

MEAT QUALITIES OF PIGS OF DIFFERENT GENOTYPES BY MELANOCORTIN RECEPTOR GENE 4 (MC4R) AND ITS CONNECTION WITH SOME BIOCHEMICAL INDICATORS OF BLOOD SERUM

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Abstract

Results of studies about fattening and meat qualities of Large White young pigs of different genotypes by melanocortin receptor gene 4 (MC4R) are presented, as well as level of correlations between these traits and some biochemical indicators of blood serum. It was established that biochemical parameters of blood serum and concentration of total lipoproteins (mg%) of young pigs correspond to physiological norm of clinically healthy animals, fattening and meat qualities of animals of different genotypes by melanocortin receptor gene 4 (MC4R) correspond to I and elite class. Considering intrabreed differentiation by genotype, difference between animals of II (MC4RAG) and I (MC4RAA) groups in average daily gain in live weight during the control fattening period is 91.9 g ($td = 7.00$, $P < 0.001$), in length of chilled carcass is 0.8 cm ($td = 0.78$, $P > 0.05$), in length of the bacon side of chilled half carcass is 1.2 cm ($td = 0.48$, $P > 0.05$), in thickness of fatback at the level of 6-7 thoracic vertebrae is 1.8 mm ($td = 2.22$, $P < 0.01$) and in age of reaching live weight of 100 kg is 9.9 days ($td = 5.78$, $P < 0.001$).

Key words: biochemical parameters of blood serum, correlation, fattening qualities, genotype, young pigs.

INTRODUCTION

The practice and scientific researches of native and foreign scientists indicate that an effective method of determining the genetic potential by the reproductive traits of pigs in the main herd, as well as the fattening and meat qualities of their offspring, is the use of modern genetic methods DNA markers (Zhukorskii & Tsereniuk, 2015; Tsereniuk, 2014; Bazhov & Konlatskii, 1989; Khalak et al., 2020; Topikha et al., 2012; Lykhach et al., 2016; Noguera et al., 2014; Ryzhova & Kalashnikova, 2003; Zinovieva et al., 2013; Loban et al., 2011; Kim et al., 2006; Walsh et al., 1991; Dyman et al., 2001; Muñoz et al., 2011; Berezovskii & Khatko, 2005; Berezovskii, 1999; Vlizlo, 2012; Lakin, 1990).

Research work provided by different scientific institutions have established that the polygenic hereditary traits of pigs are determined by the

complex interaction of animal genotype and environmental conditions. Consequently, in order to increase the economy of high-quality pork production, taking into account the optimization of fattening conditions and housing of animals of different gender and age groups in selecting and breeding work, it is necessary to use modern genetic methods (DNA markers) in selection and breeding work. It was proved in works of Konoval et al., 2008; Hetmantseva et al., 2012; Hladyr et al., 2009; Dyman et al., 2001; Yepishko, 2008; Zinovieva & Ernst, 2006; Korinnyi et al., 2005; Konoval et al., 2007; Loban, 2010; Khalak et al., 2020; Khalak et al., 2020.

The aim of the research is to study the fattening and meat qualities of Large White young pigs of different genotypes by melanocortin receptor gene 4 (MC4R), as well as to determine the level of correlations between these traits and some biochemical parameters of blood serum.

MATERIALS AND METHODS

The studies were carried out in the conditions of agricultural formations of Dnipropetrovsk region, among them there are the animal husbandry laboratory of State Institution - Institute of Grain Crops, National Academy of Sciences of Ukraine, the research centre for biosafety and environmental control of resources of the agro-industrial complex of Dnipro State Agrarian and Economic University and the laboratory of genetics of Institute of Pig Breeding and the agro-industrial institution NAAS of Ukraine.

Large White young pigs of Hungarian origin were the object of research.

DNA isolation from biomaterial samples (earmark) was performed with using ion exchange resin *Chelex-100* (Walsh et al., 1991), DNA typing with using the PLR-RFLP technique (Dyman et al., 2001) at the *MC4R* gene locus (Muñoz et al., 2011).

Evaluation of young pigs by fattening and meat qualities was carried out taking into account the following indicators: average daily gain in live weight for the period of control feeding, kg; age of achievement of live weight of 100 kg, days; thickness of fatback at the level of 6-7 thoracic vertebrae, mm; length of chilled carcass, cm; length of bacon side of chilled half carcass, cm (Berezovskii & Khatko, 2005).

Integrated assessment of the fattening and meat qualities of young pigs in the experimental groups was carried out with the use of complex

index of fattening and meat qualities (B. Tyler index) (IB):

$$I_B = 100 + (242 \times K) - (4.13 \times L) \quad (1),$$

where: IB - complex index of fattening and meat qualities (B. Tyler index), points; K - average daily gain in live weight, kg; L - thickness of fatback at the level of 6-7 thoracic vertebrae, mm; 242; 4.13 - constant coefficients (Berezovskii, 1999).

In the blood serum, the total protein content (g/l), the urea content (mmol/l) and the concentration of total lipoproteins (mg%) were determined (Vlizlo et al., 2012).

The pair correlation coefficient (r), its error (S_r), and the reliability criterion (t_r) were calculated using the formulas 2, 3, 4:

$$r = \frac{\sum xy - \frac{\sum x \cdot \sum y}{n}}{\sqrt{C_x \cdot C_y}} \quad (2)$$

$$S_r = \sqrt{\frac{1-r^2}{n-2}} \quad (3)$$

$$t_r = \frac{r}{S_r} \quad (4)$$

The strength of correlations between the traits was determined using the Chaddock scale (Table 1) (Sidorova et al., 2003).

Table 1. Chaddock scale for of strength of correlation gradation

Correlation coefficient value	Correlation strength
0.1-0.3	Weak
0.3-0.5	Moderate
0.5-0.7	Noticeable
0.7-0.9	High (close)
0.9-0.99	Strong

Biometric processing of the obtained research results was carried out according to the method of Lakin (1990).

RESULTS AND DISCUSSIONS

Analysis of primary zootechnical registration and research results indicate that Large White

young pigs from the controlled herd reach live weight of 100 kg in 171.4 ± 1.20 days (Cv = 3.73%), the average daily gain in live weight during the period of control fattening is 784.0 ± 11.34 g (Cv = 7.65%), thickness of fatback at the level of 6-7 thoracic vertebrae is 20.9 ± 0.365 mm (Cv = 9.22%), chilled carcass length is 96.5 ± 0.85 cm (Cv = 2.65%), length of the

bacon side of the chilled half carcass is 84.7 ± 1.91 cm ($Cv = 6.78\%$). The complex index of fattening and meat qualities (B. Tyler index) (IV) varies from 131.45 to 169.93 points.

The coefficient of variability of fattening and meat qualities of Large White young pigs from the controlled herd varied from 2.37 to 9.23% (Table 2).

Table 2. Indicators of variability of fattening and meat qualities of Large White young pigs from a controlled herd

Indicators, units	Biometric indicators	
	$\sigma \pm S_{\sigma}$	$Cv \pm Sc_v, \%$
Average daily gain in live weight during the control fattening period, kg	60.40±13.512	7.70±1.722
Age of achievement of live weight of 100 kg, days	5.11±1.143	2.98±0.667
Thickness of fatback at the level of 6-7 thoracic vertebrae, mm	1.93±0.431	9.23±2.064
Length of chilled carcass, cm	2.29±0.512	2.37±0.530
Length of the bacon side of chilled half carcass, cm	5.61±1.255	6.62±1.480

Laboratory studies have shown that the total protein content in the blood serum of young pigs in the experimental group is 82.00 ± 2.108 g/l ($Cv = 7.71\%$), the urea content is 4.69 ± 0.208 mmol/l ($Cv = 16.60\%$), the concentration of total lipoproteins is 611.36 ± 48.872 mg% ($Cv = 33.66\%$).

The results of studies of blood serum biochemical parameters, fattening and meat

qualities of young pigs of different interbreed differentiation by genotype are shown in Tables 3 and 4.

It was established that the biochemical parameters of blood serum of young pigs from I (MC4RAA) and II groups (MC4RAG) correspond to the physiological norm of clinically healthy animals (Bazhov & Konlatskii, 1989).

Table 3. Biochemical parameters of blood serum, fattening and meat qualities of young pigs of different intrabreed differentiation by genotype SNP c. 1426 G> A melanocortin receptor gene 4 (Mc4r), n = 5

Indicators, units	Biometric indicators	Genotype	
		MC4R ^{AA}	MC4R ^{AG}
		Group	
		I	II
Total protein content, g/l	$\bar{X} \pm S_{\bar{X}}$	83.25±2.528	85.00±1.527
	$\sigma \pm S_{\sigma}$	5.05±1.598	2.64±0.835
	$Cv \pm Sc_v, \%$	6.08±1.924	3.11±0.984
Urea content, mmol/l	$\bar{X} \pm S_{\bar{X}}$	4.46±0.238	4.72±0.331
	$\sigma \pm S_{\sigma}$	0.58±0.183	0.87±0.275
	$Cv \pm Sc_v, \%$	13.11±4.148	18.59±5.882
Concentration of total lipoproteins, mg%	$\bar{X} \pm S_{\bar{X}}$	528.00±38.782	581.33±31.399
	$\sigma \pm S_{\sigma}$	109.69±34.712	76.91±24.338
	$Cv \pm Sc_v, \%$	20.78±6.575	13.23±4.186

The difference between animals from the indicated groups and genotypes in terms of the total protein content is 1.75 g/l (td = 0.59, $P > 0.05$), in the urea content is 0.26 mmol/l (td = 0.65, $P > 0.05$), in the concentration of total lipoproteins is 53.33 mg% (td = 1.06, $P > 0.05$). The analysis of results of control fattening showed that young pigs from the II group (MC4R^{AG}), in comparison with their peers from the I group (MC4R^{AA}), are characterized

by higher indicators of the average daily gain in live weight during the control fattening period (by 91.9 g, td = 7.00, $P < 0.001$), length of chilled carcass (by 0.8 cm; td = 0.78, $P > 0.05$), length of the bacon side of the chilled half carcass (by 1.2 cm; td = 0.48, $P > 0.05$), smaller indicators of thickness of fatback at the level of 6-7 thoracic vertebrae (by 1.8 mm, td = 2.22, $P < 0.01$), and age of achievement of live weight of 100 kg (by 9.9 days, td = 5.78, $P < 0.001$).

Table 4. Fattening and meat qualities of young pigs of different genotypes by melanocortin receptor gene 4 (Mc4R), n = 10

Indicators, units	Biometric indicators	Genotype	
		MC4R ^{AA}	MC4R ^{AG}
		Group	
		I	II
Average daily gain in live weight during the control fattening period, kg	$\bar{X} \pm S\bar{X}$	721.6±10.84	813.5±7.40
	$\sigma \pm S\sigma$	34.15±7.639	23.42±5.239
	Cv±Scv, %	4.73±1.058	2.88±0.644
Age of achievement of live weight of 100 kg, days	$\bar{X} \pm S\bar{X}$	178.0±1.16	168.1±1.271
	$\sigma \pm S\sigma$	3.69±0.825	4.02±0.899
	Cv±Scv, %	2.07±0.463	2.39±0.534
Thickness of fatback at the level of 6-7 thoracic vertebrae, mm	$\bar{X} \pm S\bar{X}$	22.3±0.57	20.5±0.58
	$\sigma \pm S\sigma$	1.82±0.407	1.84±0.411
	Cv±Scv, %	8.19±1.832	8.97±2.00
Length of chilled carcass, cm	$\bar{X} \pm S\bar{X}$	95.4±0.82	96.2±0.61
	$\sigma \pm S\sigma$	2.60±0.581	1.93±0.431
	Cv±Scv, %	2.71±0.607	2.01±0.449
Length of the bacon side of chilled half carcass, cm	$\bar{X} \pm S\bar{X}$	82.0±2.22	83.2±1.14
	$\sigma \pm S\sigma$	7.03±1.572	3.61±0.807
	Cv±Scv, %	8.58±1.919	4.34±0.970
Complex index of fattening and meat qualities (B. Tyler index), points	$\bar{X} \pm S\bar{X}$	141.77±2.018	157.22±3.029
	$\sigma \pm S\sigma$	6.38±1.427	9.58±2.143
	Cv±Scv, %	4.50±1.006	6.09±1.362

The difference between animals from the II (MC4R^{AG}) and I (MC4R^{AA}) groups in terms of the complex index of fattening and meat qualities (B. Tyler index) is 15.45 points (td = 4.25, P<0.001).

The coefficient of variability of biochemical parameters of blood serum, fattening and meat quality of young pigs of different intrabreed differentiation by melanocortin receptor gene 4 (Mc4R) varies from 2.01 (the length of chilled carcasses of animals of the MC4R^{AG} genotype)

to 20.78% (the concentration of total lipoproteins in blood of The results of calculating the coefficients of pair correlation between the biochemical parameters of blood serum, fattening and meat qualities of Large White young pigs are shown in Table 5.

It was found that correlation coefficient between biochemical parameters of blood serum, fattening and meat qualities of Large White young pigs varied from -0.533 to +0.375.

Table 5. Coefficients of paired correlation between biochemical parameters of blood serum, fattening and meat qualities of Large White young pigs

Features		Biometric indicators		Correlation strength
x	y	r±Sr	tr	
Average daily gain in live weight during the control fattening period, kg	1	-0.209±0.2445	0.85	Weak
	2	0.277±0.2402	1.15	Weak
	3	0.155±0.2470	0.63	Weak
Age of achievement of live weight of 100 kg, days	1	0.107±0.2486	0.43	Weak
	2	0.024±0.2499	0.10	Weak
	3	0.074±0.2493	0.30	Weak
Thickness of fatback at the level of 6-7 thoracic vertebrae, mm	1	0.375±0.2318	1.62	Moderate
	2	0.007±0.2500	0.03	Weak
	3	0.132±0.2478	0.53	Weak
Length of chilled carcass, cm	1	-0.321±0.2368	1.36	Moderate
	2	-0.445±0.2239	1.99	Moderate
	3	0.023±0.2499	0.09	Weak
Length of the bacon side of chilled half carcass, cm	1	-0.533±0.2115	2.52	Noticeable
	2	0.019±0.2500	0.08	Weak
	3	-0.101±0.2487	0.41	Weak

Note: 1 - total protein content, r/g; 2 - urea content, mmol/l; 3 - concentration of total lipoproteins, mg%

A reliable relationship with a probability of $P < 0.05$ was established between the length of bacon side of chilled half carcass and the total protein content in the blood serum ($r = -0.533$, $tr = 2.52$).

Thus, the experiment showed that the biochemical parameters of blood serum of young pigs correspond to the physiological norm of clinically healthy animals; the fattening and meat qualities of animals of different genotypes by melanocortin receptor gene 4 (MC4R) correspond to class I and elite class.

CONCLUSIONS

It was established that the biochemical parameters of the blood serum of young pigs correspond to the physiological norm of clinically healthy animals, the fattening and meat qualities of animals of different genotypes by melanocortin receptor gene 4 (MC4R) correspond to class I and elite class.

Young pigs of MC4RAG genotype significantly exceeded their peers of MC4RAA genotype Average daily gain in live weight during the control fattening period by 91.9 g, in chilled carcass length by 0.8 cm, in length of the bacon side of chilled half carcass by 1.2 cm, in thickness of fatback at the level of 6-7 thoracic vertebrae by 1.8 mm and in age of achievement of live weight of 100 kg by 9.9 days.

Correlation links between biochemical parameters of blood serum (total protein content, urea content, concentration of total lipoproteins), fattening and meat qualities of young pigs are unreliable by 93.3% and cannot be used in selection as markers of these traits.

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