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ANALYSIS OF THE POSSIBILITY OF IMPROVING THE INDICATORS OF PORK QUALITY THROUGH SELECTION WITH PARTICULAR CONSIDERATION OF INTRAMUSCULAR FAT (IMF) CONTENT*

Mirosław Tyra, Grzegorz Żak

Department of Animal Genetics and Breeding, National Research Institute of Animal Production, 32-083 Balice n. Kraków, Poland

Abstract

The aim of the study was to estimate coefficients of heritability for intramuscular fat (IMF) content and other fattening, slaughter and meat quality traits of the pig breeds raised in Poland. In addition, genetic correlations were estimated between IMF content and a group of fattening, slaughter and meat quality traits, which enables this parameter to be included in the BLUP estimation of breeding value. The experiment used Polish Landrace (PL), Polish Large White (PLW), Puławska, Hampshire, Duroc, Pietrain and line 990 animals. A total of 4430 gilts of these breeds, tested at Pig Performance Testing Stations (SKURTCh), were investigated. Heritability of IMF was at intermediate level for the two most common breeds raised in Poland ($h^2 = .318$ for PLW, $h^2 = .291$ for PL). In the group of meat quality traits, high heritability was noted for meat colour lightness (L*) measured by Minolta (from $h^2 = .453$ to $h^2 = .572$). No relationships were found between IMF level and indicators of fattening performance. The highest value observed in this group of traits concerned the genetic relationship with daily feed intake ($r_G = .227$) for the entire group of animals. For the PLW and PL breeds, these relationships were with feed conversion (kg/kg gain) ($r_G = .151$ and $r_G = .167$, respectively). One of the higher relationships observed were genetic correlations with water holding capacity (above $r_G = -.3$) and, for the PLW and PL breeds, with meat redness (a*), which amounted to $r_G = .155$ and $r_G = .143$, respectively.

Key words: pigs, heritability, genetic correlations, intramuscular fat, performance, meat quality

The current overproduction of meat, notably pork, makes its quality particularly important. Faced with a wide range of products to choose from, conscious consumers attach increasing importance to the quality of meat. This consumer attitude will have to be addressed by the first link of the animal production chain, namely breeders. Their task will be to produce breeding material with proper parameters, which

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will be passed on to the lower tiers of the production chain. To make this feasible, breeders should be provided with a system of information on the quality of breeding material being produced. The list of factors that determine this quality is long (Wood et al., 2008), from aspects of microbiological evaluation to animal housing system. However, the main determinant of several traits associated with sensory perceptions of consumers is the level of intramuscular fat (IMF). This fat has positive effects on meat texture parameters such as tenderness, palatability and juiciness, and reduces cooking and grilling loss. In higher amounts it positively affects the water holding capacity of meat and carries taste (Enser, 2004). When analysing IMF level in the domestic population of pigs (Tyra and Żak, 2010) and its unfavourable downward trend, as well as the lack of significant relationships between IMF level and basic fattening and slaughter indicators, it seems appropriate to include this parameter in the estimation of breeding value using BLUP. Positive results in this area were obtained by Schwab et al. (2006). When using standard selection we cannot improve this parameter (there is no objective method to evaluate this parameter on live animals), and selection based on intermediate indicators cannot be applied in practice (Tyra and Żak, 2012). This parameter can be introduced to BLUP evaluation using relevant results obtained from Polish Pig Performance Testing Stations (SKURTCh). The implementation of this task is conditional on subjecting a greater number of pedigree herds to station testing. Another precondition is to identify genetic parameters (coefficients of heritability) for IMF level in different breeds raised in Poland and to determine the association between IMF level, other indicators currently used in the testing, as well as other traits of economic and breeding importance. In the case of IMF level, these parameters are unknown for the domestic population of pigs. Therefore, the aim of the present study is to estimate the coefficients of heritability for breeds recorded in herd books. The study also attempts to estimate genetic correlations between IMF level and a group of fattening, slaughter and meat quality traits, which will enable this parameter to be included in the estimation of breeding value using BLUP.

Material and methods

Animals, performance test and collection of fattening and slaughter data

The experiment used purebred Polish Landrace (PL), Polish Large White (PLW), Puławska, Hampshire, Duroc, Pietrain and line 990 gilts. Animals were tested at the Pig Performance Testing Stations (SKURTCh) in Chorzelów, Mełno, Pawłowice and Rossocha. A total of 4430 gilts (1240 PLW, 2083 PL, 104 Puławska, 35 Hampshire, 152 Duroc, 208 Pietrain and 608 line 990) were investigated. Throughout the test, animals were maintained and fed individually at the testing stations according to the feeding programme (Różycki and Tyra, 2010).

The performance test started when the animals reached 30 kg and finished when they reached a final weight of 100 kg. Animals were slaughtered at a final weight of 100 kg on average. Stunning with high-voltage electric tongs was followed by exsanguination. After 24-h chilling at 4°C, half-carcasses were measured. On the right half-carcass, backfat thickness was measured with a caliper to the nearest 0.1 cm, at five locations: at the thickest point over the shoulder, on the back above the joint between the last thoracic and first lumbar vertebrae, at three points above the loin – above the rostral edge (loin I), above the middle (loin II) and above the caudal edge (loin III) of gluteal muscle section. These measurements were used to calculate average backfat thickness from 5 measurements, which was accounted for when characterizing the test material. Next, the half-carcass was dissected into different cuts. All the dissected components, including the weight of ham without backfat and skin, were weighed. The contour of the *longissimus* muscle section was traced using plastic film on loin at the intersection of the last thoracic vertebra and the first lumbar vertebra, on the cephalic plane. Height and width of the *longissimus dorsi* muscle was measured on this contour and loin eye area was planimetered. The cuts obtained (loin and ham) were dissected into tissues to estimate carcass meat percentage, based on a regression equation calculated according to the testing station method (Różycki and Tyra, 2010).

Meat quality measurements

The following indicators of meat quality were studied: intramuscular fat (IMF) content of loin, loin colour (L*a*b*), water holding capacity, and meat pH 45 min and 24 h postmortem. The IMF content of meat was determined as raw meat using Soxhlet extraction with fat solvents (Soxtherm 406, Gerhardt). The modified Soxhlet method used in this apparatus allows for very accurate measurement while considerably shortening the extraction time. A sample for analysis was taken from the middle part of the *longissimus* muscle section behind the last rib. Colour was measured in loin muscle off the midline over the last rib. This parameter was measured on loin surface at 24 h postmortem using a Minolta CR 310. Meat pH was measured twice (45 min and 24 h postmortem) using a pH meter equipped with an insertion glass electrode (Matthäus). pH_{45} was measured in loin muscle off the midline over the last rib, and pH_{24} on *longissimus dorsi* muscle cross-section at three locations along cross-section length.

Statistical analysis

Statistical analysis was performed by analysis of variance using the GLM procedure of the SAS program (1989). The statistical model used in the calculations was as follows:

$$Y_{ijk} = \mu + d_i + f_j + \alpha(x_{ij}) + e_{ijk}$$

where:

Y_{ijk} – ijkth observation,
μ – overall mean,
d_i – effect of ith breed,
f_j – effect of jth sire,
$\alpha(x_{ij})$ – covariance on right half-carcass weight (for slaughter traits and IMF),
e_{ijk} – random error.

Differences between means for individual breeds were tested at the 5% and 1% level by Duncan's multiple range test.

The coefficients of heritability (h^2) for performance test traits were estimated from the sire component. Genetic parameters were estimated by GEN3 software using variance and covariance analysis in a hierarchical design according to the formula:

$$Y_{ijkl} = m + a_i + s_{ij} + d_{ijk} + e_{ijkl}$$

where:

Y_{ijkl} – ijklth observation,
m – population mean,
a_i – fixed effect of HYS,
s_{ij} – random effect of jth sire,
d_{ijk} – random effect of kth dam,
e_{ijkl} – random error.

Heritability (h^2 – heritability coefficient) is defined as expected share of phenotypic differences in each trait caused by differences in additive gene value of animals. Calculation of heritability (h^2) according to the method of intra-class correlation between half-siblings (sisters) of boar sires was done using the following formula:

$$h^2 = 4 \frac{\sigma^2_{IZ}}{\sigma^2_{IZ} + \sigma^2_{UN}}$$

where:

h^2 – heritability,
σ^2_{IZ} – variance between groups (sires),
σ^2_{UN} – variance within groups (sires).

Genetic correlations show the association between the additive gene effects that influence two traits whereas phenotypic correlations represent correlation between the result of measuring two traits on individual animal, calculated according to the following formula:

$$r_{Pxy/Gxy} = \frac{Cov_{Pxy/Gxy}}{\sqrt{\sigma^2_{Px/Gx} \times \sigma^2_{Py/Gy}}}$$

where:

$r_{Pxy/Gxy}$ – coefficient of phenotypic or genetic correlation between traits x and y,
$Cov_{Pxy/Gxy}$ – phenotypic or genetic covariance between traits x and y,
$\sigma^2_{Px/Gx}$ – phenotypic or genetic variance of trait x,
$\sigma^2_{Py/Gy}$ – phenotypic or genetic variance of trait y.

Results

Because the experimental animals originated from the testing stations (SKURTCh) in which the entire population of breeding animals is evaluated, the test material was represented by all the breeds raised in Poland, namely PLW, PL, Puławska, Hampshire, Duroc, Pietrain and line 990. In addition, the proportion of individual breeds representing the test material was commensurate with the breed structure of pedigree breeding. For Puławska, Duroc, Hampshire, Pietrain and line 990 animals, genetic parameters were not estimated due to their inadequate number. For this reason, standard errors mostly exceeded the values estimated for these parameters, in the case of both the coefficients of heritability and the genetic correlations. Accordingly, the tables present the results for PLW and PL breeds and, in the column, for all the breeds (including those mentioned above). Table 1 shows basic statistical characteristics for selected slaughter, fattening and meat quality traits, which are of great breeding and economic importance. In terms of fattening and slaughter traits, both maternal breeds (PLW and PL) are characterized by similar parameters except for mean backfat thickness from 5 measurements and loin eye area, for which PL animals obtained more favourable results ($P<0.05$). Meanwhile, in terms of meat quality PLW animals had a slight advantage over the PL breed ($P<0.05$) for IMF content of *longissimus dorsi* muscle, its pH measured 45 min postmortem, and water holding capacity.

Table 2 contains the coefficients of heritability (h^2) and their errors (±*se*) for different traits investigated. In the case of slaughter traits, the highest heritability was observed for carcass muscling traits (carcass meat content, loin eye area, meat weight of primal cuts). This ranking of the coefficients of heritability was observed for both the PLW and PL breeds and for the entire group comprising all the breeds. A relatively high heritability was found for weight of ham without backfat and skin (PLW and PL breeds) and for weight of loin (PL breed only). As regards fattening traits, the highest heritability was characteristic of lifetime daily gain (from $h^2 = .414$ to $h^2 = .512$) and station test daily gain (from $h^2 = .351$ to $h^2 = .374$), and the lowest values were observed for feed conversion (kg/kg gain) (from $h^2 = .124$ to $h^2 = .177$). Heritability of the trait of most interest to us, namely IMF, was at intermediate level for the two most common breeds raised in Poland ($h^2 = .318$ for PLW, $h^2 = .291$ for PL). In this group of traits, i.e. meat quality traits, high heritability was observed for meat colour lightness (L*) measured by Minolta (from $h^2 = .453$ to $h^2 = .572$).

Table 1. Characteristics of the test animals in terms of slaughter, fattening and meat quality traits

Traits	Total				PLW				PL			
	n	x	s	v	n	x	s	v	n	x	s	v
Slaughter:												
weight of loin – whole cut (kg)	4430	7.80	± .62	7.97	1240	7.79	± .59	7.61	2083	7.75	± .61	7.99
weight of skin and loin backfat (kg)	4430	1.57	± .44	27.9	1240	1.57	± .45	28.4	2083	1.56	± .45	28.5
weight of loin without backfat and skin (kg)	4430	6.22	± .56	9.09	1240	6.23	± .56	9.00	2083	6.18	± .55	8.90
weight of ham without backfat and skin (kg)	4430	8.91	± .69	7.81	1240	8.86	± .65	7.38	2083	8.79	± .63	7.21
mean backfat thickness from 5 measurements (cm)	4430	1.55	± .38	24.8	1240	1.52 a	± .37	24.6	2083	1.47 a	± .35	23.7
loin eye height (cm)	4430	10.2	± .76	7.43	1240	9.99	± .69	6.95	2083	10.2	± .69	6.83
loin eye width (cm)	4430	6.98	± .63	9.02	1240	6.96	± .64	9.16	2083	6.93	± .61	8.87
loin eye area (cm^2)	4430	53.8	± 6.86	12.7	1240	52.7 a	± 6.35	12.0	2083	53.4 a	± 6.47	12.1
carcass meat content (%)	4430	59.3	± 3.55	5.99	1240	58.7	± 3.23	5.51	2083	58.9	± 3.22	5.46
weight of meat of primal cuts (kg)	4430	23.5	± 1.71	7.27	1240	23.3	± 1.61	6.89	2083	23.3	± 1.57	6.76
Fattening:												
slaughter age (days)	4430	172	± 27.8	16.6	1240	171	± 26.8	15.5	2083	166	± 23.7	14.2
length of fattening period (days)	4430	83.6	± 11.6	13.9	1240	84.1	± 12.9	15.3	2083	82.9	± 11.8	14.2
daily gain, 30 to 100 kg (g)	4430	890	± 120	13.5	1240	894	± 130	14.6	2083	895	± 122	13.6
lifetime daily gain (g)	4430	606	± 87.3	14.4	1240	607	± 84.5	13.9	2083	623	± 84.8	13.6
feed conversion (kg/kg gain)	4430	2.83	± .37	13.3	1240	2.81	± .36	13.0	2083	2.83	± .38	13.6
daily feed intake (kg)	4430	2.50	± .38	15.1	1240	2.49	± .41	16.7	2083	2.52	± .39	15.6
Meat quality:												
IMF (%)	4430	1.83	± .69	37.5	1240	1.84 a	± .69	27.4	2083	1.77 a	± .66	37.4
water holding capacity (%)	3994	34.9	± 7.29	20.9	1133	35.1 a	± 6.29	17.9	1854	35.9 a	± 7.72	21.5
meat colour – L*	3186	54.9	± 3.07	5.59	983	54.8	± 2.75	5.02	1342	55.1	± 2.81	5.09
meat colour – a*	3186	15.0	± 1.50	10.0	983	14.9	± 1.45	9.73	1342	14.9	± 1.39	9.32
meat colour – b*	3186	4.05	± 1.66	40.9	983	3.77	± 1.51	40.0	1342	3.85	± 1.58	41.0
pH_{45}	2628	6.38	± .36	5.64	665	6.41 a	± .37	5.77	1289	6.36 a	± .34	5.34
pH_{24}	2628	5.61	± .17	3.03	665	5.59	± .23	4.11	1289	5.62	± .16	2.84

Values with the same superscripts show significant differences between genotypes (A, B... = P< 0.01; a, b... = P<0.05).

Table 2. Coefficients of heritability and their errors for analysed slaughter, fattening and meat quality traits

Traits	Total		PLW		PL	
	h^2	± se	h^2	± se	h^2	± se
Slaughter:						
weight of loin – whole cut (kg)	.200	± .011	.311	± .022	.414	± .024
weight of skin and loin backfat (kg)	.317	± .010	.255	± .021	.286	± .030
weight of loin without backfat and skin (kg)	.136	± .013	.298	± .021	.289	± .017
weight of ham without backfat and skin (kg)	.311	± .009	.435	± .022	.503	± .024
mean backfat thickness from 5 measurements (cm)	.327	± .012	.208	± .026	.179	± .029
loin eye height (cm)	.136	± .013	.294	± .021	.319	± .019
loin eye width (cm)	.187	± .009	.310	± .024	.418	± .020
loin eye area (cm^2)	.417	± .010	.419	± .024	.503	± .027
carcass meat content (%)	.448	± .012	.564	± .025	.614	± .026
weight of meat of primal cuts (kg)	.404	± .012	.410	± .023	.407	± .024
Fattening:						
slaughter age (days)	.168	± .027	.213	± .028	.177	± .028
length of fattening period (days)	.169	± .010	.218	± .023	.179	± .024
daily gain, 30 to 100 kg (g)	.358	± .012	.351	± .026	.374	± .024
lifetime daily gain (g)	.490	± .016	.414	± .035	.512	± .026
feed conversion (kg/kg gain)	.128	± .010	.124	± .030	.177	± .021
daily feed intake (kg)	.214	± .011	.262	± .036	.201	± .027
Meat quality:						
IMF (%)	.281	± .011	.318	± .057	.291	± .039
water holding capacity (%)	.443	± .014	.396	± .072	.372	± .024
meat colour – L*	.572	± .017	.483	± .052	.453	± .025
meat colour – a*	.546	± .016	.435	± .036	.381	± .017
meat colour – b*	.306	± .012	.299	± .045	.272	± .019
pH_{45}	.197	± .029	.251	± .091	.215	± .021
pH_{24}	.191	± .021	.263	± .095	.272	± .014

Table 3 shows both genetic and phenotypic correlations between IMF level in the *longissimus dorsi* muscle and the other slaughter, fattening and meat quality traits. In the group of slaughter traits, most genetic correlations, and especially phenotypic correlations, are low. For this group of traits, the highest relationships (genetic correlations) were observed between IMF level and weight of loin (whole cut) and loin eye area. No relationships were found between IMF level and indicators of fattening performance. For this group of traits, the highest relationships (undesirable from a breeding perspective) were observed between IMF level and loin weight (whole cut) and loin eye area, and these were genetic relationships. The highest but favourable for breeding (improved IMF content) were the relationships with mean backfat thickness from 5 measurements. No relationships were found between the level of this fat and the indicators of fattening performance. The highest value in this group was observed for the genetic relationship with daily feed intake (r_G = .227) for the whole group of animals. For the PLW and PL breeds, these relationships were with feed conversion per kg gain (r_G = .151 and r_G = .167, respectively). The phenotypic correlations in this group of traits were below r_P<.1. One of the higher relationships observed in our study were genetic correlations with water holding capacity (above r_G = -.3) and, for the PLW and PL breeds, with meat redness (a*), which were r_G = .155 and r_G = .143, respectively.

Table 3. Coefficients of genetic (r_G) and phenotypic (r_P) correlations between the level of intramuscular fat (IMF) in *longissimus dorsi* muscle and selected slaughter, fattening and meat quality traits

Traits	Total			PLW			PL		
	r_G	± se	r_P	r_G	± se	r_P	r_G	± se	r_P
Slaughter:									
weight of loin – whole cut (kg)	-.135	± .013	-.009	-.138	± .015	-.021	-.191	± .009	-.006
weight of skin and loin backfat (kg)	.131	± .010	.058	.104	± .015	.026	.133	± .008	.086
weight of loin without backfat and skin (kg)	-.147	± .015	-.057	-.077	± .011	-.043	-.030	± .011	-.063
weight of ham without backfat and skin (kg)	-.181	± .060	-.069	-.156	± .016	-.035	-.186	± .009	-.108
mean backfat thickness from 5 measurements (cm)	.151	± .011	.037	.154	± .017	.006	.182	± .009	.020
loin eye height (cm)	-.016	± .015	-.058	-.013	± .014	-.016	-.010	± .011	-.064
loin eye width (cm)	-.086	± .013	-.062	-.015	± .015	-.047	-.012	± .010	-.059
loin eye area (cm^2)	-.207	± .011	-.090	-.180	± .014	-.060	-.167	± .009	-.085
carcass meat content (%)	-.095	± .012	-.084	-.103	± .018	-.027	-.091	± .009	-.149
weight of meat of primal cuts (kg)	-.011	± .011	-.078	-.041	± .015	-.038	-.035	± .010	-.107
Fattening:									
slaughter age (days)	.096	± .008	.012	.102	± .017	-.061	.079	± .010	.011
length of fattening period (days)	.221	± .014	.015	.127	± .017	.009	.149	± .007	.015
daily gain, 30 to 100 kg (g)	-.085	± .012	-.037	-.142	± .015	-.026	-.117	± .009	-.017
lifetime daily gain (g)	-.081	± .010	-.016	-.139	± .013	-.013	-.129	± .011	-.007
feed conversion (kg/kg gain)	-.209	± .013	.016	-.151	± .012	.080	-.167	± .004	.039
daily feed intake (kg)	.227	± .016	-.020	.016	± .013	.022	.115	± .011	.017
Meat quality:									
water holding capacity (%)	-.335	± .009	-.067	-.323	± .015	-.048	-.357	± .007	-.016
meat colour – L*	.099	± .013	-.024	.076	± .011	-.037	.072	± .006	-.028
meat colour – a*	.132	± .007	.028	.155	± .012	.110	.143	± .008	.038
meat colour – b*	-.127	± .011	-.097	-.095	± .017	-.131	-.132	± .012	-.143
pH_{45}	-.113	± .008	-.015	-.104	± .025	-.051	-.108	± .027	-.138
pH_{24}	-.110	± .007	-.083	-.103	± .026	-.017	-.114	± .028	-.126

Discussion

The unfavourable trend for a decreasing IMF level, which has been observed in the Polish pedigree population, concerns mainly the PLW and PL breeds. In these breeds, IMF level decreased over 6 years from 1.88% to 1.76% (Tyra and Orzechowska, 2006; Tyra and Żak, 2010). An even greater difference was noted for the Puławska breed (2.43% and 2.17%, respectively). According to the latest data, IMF level in the Duroc and Puławska breeds is 2.23% and 2.17%, respectively (Tyra and Żak, 2010). The lowest level of this fat is observed in the Pietrain breed (1.68%), which receives considerable use as a sire component in commercial production. Measures should therefore be taken to stop this process. However, the process of IMF deposition in muscle tissue is not completely understood and attempts to find genetic markers associated with this process produced inconclusive and unsatisfactory results (Gerbens, 2001; Li et al., 2010; Schwab et al., 2009 a; Tyra and Ropka-Molik, 2011).

The coefficients of heritability obtained for IMF in the PLW and PL breeds (0.3) are not high but do not differ significantly from the findings of other authors (Suzuki et al., 2005 – 0.39; Cai et al., 2008 – 0.28; Schwab et al., 2009 a – 0.38; van Wijk et al., 2005 – 0.31; Newcom et al., 2005 a – from 0.42 to 0.57). Analysis of the current breeding programme for the national pedigree population of pigs, which is oriented towards improvement of fattening and slaughter traits (growth rate, meatiness and fatness of carcasses) offers hope that also IMF level will see some progress. With systematic breeding work, only slightly higher coefficients of heritability for these traits (Table 2) resulted in considerable progress in this respect over the last decade. It will be possible to obtain a satisfactory IMF level in the national pedigree population when, following the example of other EU countries, this indicator will be included in the selection index as part of the national breeding programme, or breeding value will be estimated for this indicator using BLUP. In Austria, Germany, Switzerland, Denmark or France (Österreichische Schweineprüfanstalt, 2007) meat quality traits have a weighting of up to 30%, a considerable proportion of which (over 50%) is given to IMF level. To incorporate this parameter into the BLUP method, it was necessary to identify the basic genetic parameters (heritability, genetic correlations with other traits included in the BLUP analysis) for the population being improved. In the case of the Polish pig population, these parameters were unknown.

At present, there is no objective and inexpensive method to determine IMF directly on live animals. Attempts to determine this parameter based on analysis of ultrasound images are associated with large errors (Morlein et al., 2005), while the use of computer tomography or magnetic resonance imaging, despite their high accuracy, is limited due to high costs and lack of equipment portability (Goodpaster et al., 2004). In this case, it might be well to use indirect selection, but the results obtained in this respect are not promising (Table 3). Because no significant genetic or phenotypic correlations were found between IMF level and the indicators that might be determined on a live animal, the use of intermediate traits for this purpose will fail to produce expected results in the form of increased IMF level in a relatively short period of time. The only positive result of this analysis is the low correlation between IMF level and the overall level of carcass fatness. It was believed for many years that external fat thickness is strongly correlated with the level of intramuscular fat. Our results concur with the findings of Suzuki et al. (2006) and Newcom et al. (2005 a), who also reject the view about the strong correlation between subcutaneous and intramuscular fat because they obtained low coefficients of genetic correlation between backfat thickness and IMF content (from r_G = -0.03 to r_G = 0.29). The lack of a relationship between backfat thickness and IMF level was also shown by Ville et al. (1997), who also found that the two traits are highly variable, as observed in our study (Table 1). This possibly indicates that these two fatness traits may be determined by other groups of genes (Tyra and Ropka-Molik, 2011). This information is valuable for breeders because, to a certain extent, it enables the amount of external (subcutaneous) fat to be decreased without reducing the amount of intramuscular fat, which means that selection can be made in these two directions at the same time.

Despite the unfavourable results of the analyses, it is possible to achieve progress in IMF level, as evidenced by the results of Schwab et al. (2006) and Newcom et al. (2005 b), who made considerable progress in this trait over several generations using BLUP estimation of breeding value. Similarly, Schwab et al. (2009 b) achieved a considerable increase in IMF level in the herd being improved using the BLUP method with support from the results of molecular research (FABP3). Thus, the use of this method in the national breeding programme together with genetic markers, despite the fact that they do not produce very high results in combination with BLUP, may translate into a real increase in this parameter. Another possibility is the application of BLUP and station test results, which can be used to monitor about 20% of the pedigree boar population. By obtaining IMF data of these boars from the testing station and using BLUP pedigree relationships, we can estimate breeding value in terms of this trait for a considerable proportion of pedigree animals, which may translate into improvement of this trait. The current focus is on searching for relationships between histological structure of muscles and the degree of their fatness. Our study suggests that such relationships (one of the higher relationships observed between IMF and loin eye area – Table 3) exist. However, considerable breakthrough in this respect will be obtained by understanding the genetic mechanisms of IMF accumulation in muscle tissue, by developing genetic markers that determine this trait (based on the knowledge obtained), and by identifying genetic factors that determine the histological composition of muscles.

The heritabilities obtained for IMF content of the *longissimus dorsi* muscle, which are at the same level as other fattening and slaughter traits used in the current breeding programme, allow a conclusion that it is feasible to improve the national pedigree population in this respect. An unfavourable result from our study is that IMF level is unrelated to most parameters analysed, which means that this trait cannot be improved through indirect selection. The lack of a relationship between the analysed traits, in particular between IMF and carcass fatness, is an important information for breeders, allowing them, to a certain extent, to improve the national pig population in both directions at the same time (improvement of IMF level and reduction of external fat level). However, to stop the unfavourable downward trend for the trait of interest, the national breeding programme based on the BLUP method should estimate IMF level as an independent breeding value or as a component of total breeding value by using station test data.

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MIROSŁAW TYRA, GRZEGORZ ŻAK

Analiza możliwości poprawy wskaźników jakości wieprzowiny na drodze selekcji ze szczególnym uwzględnieniem zawartości tłuszczu śródmięśniowego (IMF)

STRESZCZENIE

Celem pracy było oszacowanie współczynników odziedziczalności dla zawartości tłuszczu śródmięśniowego (IMF) i innych cech tucznych, rzeźnych i jakości mięsa dla ras hodowanych w kraju. Ponadto oszacowano korelacje genetyczne pomiędzy tym wskaźnikiem (IMF) a grupą cech tucznych, rzeźnych i jakości mięsa, co daje możliwość uwzględnienia tego parametru w systemie oceny wartości hodowlanej metody BLUP. Badania prowadzone były na zwierzętach ras wbp, pbz, Puławskiej, Hampshire, Duroc, Pietrain i linii 990. Łącznie w badaniach uwzględniono 4430 loszek wymienionych ras, które ukończyły ocenę w Stacjach Kontroli Użytkowości Rzeźnej Trzody Chlewnej (SKURTCh). Odziedziczalność IMF była na średnim poziomie dla obu najliczniej hodowanych w kraju ras (dla wbp h^2 = .318, dla pbz h^2 = .291), natomiast w grupie cech jakości mięsa wysoką odziedziczalność obserwowano dla jasności barwy mięsa (L*) mierzonej aparatem Minolta (od h^2 = .453 do h^2 = .572). Nie stwierdzono zależności pomiędzy poziomem tłuszczu śródmięśniowego a wskaźnikami dotyczącymi użytkowości tucznej. Najwyższa wartość jaką obserwowano w tej grupie cech dotyczyła genetycznej zależności z dziennym pobraniem paszy (r_G = .227) dla całej grupy zwierząt, natomiast dla ras wbp i pbz były to zależności z wykorzystaniem paszy na kilogram przyrostu (odpowiednio r_G = .151 i r_G = .167). Jedną z wyższych zależności jaką obserwowano były korelacje genetyczne z wodochłonnością (przekraczały poziom r_G = -.3) oraz w przypadku ras wbp i pbz z odcieniem czerwonym barwy mięsa (a*) i wynosiły odpowiednio r_G = .155 i r_G = .143.