpha$ -amylase was determined. Physicochemical properties and chemical composition of the longest muscle of the back (m. Longissimus dorsi) were studied on the indicators of "moisture holding capacity, %", "color intensity, units. ext.  $\times$  1000", "tenderness", c, "fat content, %", "total moisture content, %", "protein content, %", "heat loss, %", and "energy value of muscle tissue, kcal". It was found that the biochemical parameters of blood serum of young pigs of large white breed at 5 months of age correspond to the physiological norm of clinically healthy animals. Thus, the activity of aspartate aminotransferase (AST) is  $1.33 \pm 0.074$  mmol/h/l, alanine aminotransferase (ALT) –  $1.87 \pm 0.063$  mmol/h/l, alkaline phosphatase –  $291.99 \pm 12.517$  IU/l,  $\alpha$ -amylase –  $169.82 \pm 5.005$  g/h $\times$ l. Studies of physicochemical properties and chemical composition of samples of the longest back muscle of young pigs of large white breed show that the number of high quality samples in terms of "moisture holding capacity, %" is equal to 12.0%, "color intensity, units. ext.  $\times$  1000" – 16.0 %, "tenderness, c" – 12.0 % and "fat content, %" – 16.0 %. Significant correlations were established between the following pairs of features: moisture holding capacity, %  $\times$  protein content, % ( $-0.484 \pm 0.1825$ ,  $tr = 2.65$ ), moisture holding capacity, %  $\times$  heat loss, % ( $-0.416 \pm 0.1896$ ,  $tr = 2.19$ ), fat content, %  $\times$  moisture holding capacity, % ( $-0.450 \pm 0.1862$ ,  $tr = 2.42$ ), fat content, %  $\times$  energy value, kcal ( $0.836 \pm 0.1144$ ,  $tr = 7.31$ ), alanine aminotransferase (ALT) activity, mmol/h/l  $\times$  pH, units of acidity, ( $0.443 \pm 0.1859$ ,  $tr = 2.37$ ), alkaline phosphatase activity, units/l  $\times$  color intensity, units. ext.  $\times$  1000 ( $-0.483 \pm 0.1826$ ,  $tr = 2.65$ ), alkaline phosphatase activity, units/l  $\times$  P, % ( $0.484 \pm 0.1825$ ,  $tr = 2.65$ ).

**Key words:** young pigs, breed, serum biochemical parameters, physicochemical properties and chemical composition of muscle tissue, variability, correlation.

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### 1. Introduction

Intensification of the pig industry involves, along with improving the conditions of keeping and feeding the use of highly productive breeds, types and lines in the selection process, as well as the development and implementation of effective methods for assessing growth and development in early ontogeny, reproductive capacity of sows and breeding boars, fattening and meat qualities of their offspring (Kabanov, 2009; Allison & Laven, 2000; Aknevs'kyi et al., 2013; Khalak et al., 2020).

An important issue is the study of interior features, data

analysis and their use as markers of early prediction of signs of fattening, slaughter, meat qualities, as well as physicochemical and chemical properties of muscle tissue and serum (Lugovoy et al., 2017; Tserenyuk, 2018; Kramarenko et al., 2018; 2019; Martyshuk et al., 2019; 2020; Vuhliar, 2020; Novakovska, 2020; Khalak & Gutyj, 2020).

The aim of the study was to investigate the biochemical parameters of blood serum, physicochemical properties and chemical composition of muscle tissue of young white pigs of English origin, as well as to calculate the level of correlations between the main quantitative traits.

## 2. Materials and methods

The study was conducted in the conditions of breeding facilities for reproducing large white pigs at Ltd “AF Dzerzhynets” Dnipropetrovsk region, Research Center for Biosafety and Environmental Control of Agricultural Resources of the Dnipro State Agrarian and Economic University, Ltd “Globinsky Meat Plant” Poltava region, laboratory Institute of Pig Breeding and Agroindustrial Production of NAAS and Animal Husbandry Laboratory of the State Institution Institute of Grain Crops of NAAS. The work was performed according to the research program of NAAS № 30 “Pig breeding”.

Control fattening of young pigs of this genotype was carried out in the farm in accordance with the requirements of modern research methods in pig breeding.

Sampling of blood from animals of the experimental group was performed at 5 months of age. Serum activity of aspartate aminotransferase (AST), mmol/h/l, alanine ami-

notransferase (ALT), mmol/h/l, alkaline phosphatase activity, units/l and  $\alpha$ -amylase, g/h $\times$ l (Vlizlo, 2012).

Physicochemical properties and chemical composition of the longest muscle of the back (m. Longissimus dorsi) were studied by the following parameters: pH, acidity units, moisture holding capacity, %, color intensity, units. ext.  $\times$  1000, tenderness, s, fat content, %, total moisture, %, protein, %, calcium, %, phosphorus, %, heat loss, %, (Polyvoda, 1976; Polivoda et al., 1977).

The energy value of muscle tissue was calculated by the chemical composition of the average sample of minced meat by the formula:

$$X = (C - (F+Z)) \times 4.1 + F \times 9.3$$

where: X – caloric content 100 g of meat, cal; C – the amount of dry matter, g; F – amount of fat, g; Z – amount of ash, g.

A comprehensive assessment of meat quality was performed according to the method (Table 1) (Polyvoda, 1976).

**Table 1**

Scale for assessing the quality of meat by physico-chemical parameters

Evaluation	Meat quality indicator				
	moisture holding capacity, %	color intensity, (extinction coefficient $\times$ 1000)	tenderness, seconds	fat, %	melting point of sebum, degrees
Limits	46.8–71.8	27–119	5.8–15.5	0.7–4.8	23.5–46.8
A high quality	67.0 and more	83 and more	7.9 and less	3.1 and more	–
Normal quality	53.0–66.0	48–82	8.0–12.0	1.2–3.0	32.5–41.5
Low quality	52.0 and less	47 and less	12.1 and more	1.1 and less	41.6 and more 32.4 and less

The strength of the correlations between traits was determined by the Cheddock scale (Table 2).

**Table 2**

Cheddock scale for grading the strength of the correlation between quantitative features

The value of the correlation coefficient	Correlation strength
0.1–0.3	Weak
0.3–0.5	Moderate
0.5–0.7	Noticeable
0.7–0.9	High
0.9–0.99	Very high

**Table 3**

Biochemical parameters of blood serum of young pigs of the experimental groups, n = 25

Indicators, units of measurement	Biometric indicators		
	$\bar{X} \pm \bar{S}_x$	$\sigma \pm S\sigma$	$Cv \pm S_{Cv}, \%$
Activity: aspartate aminotransferase (AST), mmol/hour/l	1.33 $\pm$ 0.073	0.36 $\pm$ 0.070	27.06 $\pm$ 3.827
alanine aminotransferase (ALT), mmol/h/l	1.87 $\pm$ 0.063	0.32 $\pm$ 0.045	17.11 $\pm$ 2.420
alkaline phosphatase, units/liter	291.99 $\pm$ 12.51	62.58 $\pm$ 8.851	21.43 $\pm$ 3.011
$\alpha$ -amylase, g/h $\times$ l	169.82 $\pm$ 5.005	25.02 $\pm$ 3.538	14.73 $\pm$ 2.083

In terms of physicochemical properties and chemical composition, the samples of the longest muscle of the back were characterized by the following indicators: moisture holding capacity was 60.10  $\pm$  0.981 %, color intensity – 73.60  $\pm$  2.147 units. ext.  $\times$  1000, tenderness – 9.41  $\pm$

Biometric processing of the obtained research results was performed according to the method (Lakin, 1990) using the programmable module “Data Analysis” in Microsoft Excel.

## 3. Results and discussion

Studies of biochemical parameters of blood serum of young pigs showed that in animals of large white breed of English origin at 5 months of age the activity of aspartate aminotransferase (AST) is 1.33  $\pm$  0.074 mmol/h/l, alanine aminotransferase (ALT) – 1.87  $\pm$  0.063 mmol/h/l, alkaline phosphatase – 291.99  $\pm$  12.517 units/l and  $\alpha$ -amylase – 169.82  $\pm$  5.005 g/h $\times$ l (Table 3). These indicators correspond to the physiological norm of clinically healthy animals (Vlizlo, 2012).

0.283 s, fat content – 2.28  $\pm$  0.341 % (Table 4). The indicators “total moisture content”, “air-dry matter content”, “ash content”, “protein content”, “fat content”, “calcium content, %”, “phosphorus content, %”, respectively, were equal to 74.13  $\pm$  0.446, 27.25  $\pm$  0.450, 1.13  $\pm$  0.019, 22.36  $\pm$  0.400,

2.28 ± 0.341, 0.045 ± 0.0011 and 0.126 ± 0.0047 %. The loss of absolute mass of the muscle tissue sample during heat treatment is 22.36 ± 0.400 %, and its energy value is 21.88 ± 3.110 kcal.

The coefficient of variation of the indicators characteriz-

ing the physicochemical properties and chemical composition of the longest back muscle in the animals of the experimental group ranges from 2.49 (pH, acidity units) to 74.56 % (fat content, %).

**Table 4**

Physico-chemical properties and chemical composition of the longest back muscle of young pigs of large white breed, n = 25

Indicators, units of measurement	Biometric indicators		
	$\bar{X} \pm S\bar{x}$	$\sigma \pm S\sigma$	$Cv \pm S_{Cv}, \%$
pH, units of acidity	5.62 ± 0.028	0.14 ± 0.091	2.49 ± 0.352
tenderness, p	9.41 ± 0.283	1.41 ± 0.199	14.98 ± 2.118
moisture holding capacity,%	60.10 ± 0.981	4.90 ± 0.693	8.15 ± 1.152
color intensity, units ext. × 1000	73.60 ± 2.147	10.73 ± 1.517	14.57 ± 2.060
heat treatment losses,%	22.03 ± 0.667	3.33 ± 0.471	15.11 ± 2.137
Content,%:			
total moisture	74.13 ± 0.446	2.23 ± 0.315	3.01 ± 0.425
air-dry matter	27.25 ± 0.450	2.25 ± 0.318	8.25 ± 1.167
ashes	1.13 ± 0.019	0.09 ± 0.012	7.96 ± 1.125
protein	22.36 ± 0.400	2.00 ± 0.282	8.94 ± 1.264
fat	2.28 ± 0.341	1.70 ± 0.240	74.56 ± 1.054
calcium (Ca)	0.045 ± 0.0011	0.005 ± 0.0007	11.11 ± 1.571
phosphorus (P)	0.126 ± 0.0047	0.023 ± 0.0032	18.25 ± 2.581
Energy value of muscle tissue, kcal	121.88 ± 3.110	15.55 ± 2.199	12.75 ± 1.773

According to the scale of meat quality assessment according to physicochemical parameters (Polyvoda, 1976), the number of high quality samples according to the indicators “moisture holding capacity, %” is equal to 12.0 %, “color intensity, units. ext. × 1000” – 16.0 %, “tenderness, c” – 12.0 % and “fat content, %” – 16.0 %.

Analysis of the data shows that the correlations between physicochemical properties and chemical composition of the longest back muscle (Table 5), physicochemical properties, chemical composition of the longest back muscle and biochemical parameters of serum in young white pigs breed (Table 6) are multidirectional, and vary in strength from weak to moderate.

**Table 5**

Correlation coefficient between physicochemical properties and chemical composition of the longest back muscle of young white pigs, n = 25

Features		Biometric indicators	
x	y	r ± Sr	tr
1	6	0.121 ± 0.2070	0.58
	7	-0.054 ± 0.2082	0.26
	8	-0.124 ± 0.2069	0.60
	9	0.119 ± 0.2070	0.57
	10	-0.141 ± 0.2064	0.68
	11	-0.160 ± 0.2058	0.78
2	12	-0.207 ± 0.2039	1.01
	6	0.296 ± 0.1992	1.49
	7	-0.484 ± 0.1825*	2.65
	8	-0.361 ± 0.1945	1.86
	9	-0.416 ± 0.1896*	2.19
	10	-0.101 ± 0.2074	0.49
	11	-0.310 ± 0.1981	1.56
	12	-0.061 ± 0.2081	0.29

3	6	0.318 ± 0.1977	1.61
	7	-0.209 ± 0.2039	1.02
	8	-0.225 ± 0.2032	1.11
	9	0.176 ± 0.2053	0.86
	10	-0.275 ± 0.2005	1.37
	11	-0.021 ± 0.2085	0.10
4	12	0.131 ± 0.2067	0.63
	6	0.179 ± 0.2051	0.87
	7	-0.086 ± 0.2077	0.41
	8	0.058 ± 0.2082	0.28
	9	-0.107 ± 0.2073	0.52
	10	-0.165 ± 0.2057	0.80
5	11	-0.020 ± 0.2085	0.10
	12	-0.254 ± 0.2016	1.25
	6	-0.450 ± 0.1862*	2.42
	7	-0.319 ± 0.1976	1.61
	8	-0.167 ± 0.2056	0.81
	9	-0.250 ± 0.2019	1.24
	10	0.836 ± 0.1144***	7.31
	11	0.172 ± 0.2054	0.84
	12	0.178 ± 0.2051	0.86

Note: 1 – pH, units of acidity, 2 – moisture holding capacity,%, 3 – color intensity, units ext. × 1000, 4 – tenderness, s, 5 – fat content, %, 6 – total moisture content, %, 7 – protein content,%, 8 – ash content, %, 9 – heat loss, %, 10 – energy value, kcal, 11 – Ca, %, 12 – P, %, \* – P < 0.05, \*\*\* – P < 0.001.

Significant correlations were established between the following pairs of features: moisture holding capacity, % × protein content, % (-0.484 ± 0.1825, tr = 2.65), moisture holding capacity, % × heat loss, % -0.416 ± 0.1896, tr = 2.19), fat content, % × moisture holding capacity, %, (-0.450 ± 0.1862, tr = 2.42), fat content, % × energy value, kcal (0.836 ± 0.1144, tr = 7.31), alanine aminotransferase (ALT) activity, mmol/h/l × pH, units of acidity, (0.443 ± 0.1859, tr = 2.37), alkaline phosphatase activity, units / l × color intensity, units. ext. × 1000 (-0.483 ± 0.1826, tr = 2.65), alkaline phosphatase activity, units/l × P, % (0.484 ± 0.1825, tr = 2.65).

**Table 6**

Correlation coefficient between biochemical parameters of blood serum, physicochemical properties and chemical composition of the longest back muscle of young pigs of large white breed, n = 25

Features		Biometric indicators		
x	y	r ± Sr	tr	
1	5	0.165 ± 0.2057	0.80	
	6	0.066 ± 0.2081	0.32	
	7	0.301 ± 0.1988	1.51	
	8	-0.104 ± 0.2074	0.50	
	9	0.255 ± 0.2016	1.26	
	10	-0.292 ± 0.1994	1.46	
	11	0.026 ± 0.2084	0.12	
	12	0.190 ± 0.2047	0.93	
	13	-0.027 ± 0.2084	0.13	
	14	-0.283 ± 0.2000	1.42	
	15	-0.030 ± 0.2084	0.14	
	16	0.178 ± 0.2052	0.87	
	2	5	0.443 ± 0.1859*	2.37
		6	0.013 ± 0.02085	0.06
		7	0.283 ± 0.2000	1.42
		8	-0.174 ± 0.2053	0.85
9		-0.184 ± 0.2050	0.90	
10		0.084 ± 0.2078	0.40	
11		0.126 ± 0.2069	0.61	
12		0.215 ± 0.2036	1.06	
13		0.012 ± 0.2085	0.06	
14		0.159 ± 0.2059	0.77	
15		0.124 ± 0.2069	0.60	
16		0.392 ± 0.1918	2.04	
3		5	0.018 ± 0.2085	0.09
		6	0.120 ± 0.2070	0.58
		7	0.483 ± 0.1826*	2.65
		8	0.105 ± 0.2074	0.51
	9	-0.051 ± 0.2082	0.24	
	10	-0.116 ± 0.2071	0.56	
	11	0.118 ± 0.2071	0.57	
	12	-0.158 ± 0.2059	0.77	
	13	0.135 ± 0.2066	0.65	
	14	0.050 ± 0.2083	0.24	
	15	0.140 ± 0.2065	0.68	
	16	0.484 ± 0.1825*	2.65	
	4	5	-0.129 ± 0.2068	0.62
		6	-0.062 ± 0.2081	0.30
		7	0.177 ± 0.2052	0.86
		8	-0.081 ± 0.2078	0.39
9		0.112 ± 0.2072	0.54	
10		-0.068 ± 0.2080	0.33	
11		-0.090 ± 0.2077	0.43	
12		0.078 ± 0.2079	0.38	
13		-0.028 ± 0.2084	0.13	
14		-0.122 ± 0.2070	0.59	
15		0.258 ± 0.2015	1.28	
16		0.287 ± 0.1997	1.44	

Note: 1 – aspartate aminotransferase (AST) activity, mmol/h/l, 2 – alanine aminotransferase (ALT) activity, mmol/h/l, 3 – alkaline phosphatase activity, units/l, 4 – a-amylase activity, g/h × l, 5 – pH, units of acidity, 6 – moisture holding capacity, %, 7 – color intensity, units ext. × 1000, 8 – tenderness, s, 9 – total moisture content, %, 10 – fat content, %, 11 – protein content, %, 12 – heat loss, %, 13 – ash content, %, 14 – energy value, kcal, 15 – calcium (Ca), %, 16 – phosphorus (P), %, \* – P < 0.05.

## 4. Conclusions

1. According to the results of research it is established that the biochemical parameters of the serum of young pigs correspond to the physiological norm of clinically healthy animals of this species and age.

2. The number of samples of the longest back muscle of high quality in terms of “moisture holding capacity” is 3 (12 %), “fat content” – 4 (16 %), “tenderness” – 3 (12 %) and “color intensity” – 4 (16 %).

3. Effective biochemical markers for early prediction of high quality meat by active acidity (pH) and color intensity are the activity of alanine aminotransferase (ALT) and alkaline serum phosphatase of young pigs of large white breed of English origin at 5 months of age.

*Prospects for further research.* Further work in this area involves the study of fattening and meat qualities of young pigs of different intra-breed and inter-breed combinations, taking into account their genotype for some DNA markers.

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