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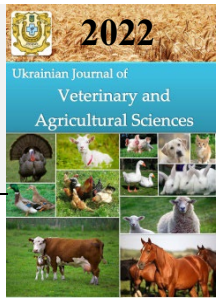

Feeding and meat qualities of young pigs of different genotypes according to melanocortin 4 receptor (Mc4r) gene and interbreed differentiation according to the coefficient of decrease in growth intensity in early ontogenesis

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Abstract

The paper presents the results of studies of fattening and meat qualities of young large white pigs of different genotypes for the melanocortin receptor 4 (Mc4r) gene and the decline in growth intensity in early ontogeny. The research was carried out in the agricultural formations of the Dnipropetrovsk region, the Jazz meat processing plant, the laboratory of the genetics of the Institute of Pig Breeding and APV of the National Academy of Sciences, and the laboratory of animal husbandry of the State Institution "Institute of Grain Crops of the National Academy of Sciences". The work was carried out following the scientific research program of the National Academy of Sciences No. 30, "Innovative technologies of breeding, industrial and organic production of pig farming products" ("Pig farming"). Assessment of animals for fattening and meat quality was carried out taking into account the following characteristics: average daily gain of live weight during the period of control fattening, g; the age of reaching 100 kg live weight, days, length of the chilled carcass, cm; length of the bacon half of the cooled carcass, cm; thickness of lard at the level of 6–7 thoracic vertebrae, mm. The coefficient of decline in growth intensity was calculated according to the method of Yu. K. Sviechin. Biometric research results were processed using generally accepted methods. It was established that according to live weight at 4 and 6 months of age, fattening and meat qualities (age of reaching a live weight of 100 kg, days; lard thickness at the level of 6–7 thoracic vertebrae, mm; length of the chilled carcass, cm) young pigs the controlled population belongs to the I class and the elite class. The coefficient of growth decline in animals of the controlled population ranges from 108.57 to 142.51 points. The data analysis shows that according to the live weight at 4 and 6 months of age, the age of reaching the live weight of 100 kg, the fat thickness at the level of 6–7 thoracic vertebrae, and the length of the chilled carcass, the young pigs of the controlled population belong to the I class and the elite class. Animals of the Mc4r AΓ genotype prevail over peers of the Mc4r AA genotype in terms of fattening and meat qualities by an average of 5.90 %. The interbreed differentiation of young pigs by the coefficient of the intensity of growth decline (ΔK) shows that the difference between the animals of the experimental groups in terms of the average daily gain in live weight is 23.3 g (td = 2.62), the age of reaching 100 kg live weight is 2.7 days (td = 1.59), the length of the cooled carcass is 1.4 mm (td = 2.12). The number of reliable correlations between fattening and meat qualities, coefficient of the intensity of growth decline (ΔK), and Tyler B. index is 75.0 %, which indicates the possibility of their use in selection and breeding work. The use of young pigs of the Mc4r AG genotype and animals of the I group, in which the coefficient of the intensity of growth decline (ΔK) ranges from 115.61 to 123.27 points, provides additional production at the level of +3.68 – +1.75 % respectively.

Keywords: young pigs, breed, genotype, coefficient of decline in growth intensity, ontogenesis, fattening and meat qualities, correlation, cost of additional products.

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1. Introduction

Intensification of the breeding process in pig breeding involves, along with the use of traditional methods of assessing the breeding value of animals, the introduction of specific innovations in this direction, as well as the use of animals of foreign breeding (Topiha & Grigor'eva, 2013; Khramkova, 2017; Lykhach et al., 2021; Krupa et al., 2021; Li et al., 2021; Martyshuk et al., 2021; Johnson et al., 2022; Fu et al., 2022).

The traditional methods of assessing the breeding value of pigs include the methods whose main provisions are given in the Pig Scoring Instructions to innovative ones – the method of index selection (Khalak et al., 2020a; Khalak et

al., 2021; Khalak & Gutyj, 2022) and the method of selecting highly productive animals based on the results of molecular genetic studies (Khalak, 2019; Khalak et al., 2020b; Xu et al., 2021; Du et al., 2022).

The results of the research of domestic and foreign scientists show that marker selection allows the selection of animals according to their genotype. It was established that the Ryr-1 rheanodine receptor gene is a marker of animals' sensitivity to stress, the estrogen (ESR) and prolactin (PRLR) receptor gene of reproductive qualities of sows, and the MC4R melanocortin receptor gene is a marker of the intensity of adipose tissue deposition in young pigs (Khalak, 2020; Du et al., 2022; Knol et al., 2022; Zorc et al., 2022; Ros-Freixedes et al., 2022).

This indicates the relevance of these areas of research and their practical significance.

Aim of the research – investigate the fattening and meat qualities of young pigs of the large white breed of different genotypes according to the melanocortin four receptor (Mc4r) gene and the intensity of growth decline in early ontogeny. Based on the obtained data, calculate the level of correlation between the characteristics, as well as the value of additional products obtained from the use of animals of the experimental groups.

2. Materials and methods

The research was carried out in the agricultural formations of the Dnipropetrovsk region, the meat processing plant "Jaz", the laboratory of the genetics of the Institute of Pig Breeding and APP of the National Academy of Sciences, and the Laboratory of Animal Husbandry of the State Institution "Institute of Grain Crops of the National Academy of Sciences". The work was carried out following the scientific research program of the National Academy of Sciences No. 30, "Innovative technologies of breeding, industrial and organic production of pig farming products" ("Pig farming").

The evaluation of young pigs of the large white breed according to indicators of individual development in early ontogeny, fattening, and meat qualities were carried out taking into account the following indicators: live weight at the time of birth, at 2 and 4 months of age (kg), average daily increase in live weight during the control period fattening, g; the age of reaching 100 kg live weight, days, length of a chilled carcass, cm; thickness of bacon at the level of 6–7 thoracic vertebrae, mm (Berezovskyi & Khatko, 2005).

The coefficient of the intensity of growth decline (ΔK) of young pigs of the experimental group during the period of their control rearing from birth to 4 months of age was calculated according to the method of Yu. K. Svechin (1):

$$\Delta K = \left[\left(\frac{W_2 - W_0}{\frac{W_2 + W_0}{2}} \right) - \left(\frac{W_4 - W_2}{W_4 + W_2} \right) \right] \times 100, \quad (1)$$

where: ΔK is the coefficient of decline in growth intensity, score; W_2 – live weight at the age of 2 months, kg, W_0 – live weight at the time of birth, kg, W_4 – live weight at the age of 4 months, kg (Bazhov & Komlackij, 1989).

A comprehensive assessment of young pigs of the experimental group for fattening and meat qualities was carried out according to the Tyler index (2):

$$I = 100 + (242 \times K) - (4{,}13 \times L) \quad (2)$$

where: I – Tyler index, point, K – average daily gain, kg; L – fat thickness at the level of 6–7 thoracic vertebrae, mm.

DNA typing of young pigs was carried out in the laboratory of the genetics of the Institute of Pig Breeding and APP of the National Academy of Agricultural Sciences (Kim et al., 2000a).

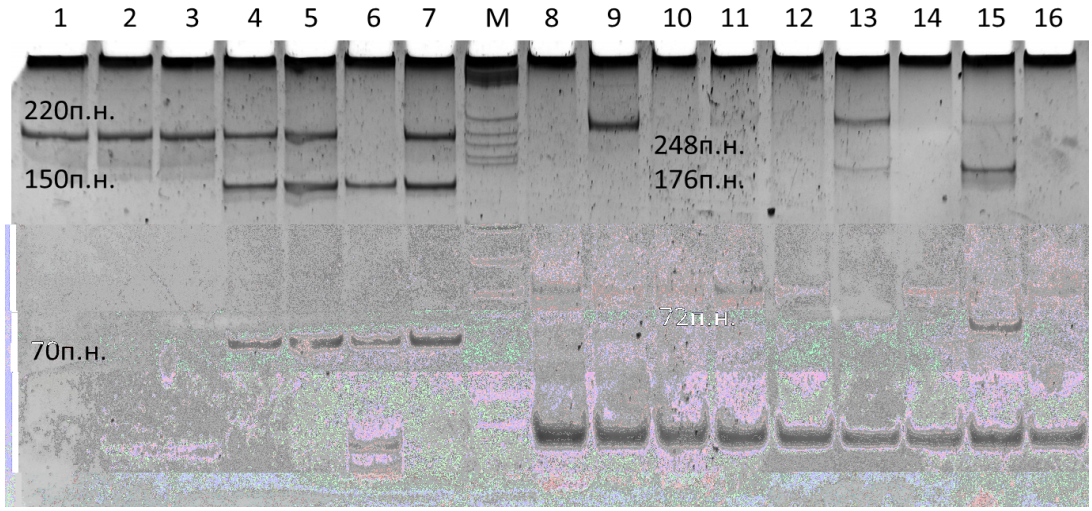

Fig. 1. Electrophoresis in 8% polyacrylamide gel of MC4R and Leptin(LEP) gene restrictions. Lane: 1-3 AA genotype, lane: 4, 5, 7 AG genotype, lane: 6 GG genotype, MC4R gene. Lane: 8, 10, 11, 12, 14, 15, 16 genotype TT, lane: 9 genotype AA, lane: 13 genotypes AT, Leptin(LEP) - gene. M is the pBR322 DNA/BsuRI molecular weight marker.

Biometric processing of the received data was carried out according to the methods of V.P. Kovalenko and others (Kovalenko et al., 2010).

The coefficient of pair correlation (3), its error (4), and reliability (5) of this biometric indicator was calculated according to the following formulas:

$$r = \frac{\sum xy - \frac{\sum x \cdot \sum y}{n}}{\sqrt{C_x \cdot C_y}} \quad (3)$$

$$S_r = \sqrt{\frac{1-r^2}{n-2}}. \quad (4)$$

$$t_r = \frac{r}{S_r} \quad (5)$$

3. Results and discussion

The analysis of the data shows that the live weight of young pigs at the time of birth is 1.53 ± 0.033 kg (Cv = 12.16 %), at the age of 2 and 4 months – 18.1 ± 0.27 (Cv = 8.16 %) and 48.1 ± 0.58 kg (Cv = 6.63 %). The coefficient of the intensity of growth decline (ΔK) during the period of growing young pigs from birth to 4 months of age ranges from 108.57 to 142.51 points, Tyler B.'s index – from 127.46 to 163.01 points. The average daily increase in live weight of young pigs during the period of control fattening is 772.6 ± 6.56 g (Cv = 3.95 %), the age of reaching a live weight of 100 kg is 178.5 ± 0.80 days (Cv = 2.46 %), the thickness of lard at the level of 6–7 thoracic vertebrae is 21.3 ± 0.31 mm (Cv = 8.01 %), the length of the chilled carcass is 96.7 ± 0.35 cm (Cv = 1.73 %).

The results of studies of growth indicators in early ontogenesis, fattening, and meat qualities of young pigs of different genotypes according to the melanocortin receptor 4 (Mc4r) gene are shown in Tables 1 and 2.

The analysis of the data in Table 1 shows that the difference between the groups in live weight of young pigs of different genotypes for the melanocortin receptor 4 (Mc4r) gene at the time of birth is 0.03 kg (td = 0.44; P>0.05), in 2 and at four months of age – 0.4 (td = 0.75; P > 0.05) and 2.9 kg (td = 2.68; P < 0.05), respectively.

The difference between animals of different genotypes according to the coefficient of the intensity of growth decline (ΔK) is equal to 5.850 points (td = 2.44; P < 0.05).

The analysis of the results of the control feeding of young pigs shows that the young pigs of the II experimental group ($Mc4r^{AG}$) prevailed over peers of the I group ($Mc4r^{AA}$) in terms of the average daily increase in live weight by 55.1 g (td = 7.80; P < 0.001), the age of reaching a live weight of 100 kg – 6.2 days (td = 4.18; P < 0.001) (Table 2).

Young pigs of the II experimental group ($Mc4r^{AG}$) compared to peers of the 1st group ($Mc4r^{AA}$) were characterized by a smaller index of fat thickness at the level of 6–7 thoracic vertebrae (by 2.6 mm; td = 5.65; P < 0.001), and the difference between the groups in the length of the chilled carcass was 1.7 cm (td = 3.14; P < 0.01). According to the Tyler index, the young pigs of the II experimental group outperformed the same-aged pigs of the same age by 14.55 points (td = 7.61; P < 0.001).

Interbreed differentiation of young pigs according to the coefficient of the intensity of growth decline (ΔK) showed that the difference between groups (II–I) in terms of average daily live weight gain is 23.3 g (td = 2.62; P < 0.05), the age of reaching of live weight 100 kg – 2.7 days (td = 1.59; P > 0.05), fat thickness at the level of 6–7 thoracic vertebrae – 1.4 mm (td = 2.12; P < 0.05), Tyler B. index – 7.46 points (td = 2.10; P < 0.05) (Table 3).

The difference between the groups in the length of the chilled carcass is 1.7 cm (td = 2.36; P < 0.05).

The results of the calculation of the pairwise correlation coefficient between the signs of fattening and meat qualities, the coefficient of growth decline (Δt), and the Tyler index are shown in Table 4.

It was found that this biometric indicator varies from -0.918 (Tyler's index × fat thickness at the level of 6–7 thoracic vertebrae) to +0.876 (coefficient of the intensity of growth decline (ΔK). × live weight at two months of age).

Table 1

Absolute and integrated indicators of growth of young pigs of experimental groups, n = 15

Indicator	Biological indicators	Genotype	
		$Mc4r^{AA}$	$Mc4r^{AG}$
		Group	
		I	II
Live weight at the time of birth, kg	$X \pm Sx$	1.54 ± 0.052	1.51 ± 0.044
	$\sigma \pm X_\sigma$	0.20 ± 0.037	0.17 ± 0.031
	$Cv \pm Sc_v$, %	13.18 ± 2.409	11.25 ± 2.056
Live weight at the age of 2 months, kg	$X \pm Sx$	18.3 ± 0.35	17.9 ± 0.41
	$\sigma \pm X_\sigma$	1.38 ± 0.252	1.59 ± 0.290
	$Cv \pm Sc_v$, %	7.54 ± 1.378	8.88 ± 1.623
Live weight at the age of 4 months, kg	$X \pm Sx$	45.6 ± 0.73	48.5 ± 0.81
	$\sigma \pm X_\sigma$	2.83 ± 0.517	3.54 ± 0.647
	$Cv \pm Sc_v$, %	6.20 ± 1.133	7.29 ± 1.332
Coefficient of the intensity of growth decline (ΔK), score	$X \pm Sx$	126.90 ± 1.368	121.05 ± 1.962
	$\sigma \pm X_\sigma$	6.17 ± 1.127	7.60 ± 1.389
	$Cv \pm Sc_v$, %	4.86 ± 0.888	6.27 ± 1.146

Table 2
Feeding and meat qualities of young pigs of different genotypes according to the melanocortin receptor gene 4 (*Mc4r*), n = 15

Indicator (sign), units of measurement	Biological indicators	Genotype	
		$Mc4r^{AA}$	$Mc4r^{AG}$
		Group	
		I	II
Average daily gain of live weight during the period of control fattening, kg	$X \pm Sx$	747.1 ± 3.17	802.2 ± 6.31
	$\sigma \pm X_\sigma$	12.29 ± 2.246	28.23 ± 5.160
	$Cv \pm Sc_v$, %	1.64 ± 0.299	3.51 ± 0.641
Age of reaching 100 kg live weight, days	$X \pm Sx$	180.4 ± 1.08	174.2 ± 1.02
	$\sigma \pm X_\sigma$	4.20 ± 0.767	4.56 ± 0.833
	$Cv \pm Sc_v$, %	2.32 ± 0.424	2.61 ± 0.477
The thickness of the lard at the level of 6–7 thoracic vertebrae, mm	$X \pm Sx$	22.4 ± 0.32	19.8 ± 0.34
	$\sigma \pm X_\sigma$	1.24 ± 0.226	1.47 ± 0.268
	$Cv \pm Sc_v$, %	5.53 ± 1.010	7.42 ± 1.356
Tyler B. index, score	$X \pm Sx$	138.60 ± 1.635	153.15 ± 1.410
	$\sigma \pm X_\sigma$	6.33 ± 1.157	5.46 ± 0.998
	$Cv \pm Sc_v$, %	4,56 ± 0,833	3.56 ± 0.651
The length of the cooled carcass, cm	*n*	*9*	*13*
	$X \pm Sx$	95,7 ± 0,33	97.4 ± 0.44
	$\sigma \pm X_\sigma$	1,00 ± 0,235	1.65 ± 0.324
	$Cv \pm Sc_v$, %	1,04 ± 0,245	1.69 ± 0.332

Table 3
The fattening and meat qualities of young pigs of different interbreed differentiation according to the coefficient of growth decline (ΔK), n = 15

Indicator (sign), units of measurement	Biological indicators	Gradations of the coefficient of the intensity of growth decline (ΔK), score	
		125.94–142.51	115.61–123.27
		Group	
		I	II
Average daily gain of live weight during the period of control fattening, kg	$X \pm Sx$	763.2 ± 6.72	786.4 ± 5.81
	$\sigma \pm X_\sigma$	24.93 ± 4.557	20.13 ± 3.680
	$Cv \pm Sc_v$, %	3.26 ± 0.595	2.55 ± 0.467
Age of reaching 100 kg live weight, days	$X \pm Sx$	177.9 ± 1.24	175.2 ± 1.16
	$\sigma \pm X_\sigma$	4.14 ± 0.756	4.54 ± 0.829
	$Cv \pm Sc_v$, %	2.32 ± 0.424	2.59 ± 0.473
The thickness of the lard at the level of 6–7 thoracic vertebrae, mm	$X \pm Sx$	21.9 ± 0.43	20.5 ± 0.51
	$\sigma \pm X_\sigma$	1.44 ± 0.263	1.78 ± 0.325
	$Cv \pm Sc_v$, %	6.57 ± 1.201	8.68 ± 1.586
Tyler B. index, score	$X \pm Sx$	143.48 ± 2.456	150.94 ± 2.567
	$\sigma \pm X_\sigma$	8.14 ± 1.488	8.89 ± 1.625
	$Cv \pm Sc_v$, %	5.67 ± 1.036	5.88 ± 1.074
The length of the cooled carcass, cm	*n*	*8*	*14*
	$X \pm Sx$	95.8 ± 0.40	97.5 ± 0.61
	$\sigma \pm X_\sigma$	0.98 ± 0.245	1.95 ± 0.368
	$Cv \pm Sc_v$, %	1.02 ± 0.255	2.00 ± 0.378

Table 4
The level of correlations between fattening and meat qualities, the "formation intensity" index (Δt; 0-2-4), and the Tyler B index, n = 30

Feature		Biometrical indicators	
x	*y*	r ± Sr	tr
Live weight at the time of birth, kg	1	-0,473 ± 0,1419**	3.33
	2	-0,126 ± 0,1799	0.70
Live weight at the age of 2 months, kg	1	0,876 ± 0,0425***	20.60
	2	-0,134 ± 0,1795	0.75
Live weight at the age of 4 months, kg	1	-0,688 ± 0,0963***	7.15
	2	0,221 ± 0,1739	1.27
Average daily gain of live weight during the period of control fattening, kg	1	0.080 ± 0.1836	0.44
	2	0.660 ± 0.1032***	6.40
Age of reaching 100 kg live weight, days	1	-0.258 ± 0.1706	1.51
	2	-0.590 ± 0.1192***	4.95
The thickness of the lard at the level of 6–7 thoracic vertebrae, mm	1	0.239 ± 0.1724	1.39
	2	-0.918 ± 0.0288***	31.93
The length of the cooled carcass, cm	1	-0.110 ± 0.1805	0.61
	2	0.371 ± 0.1577*	2.35

Note: 1 – coefficient of the intensity of growth decline (ΔK), score; 2 – Tyler B. index, score; * – P < 0.05; ** – P < 0.01; *** – P < 0.001

Reliable pairwise correlation coefficients were established between the following pairs of traits: coefficient of the intensity of growth decline (ΔK) × live weight at birth (r = -0.473), coefficient of the intensity of growth decline (ΔK) × live weight at two months of age. Age of reaching a live weight of 100 kg (r = -0.590), Tyler B. index × fat thickness at the level of 6–7 thoracic vertebrae (r = -0.918), Tyler B. index × length of the chilled carcass (r = +0.371).

The calculation of the economic efficiency of the research results shows that the maximum increase in additional production was obtained from young pigs of the genotype Mc4r AΓ (+3.68 %), as well as animals of the 1st group of interbreeding differentiation according to the coefficient of the intensity of growth decline (ΔK) (+1.75 %) (Table 5).

Table 5
Economic efficiency of research results

Group	Average daily gain of live weight during the period of control fattening, kg	Increase in additional products, %	The cost of additional products, UAH/head
General sample	772.6 ± 6.56	-	-
interbreed differentiation by genotype			
I	747.1 ± 3.17	-3.30	-163.72
II	802.2 ± 6.31	+3.68	+176.30
interbreed differentiation according to the coefficient of the intensity of growth decline (ΔK)			
I	763.2 ± 6.72	-1.21	-59.20
II	786.4 ± 5.81	+1.75	+84.32

The value of additional products obtained from young pigs of the specified groups is +176.30 and +84.32 hryvnias/goal respectively.

4. Conclusions

1. It was established that according to live weight at 4 and 6 months of age, fattening and meat qualities (age of reaching a live weight of 100 kg, days; lard thickness at the level of 6–7 thoracic vertebrae, mm; length of the chilled carcass, cm) young pigs the controlled population belongs to the I class and the elite class.

2. Young pigs of the Mc4r AG genotype outperform peers of the Mc4r AA genotype in terms of average daily live weight gain, age of reaching a live weight of 100 kg, lard thickness at the level of 6–7 thoracic vertebrae, and chilled carcass length by an average of 5.90 %. According to Tyler B.'s index, the difference between the groups is 7.46 points (td = 2.10; P < 0.05).

3. Intrabreed differentiation of young pigs by the coefficient of the intensity of growth decline (ΔK) shows that the difference between the animals of the experimental groups in terms of average daily gain in live weight is 23.3 g (td = 2.62; P < 0.05), the age of reaching a live weight of 100 kg – 2.7 days (td = 1.59; P > 0.05), length of the cooled carcass – 1.4 mm (td = 2.12; P < 0.05).

4. The number of reliable correlations between fattening and meat qualities, coefficient of the intensity of growth decline (ΔK), and Tyler B. index is 75.0 %, which indicates the possibility of their use in selection and breeding work.

5. The use of young pigs of the Mc4r AG genotype and animals of group I, in which the coefficient of the intensity of growth decline (ΔK) ranges from 115.61 to 123.27 points, ensures the production of additional products at the level of +3.68 – +1.75 % respectively.

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Conflict of interest
The authors declare that there is no conflict of interest.

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