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Level of phenotypic manifestation of feeding and meat qualities of young pigs of different intrabreed differentiation according to some multi-component evaluation indexes

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Abstract

The paper deals with the results of the search for fattening and meat qualities of young pigs of Large White breeds of different interbreeding differentiation according to some integrated indicators, the level of correlations between traits, and the economic efficiency of research results is calculated. The experimental part of the work was performed in agricultural formations of the Dnipropetrovsk region and the laboratory of animal husbandry of the State Establishment Institution "Institute of Grain Crops of NAAS of Ukraine". Evaluation of young pigs for fattening and meat qualities was carried out taking into account the following indicators: average daily gain of live weight during the period of control fattening, kg, age achievement of live weight 100 kg, days, the thickness of the lard at the level of 6–7 thoracic vertebrae, mm, the length of the chilled carcass, cm. A comprehensive evaluation of young pigs for fattening and meat qualities was performed according to the Tyler and Sazer-Fredin indices. Economic efficiency of research results and biometric processing of the obtained data were carried out according to generally accepted methods. It was found that young pigs of the Large White breed of the controlled population at the age of 100 kg exceeded the minimum requirements of the elite class by 6.13%, the thickness of the lard at the level of 6-7 thoracic vertebrae – 32.25 % and the length of the chilled carcass – 3.92 %. A significant difference between animals of different interbreeding differentiation according to the Tyler index (groups I and III) was set up by the average daily gain of live weight during the control period of fattening (91.7 g), age of 100 kg live weight (7.3 days), lard thickness at the level of 6–7 thoracic vertebrae (3.4 mm), length of the chilled carcass (1.7 cm), length of bacon half of chilled carcass (2.7 cm). Taking into account the interbreed differentiation according to the Sazer-Fredin index, it is found that young pigs of the II group prevailed over their peers of I in terms of average daily increase in live weight during the period of control fattening by 4.03 %, age of achievement of live weight of 100 kg – 3.67 % and length of the chilled carcass – 0.2 %. The pairwise correlation coefficient between fattening and meat qualities of young pigs and evaluation indices ranges from -0.710 (tr = 10.24) to +0.844 (tr = 20.98). The maximum increase in additional products was obtained from young pigs of the first experimental group according to the Tyler index (+5.03 %) and the second experimental group according to the Sazer-Fredin index (+1.12 %). The cost of additional products got from the young pigs of these groups, provided that the selling price per 1 kg of live weight of young pigs at the time of the search was 47.5 UAH is +247.51 and +55.42 UAH/head, respectively.

Keywords: young pigs, breed, fattening and meat qualities, index, economic efficiency, variability, correlation.

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1. Introduction

Research on the fattening and meat qualities of young pigs of modern breeds, as well as animals got based on industrial crossing and hybridization, indicate a high level of their phenotypic development under conditions of maintenance and feeding following physiological norms (Loban, 2014; Strel'cov et al., 2018; Tsereniuk, 2018; Kramarenko et al., 2018; 2019; Khalak, 2020; Martyshuk et al., 2020; Tsereniuk et al., 2020; Tretyakova et al., 2021). Thus, according to Khramkova O. M. (2021), it was found that young pigs characterize the best fattening qualities got from sows of genotype F1 (Li × Ji) and boars of the synthetic line "MaxGrow". They reached a live weight of 100 kg in 171.6 days, 14.9 days or 7.99 % less than their peers of the Large White breed ($P \leq 0.001$). Compared to the peers of the synthetic lines "MaxTer" and "OptiMus," the difference is 1.3–10.5 days or 0.75–6.12 %. Also, all the animals from boars of foreign selection had a better payment for feed in increments compared to analogs of domestic selection by 0.12–0.35 kg or 0.13–0.39 feed units.

Searches of Krasnoshchoka O. (2020) found that young pigs got based on industrial crossbreeding of sows of Large White breeds and boars of Landrace by the age of achievement of live weight 100 kg prevailed purebred peers of Large White breed by eight days or 4.5 %.

This indicates that in the period of intensification of the selection process with the use of animals for foreign selection, an important issue is to search the level of their adaptation to environmental conditions, phenotypic development of essential economic traits and economically valuable features, as well as the search for effective methods of assessing breeding value and selection of highly productive animals.

Confirm the relevance and practical value of the chosen field of research are the works of domestic and foreign scientists (Khvatova, 2012; Martins et al., 2015; Lugovoy et al., 2017; Martins et al., 2020; Novakovska, 2020; Snegin et al., 2021).

The purpose of the work is to investigate the fattening and meat qualities of young Large White pigs of different interbreeding differentiation according to the Tyler and Sazer-Fredin indices, to calculate the level of correlations between traits and economic efficiency of research results.

2. Materials and methods

The research was conducted in agricultural formations of Dnipropetrovsk region, the "Jazz" meat-packing plant, and the livestock laboratory of the State Institution "Institute of Grain Crops of NAAS".

The object of the investigation was young pigs of the Large White breed. Evaluation of animals for fattening and meat qualities was carried out taking into account the following indicators: average daily gain of live weight during the period of control fattening, kg, age of reaching live weight 100 kg, days, fat thickness at the level of 6–7 thoracic vertebrae, mm, the length of a chilled carcass, cm (Berezovskyi & Khatko, 2005).

The following formulas calculated the Tyler (1) and Sazer-Fredin indices (2):

$$I_v = 100 + (242 \times K) - (4{,}13 \times L), \quad (1)$$

Where: I_v – complex index of fattening and meat qualities, points; K – an average daily gain of live weight, kg; L is the thickness of the lard at the level of 6–7 thoracic vertebrae, mm; 242; 4.13 – constant coefficients (Berezovskyi & Vashchenko, 2019);

$$I = \frac{1}{\sigma_g} \times \Delta G_1 - \frac{1}{\sigma_f} \times \Delta F_1 \quad (2)$$

Where: I – index of A. Sazer – H. Fredin points; ΔG_1 – growth rate in deviations from the average; ΔF_1 – lard thickness in deviations from the average; σ_g – phenotypic standard deviation of growth rate; σ_f – is the phenotypic standard deviation of the thickness of the lard.

The strength of the correlations between traits was determined by the Chaddock scale (Table 1).

The cost of additional products (Khalak et al., 2022) and biometric data processing (Lakin, 1990) were carried out according to generally accepted methods.

All animal manipulations followed the European Convention for the Protection of Vertebrate Animals Used for Experimental and Scientific Purposes (Strasbourg, 1986).

Table 1
Chaddock scale for gradation of correlation strength

Correlation coefficient values	The strength of the correlation
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

3. Results and discussion

It was found that the average daily increase in live weight of young pigs in the experimental group (n = 51) for the period of control fattening is 792.4 ± 6.37 g (Cv = 5.75 %), age of reaching a live weight of 100 kg – 178.0 ± 0.68 days (Cv = 2.76 %), the thickness of the lard at the level of 6–7 thoracic vertebrae – 21.0 ± 0.26 mm (Cv = 8.93 %), the length of the cooled carcass is 96.8 ± 0.22 cm (Cv = 1.65 %).

Tyler and Sazer-Fredin indices range from 178.89 to 242.85 and from -3.018 to +3.427 points, respectively.

The results of the research on fattening and meat qualities of young pigs of the Large White breed of different intra-breed differentiation according to the Tyler and Sazer-Fredin index are shown in Tables 2 and 3.

It was found that young pigs of group I (Tyler index ranges from 214.89 to 242.85 points) outperformed peers of III (Tyler index ranges from 178.89 to 192.72 points) according to the average daily increase in live weight during the period of control fattening by 91.7 g (td = 9.28; $P < 0.001$), the age of reaching a live weight of 100 kg – 7.3 days (td = 4.42; $P < 0.001$), lard thickness at the level of 6–7 thoracic vertebrae – 3.4 mm (td = 6.07; $P < 0.001$), length of chilled carcass – 1.7 cm (td = 3.54; $P < 0.01$), length of bacon half of the cooled carcass – 2.7 cm (td = 3.64; $P < 0.01$).

According to the Tyler index, the difference between the animals of these groups is 36.2 points (td = 13.35; $P < 0.001$).

Taking into account the intra-breed differentiation according to the Sazer-Fredin index, it was found that young pigs of group II (Sazer-Fredin index ranges from -3.018 to -0.102 points) dominated peers I (Sazer-Fredin index ranges from +0.028 to +3.427 points) by the average daily gain of live weight during the period of control fattening by 32.3 g (td = 2.92; $P < 0.01$), the age of reaching a live weight of 100 kg – 6.7 days (td = 5.58; $P < 0.001$), the length of the cooled carcass is 0.2 cm (td = 0.47; $P > 0.05$).

The opposite pattern between the groups was found for the length of the bacon half of the chilled carcass and the thickness of the lard at the level of 6–7 thoracic vertebrae. The difference between the animals of groups I and II in the length of the bacon half of the chilled carcass is 1.1 cm (td = 1.54; $P > 0.05$), the thickness of the lard at the level of 6–7 thoracic vertebrae – 2.2 mm (td = 5.23; $P < 0.001$).

Table 2
According to Tyler's index, the fattening and meat qualities of young pigs of Large White breed of different interbreed differentiation

Indicators, units of measurement	Biometric indicators	Tyler index gradations		
		214.89–242.85	195.52–213.54	178.89–192.72
		group		
		I	II	III
	n	13	25	13
The average daily increase in live weight during the period of control fattening, g	$\overline{X}$ ± Sx	834.4 ± 7.80	796.4 ± 7.41	742.7 ± 6.07
	σ ± Xσ	28.12 ± 5.524	37.08 ± 5.244	21.86 ± 4.294
	Cv ± Scv, %	3.37 ± 0.662	4.65 ± 0.657	2.94 ± 0.577
Age of achievement of live weight of 100 kg, days	$\overline{X}$ ± Sx	174.4 ± 1.14	177.9 ± 0.85	181.7 ± 1.20
	σ ± Xσ	4.11 ± 0.807	4.25 ± 0.601	4.34 ± 0.852
	Cv ± Scv, %	2,35 ± 0.461	2.38 ± 0.336	2.38 ± 0.467
The thickness of the lard at the level of 6–7 thoracic vertebrae, mm	$\overline{X}$ ± Sx	19.1 ± 0.37	21.1 ± 0.28	22.5 ± 0.43
	σ ± Xσ	1.34 ± 0.263	1.43 ± 0.202	1.56 ± 0.309
	Cv ± Scv, %	7.01 ± 1.377	6.77 ± 0.957	6.93 ± 1.361
Length of a chilled carcass, cm	$\overline{X}$ ± Sx	97.4 ± 0.35	97.1 ± 0.33	95.7 ± 0.34
	σ ± Xσ	1,26 ± 2,475	1.69 ± 0.239	1.23 ± 0.241
	Cv ± Scv, %	1.29 ± 0.253	1.74 ± 0.246	1.28 ± 0.251
Length of bacon half of chilled carcass, cm	$\overline{X}$ ± Sx	87.0 ± 0.58	86.1 ± 0.59	84.3 ± 0.47
	σ ± Xσ	2.10 ± 0.412	2.98 ± 0.421	1.70 ± 0.333
	Cv ± Scv, %	2.41 ± 0.473	3.46 ± 0.489	2.01 ± 0.394

Table 3
Fattening and meat qualities of young pigs of Large White breed of different intrabreed differentiation according to the Sazer-Fredin index

Indicators, units of measurement	Biometric indicators	Gradations of the Sazer-Fredin index	
		+0.028 – +3.427	-3.018 – -0.102
		group	
		I	II
	n	28	23
The average daily increase in live weight during the period of control fattening, g	$\overline{X}$ ± Sx	769.1 ± 7.33	801.4 ± 8.25
	σ ± Xσ	34.37 ± 4.594	39.59 ± 5.839
	Cv ± Scv, %	4.46 ± 0.596	4.94 ± 0.728
Age of achievement of live weight of 100 kg, days	$\overline{X}$ ± Sx	182.1 ± 0.82	175.4 ± 0.89
	σ ± Xσ	4.39 ± 0.586	4.28 ± 0.631
	Cv ± Scv, %	2.41 ± 0.322	2.44 ± 0.359
The thickness of the lard at the level of 6–7 thoracic vertebrae, mm	$\overline{X}$ ± Sx	20.0 ± 0.29	22.2 ± 0.31
	σ ± Xσ	1.53 ± 0.204	1.50 ± 0.221
	Cv ± Scv, %	7.65 ± 1.022	6.75 ± 0.995
Length of a chilled carcass, cm	$\overline{X}$ ± Sx	96.8 ± 0.33	97.0 ± 0.29
	σ ± Xσ	1.77 ± 0.236	1.39 ± 0.205
	Cv ± Scv, %	1.82 ± 0.243	1.43 ± 0.210
Length of bacon half of chilled carcass, cm	$\overline{X}$ ± Sx	86.3 ± 0.59	85.2 ± 0.42
	σ ± Xσ	3.15 ± 0.421	2.01 ± 0.296
	Cv ± Scv, %	3.65 ± 0.487	2.35 ± 0.346

The results of calculations of the pairwise correlation coefficient between fattening and meat qualities of young pigs and evaluation indices are shown in Table 4.

The pairwise correlation coefficient between fattening and meat qualities of young pigs and evaluation indices ranges from -0.710 (tr = 10.24) to +0.844 (tr = 20.98).

The following pairs of characteristics found significant correlation coefficients: Tyler index × average daily gain of live weight during the period of control fattening (r = +0.844), Tyler index × age of live weight 100 kg (r = -0.546), Tyler index × fat thickness at the level of 6–7 thoracic vertebrae, mm (-0.647), Tyler index × length of the chilled carcass (r = +0.359), Tyler index × length of bacon half of chilled carcass (r = +0.298), Saser-Fredin index × average daily gain of live weight during the period of control fattening (r = -0.371), Sazer-Fredin index × age of live weight 100 kg (r = +0.665), Sazer-Fredin index × fat thickness at the level of 6–7 thoracic vertebrae, mm (-0.710).

The results of the calculation of the economic efficiency of using young pigs in the experimental groups are shown in table 5.

Table 4
Coefficients of pair correlation between fattening and meat qualities of young pigs and evaluation indices

Indicator (characteristic)		Biometric indicators		The strength of the correlation
x	y	r ± Sr	tr	
Tyler index, points	1	0.844 ± 0.0402***	20.98	Very high
	2	-0.546 ± 0.0982***	5.56	Noticeable
	3	-0.647 ± 0.0814***	7.95	Noticeable
	4	0.359 ± 0.1220**	2.95	Noticeable
	5	0.298 ± 0.1276*	2.34	Weak
Sazer-Fredin index points	1	-0.371 ± 0.1207**	3.08	Noticeable
	2	0.665 ± 0.0780***	8.53	Noticeable
	3	-0.710 ± 0.0694***	10.24	High
	4	-0.084 ± 0.1391	0.60	-
	5	0.010 ± 0.1400	0.07	-

Note: 1 – an average daily gain of live weight during the period of control fattening, kg; 2 – age of achievement of live weight of 100 kg, days; 3 – the thickness of the lard at the level of 6–7 thoracic vertebrae, mm; 4 – length of the cooled carcass, cm; 5 – length of the bacon half of the cooled carcass, cm. * – P < 0.05; ** – P < 0.01; *** – P < 0.001

Table 5
Economic efficiency of research results

Group	n	The average daily increase in live weight during the period of control fattening, g	Increase in additional products, %	Cost of additional products, UAH/head *
Total sample	26	792.4 ± 6.37	-	-
intrabreeding differentiation according to the Tyler index				
III	13	742.7 ± 6.07	-6.27	-321.4
II	25	796.4 ± 7.41	+0.50	+25.09
I	13	834.4 ± 7.80	+5.03	+247.51
intrabreed differentiation according to the Sazer-Fredin index				
I	28	769.1 ± 7.33	-2.94	-151.05
II	23	801.4 ± 8.25	+1.12	+55.42

Note: * – the sale price of young pigs to processing enterprises of the region at the time of the investigation was 47.5 UAH/kg

It was found that the maximum increase in additional products was obtained from young pigs of the I experimental group according to the Tyler index (+5.03 %) and the second experimental group according to the Sazer-Fredin index (+1.12 %). The cost of additional products got from the young pigs of these groups, provided that the selling price per 1 kg of live weight of young pigs at the time of the investigation was 47.5 UAH is +247.51 and +55.42 UAH/head, respectively.

4. Conclusions

1. It is found that young pigs of the Large White breed of the controlled population at the age of reaching a live weight of 100 kg exceed the minimum requirements of the elite class by 6.13 %, the thickness of the lard at the level of 6–7 thoracic vertebrae – 32.25 % and the length of the cooled carcass – 3.92 %.

2. Significant difference between animals of different intrabreeding differentiation according to the Tyler index (groups I and III) was set by the average daily increase in live weight during the period of control fattening (91.7 g; td = 9.28; P < 0.001), age of live weight 100 kg (7.3 days; td = 4.42; P < 0.001), lard thickness at the level of 6–7 thoracic vertebrae (3.4 mm; td = 6.07; P < 0.001), length chilled carcass (1.7 cm; td = 3.54; P < 0.01), the length of the bacon half of the chilled carcass (2.7 cm; td = 3.64; P < 0.01).

3. Taking into account the intrabreed differentiation according to the Sazer-Fredin index, it was found that the young pigs of group II dominated their peers in terms of the average daily gain of live weight for the period of control fattening by 4.03 %, the age of reaching a live weight of 100 kg – 3.67 % and the length of the cooled carcass – 0.2 %.

3. The pairwise correlation coefficient between fattening and meat qualities of young pigs and evaluation indices ranges from -0.710 (tr = 10.24) to +0.844 (tr = 20.98).

4. The maximum increase in additional products was obtained from young pigs of the first experimental group according to the Tyler index (+5.03 %) and the second experimental group according to the Sazer-Fredin index (+1.12 %). The cost of additional products got from the young pigs of these groups, provided that the selling price per 1 kg of live weight of young pigs at the time of the investigation was 47.5 UAH is +247.51 and +55.42 UAH/head, respectively.

Conflict of interest

The authors state that there is no conflict of interest.

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