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FATTENING PERFORMANCE OF POLISH LANDRACE PIGS AND ITS IMPROVEMENT THROUGH BREEDING WORK

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Abstract

Daily gains in the active population of Polish Landrace (PL) pigs were analysed to determine whether choosing sires differing in daily gains and assigning different weights to this trait in evaluation models may improve the growth rate. Results indicate the need to further improve the growth rate of PL pigs. Boars need 75 g and gilts need 55 g on average to attain the threshold values set for pigs of this breed in the national breeding programme. The present study showed the potential for effective regulation of the rate at which fattening traits are improved. This should form a basis for modifying breeding methods and for adjusting them to the current genetic value of the active population of the pigs. Positive effects are to be expected when using the ratio of 70% daily gain and 30% carcass meat content in the evaluation index. This construction of the indices will enable daily gains to be increased while stabilizing the meatiness of the pigs being improved.

Key words: pigs, selection index, daily gain

Fattening performance of pigs is determined by several traits. These include daily body weight gain, feed conversion (kg feed/kg gain), and daily feed intake or feed intake capacity. The first trait (daily weight gain) is used as an indicator in most breeding programmes on the basis of which the active pig population is improved in most countries (Blicharski et al., 2018; EGZH, 2020; DanBred, 2020). The models used to estimate breeding value in pigs generally place relatively high weights on daily gains, regardless of whether breeding work was conducted within maternal or sire breeds. Well designed evaluation model and well chosen economic weights assigned to different traits, contribute to the rate at which they are improved. One should consider that targeted selection and breeding work reduce genetic variation within traits, including fattening performance parameters. This phenomenon is not without an effect on the effectiveness of breeding methods and justifies the need for continuous analysis, bearing in mind the achievement of the objectives of the National

Breeding Programme (Blicharski et al., 2018). Due to periodical verification of the parameters in the indices used to evaluate the breeding value of pigs, they will keep up with the constantly changing genetic and production level of a given population, and the obtained assessment results will have a much lower estimation error. It is essential to increase daily weight gains of the pigs to achieve the positive economic effects of fattening. High daily gains enable more rapid achievement of slaughter weight or weight optimal for the breeder who needs to select replacement animals, especially in rapidly maturing breeds. This decreases feed intake from birth to the target stage depending on the animal's intended use. Considering that feeding accounts for around 60-70% of live pig production costs, the improvement of fattening parameters plays a substantial role (Kozera, 2010; Pepliński, 2013). In view of the fact that fattening traits, including weight gain, are relatively highly heritable, and the coefficients of heritability given in the literature most often exceed h^2=0.3, it is reasonable to consider that with well designed evaluation models, they can be improved through breeding work (Waterkeyn et al., 2001; Szyndler-Nędza et al., 2010; Sánchez et al. 2017). Daily gain is a trait found in every variant of the national evaluation model, in both performance testing and postslaughter evaluation. Because the national population of Polish Landrace pigs has not yet attained the target daily gains in the breeding programme, both in gilts and in breeding boars, we should take a closer look at this problem and use the analysis results to suggest some practical modifications.

The aim of the study was to analyse daily gains in the active population of Polish Landrace pigs and to determine whether choosing sires differing in daily gains and assigning different weights to this trait in evaluation models may result in the positive effect of improved growth rate.

Material and methods

The study was conducted with Polish Landrace (PL) pigs. The animal material was chosen based on the fattening and slaughter performance results of PL pigs from nucleus farms, which were analysed in Poland over 7 years. The analysed data are held in a database belonging to the Polish Pig Breeders and Producers Association POLSUS. Fattening and slaughter performance of live animals was tested on the farms based on the methodology introduced on 1 October 2004, according to which animals are evaluated at the age of 150–210 days and at the body weight of at least 70 kg (Blicharski et al., 2018; Eckert and Szyndler-Nędza, 2019). Analysis was made of standardized daily weight gains determined from age and of body weight at weighing during routine performance testing. Daily gain standardized to 180 days of age was calculated based on the formula:

$$X_1 = \frac{616974\frac{Z}{W}}{-0{,}0127W^2 + 6{,}2843W - 102{,}72}$$

where:
X_1 – daily body weight gain standardized to 180 days of age,
Z – animal's body weight on test day,
W – age on test day.

PL boars were chosen for the study based on the criterion that the test boars were selected for nucleus herd replacement or purchased for AI stations. It was also assumed that the study will use the sires tested on at least 5 purebred offspring of one sex coming from at least 2 litters. Based on these criteria, 222 boars tested on purebred male offspring and 427 boars tested on purebred female offspring were selected. Herd boars that sired the tested purebred male and female offspring were considered separately in further analyses.

Selection scheme for the test animals and their numbers

Stage 1	Purebred PL boars tested over 7 years, 13403 head	
Stage 2	Purebred PL boars selected for breeding herd replacement or purchased for AI stations, 614 head	
Stage 3	Purebred PL boars tested on at least 1 offspring, 577 head	
Stage 4	Boars tested on at least 1 male offspring, 289 head	Boars tested on at least 1 female offspring, 454 head
Stage 5	Boars tested on at least 5 male offspring from at least 2 litters, 222 head	Boars tested on at least 5 female offspring from at least 2 litters, 427 head
Stage 6	Purebred male offspring of 222 herd boars, 6744 head	Purebred female offspring of 427 herd boars, 31572 head

For all the animals under study, 5 selection indices differing in the weighting of daily body weight gain were constructed:

- Index 1: daily gain 90%, carcass meat content 10% (PD90% – ZM10%)
- Index 2: daily gain 70%, carcass meat content 30% (PD70% – ZM30%)
- Index 3: daily gain 50%, carcass meat content 50% (PD50% – ZM50%)
- Index 4: daily gain 30%, carcass meat content 70% (PD30% – ZM70%)
- Index 5: daily gain 10%, carcass meat content 90% (PD10% – ZM90%)

The selection indices were developed using the method described by Duniec et al. (1974), based on mean results for daily weight gains and meatiness of purebred PL boars (13 403 head) and purebred PL gilts (47 940 head).

The following values of traits were used when formulating the indices:

- Mean standardized daily body weight gain: boars – 686 g, gilts – 625 g;
- Mean carcass meat percentage: boars – 57.8%, gilts – 56.0%;
- Standard deviation (σ) for standardized daily gain of the boars and gilts – 77.08;
- Standard deviation (σ) for carcass meat percentage of the boars and gilts – 2.7;
- Coefficient of heritability (h^2) for standardized daily body weight gain: boars – 0.57, gilts – 0.49;
- Coefficient of heritability (h^2) for carcass meat percentage: boars – 0.42, gilts – 0.32;
- Coefficients of phenotypic (r_P) and genetic correlation (r_G) between standardized daily body weight gain and carcass meat percentage were assumed as r = 0.

The selection indices were formulated as follows:

Index 1 for boars (1A) $I = 0.193724\ X_1 + 0.52748\ X_2 – 63.3829$
Index 2 for boars (2A) $I = 0.182636\ X_1 + 1.918118\ X_2 – 136.1557$
Index 3 for boars (3A) $I = 0.147662\ X_1 + 3.61855\ X_2 – 210.4485$
Index 4 for boars (4A) $I = 0.086928\ X_1 + 4.970489\ X_2 – 246.9265$
Index 5 for boars (5A) $I = 0.024981\ X_1 + 5.509591\ X_2 – 235.5914$
Index 1 for gilts (1B) $I = 0.193823\ X_1 + 0.496842\ X_2 – 48.96266$
Index 2 for gilts (2B) $I = 0.183887\ X_1 + 1.818144\ X_2 – 116.7452$
Index 3 for gilts (3B) $I = 0.151358\ X_1 + 3.491885\ X_2 – 190.1443$
Index 4 for gilts (4B) $I = 0.091176\ X_1 + 4.908068\ X_2 – 231.8366$
Index 5 for gilts (5B) $I = 0.026507\ X_1 + 5.503777\ X_2 – 224.7785$

where: X_1 – daily body weight gain standardized to 180 days of age, X_2 – meat percentage standardized to 180 days of age.

The herd boars were grouped according to the daily body weight gains standardized to 180 days of age. The following 5 groups were identified based on daily gains:
Group A – 5% of the best boars (sires of offspring),
Group B – 10% of the best boars (sires of offspring),
Group C – 15% of the best boars (sires of offspring),
Group D – 20% of the best boars (sires of offspring),
Group E – 25% of the best boars (sires of offspring).

Selection efficiency based on the five selection indices, as well as the values of standardized daily body weight gains were tested based on performance of the progeny of the tested boars. Each boar was assigned to a group of young boars or gilts, which were its progeny and were performance tested. The analyses were based on the changes that occurred between the groups for daily body weight gains standardized to 180 days of age.

The experimental material was analysed using arithmetic means, standard deviations and coefficients of variation. The results were analysed using SAS statistical package. One-way analysis of variance was employed to determine significant differences between the groups. Significant differences between the means were tested with Duncan's test at $P \leq 0.01$ and $P \leq 0.05$.

Results

Characteristics of the test animals are shown in Table 1. The herd boars with both male and female progeny were tested on average at 169 days of age and at 124 kg of body weight. Higher standardized daily gains (by 4 g) were characteristic of the boars that sired gilts (768 g) compared to the boars that sired male progeny (764 g). The boars' offspring were performance tested at an average age of 174 days and at 114 kg and 106 kg of body weight (barrows and gilts, respectively). The analysed barrows had 50 g higher standardized daily weight gains than the gilts.

Table 1. Characteristics of the research material

Grupa zwierząt Group of animals		Knury stadne – ojcowie knurków Herd boars – sires of young boars	Potomstwo męskie knurów stadnych Male offspring of herd boars	Knury stadne – ojcowie loszek Herd boars – sires of gilts	Potomstwo żeńskie knurów stadnych Female offspring of herd boars
Liczba sztuk (szt.) Number of animals		222	6 744	427	31 572
Wiek (dni) Age (days)	$\bar{x}$	**169**	**174**	**169**	**174**
	σ	*14.37*	*15.00*	*13.42*	*14.92*
Masa ciała (kg) Body weight (kg)	$\bar{x}$	**124**	**114**	**124**	**106**
	σ	*16.38*	*12.79*	*16.18*	*11.91*
Przyrost dzienny standaryzowany (g) Standardized daily gain (g)	$\bar{x}$	**764**	**675**	**768**	**625**
	σ	*91.28*	*76.94*	*91.47*	*67.43*

Breeding value was estimated for the herd boars and the sires of male and female offspring, which were selected from the entire population and assigned to 5 groups. The groups were established according to the rate of growth, using 6 indices differing in the weights applied to the trait daily gain. The results for the herd boars and their male offspring are presented in Table 2.

Table 2. Average values of performance traits and selection indices of sires of male offspring and male offspring in ranges of daily body weight gains

Grupa zwierząt Group of animals		Liczba sztuk Number of animals	Przyrost dzienny standaryzowany Standardized daily gain (g)	Aktualnie stosowany indeks oceny przyżyciowej Current performance test index (PD60%-ZM40%) (pkt / pts)	Indeks oceny przyżyciowej 1A Performance test index 1A (PD90%-ZM10%) (pkt / pts)	Indeks oceny przyżyciowej 2A Performance test index 2A (PD70%-ZM30%) (pkt / pts)	Indeks oceny przyżyciowej 3A Performance test index 3A (PD50%-ZM50%) (pkt / pts)	Indeks oceny przyżyciowej 4A Performance test index 4A (PD30%-ZM70%) (pkt / pts)	Indeks oceny przyżyciowej 5A Performance test index 5A (PD10%-ZM90%) (pkt / pts)
Ojcowie potomstwa męskiego / Sires of male offspring									
Grupa A (5% najlepszych) Group A (5% of the best)	$\bar{x}$	11	**915** ^{Aa}	**148**	**145** ^{ab}	**145** ^{a}	**140**	**129**	**115**
	σ		*22.30*	*5.52*	*4.45*	*5.02*	*6.05*	*6.96*	*7.24*
Grupa B (10% najlepszych) Group B (10% of the best)	$\bar{x}$	22	**896**	**145**	**142**	**142**	**138**	**128**	**116**
	σ		*25.05*	*5.25*	*4.79*	*4.92*	*5.76*	*6.92*	*7.60*
Grupa C (15% najlepszych) Group C (15% of the best)	$\bar{x}$	33	**886**	**145**	**140**	**141**	**137**	**128**	**117**
	σ		*25.11*	*4.77*	*4.75*	*4.65*	*5.20*	*6.23*	*6.96*
Grupa D (20% najlepszych) Group D (20% of the best)	$\bar{x}$	43	**878** ^{a}	**144**	**138** ^{a}	**140**	**137**	**128**	**118**
	σ		*25.89*	*4.72*	*4.85*	*4.63*	*5.08*	*6.15*	*6.97*
Grupa E (25% najlepszych) Group E (25% of the best)	$\bar{x}$	55	**870** ^{A}	**143**	**137** ^{b}	**138** ^{a}	**136**	**128**	**118**
	σ		*27.37*	*4.86*	*5.15*	*4.89*	*5.15*	*6.04*	*6.79*
Potomstwo męskie / Male offspring									
Grupa A (5% najlepszych) Group A (5% of the best)	$\bar{x}$	341	**706** ^{ABa}	**112** ^{Aa}	**104** ^{ABa}	**105** ^{AB}	**105** ^{ab}	**105**	**104**
	σ		*86.74*	*14.64*	*16.73*	*16.04*	*14.58*	*13.03*	*12.56*
Grupa B (10% najlepszych) Group B (10% of the best)	$\bar{x}$	940	**702** ^{CD}	**111** ^{b}	**104** ^{CD}	**104** ^{CD}	**105**	**105**	**104**
	σ		*78.26*	*13.62*	*15.07*	*14.53*	*13.77*	*13.33*	*13.52*
Grupa C (15% najlepszych) Group C (15% of the best)	$\bar{x}$	1141	**697** ^{ab}	**111**	**103** ^{a}	**103**	**104**	**105**	**104**
	σ		*77.87*	*13.35*	*14.97*	*14.35*	*13.47*	*12.97*	*13.20*
Grupa D (20% najlepszych) Group D (20% of the best)	$\bar{x}$	1374	**691** ^{AC}	**110** ^{ab}	**101** ^{AC}	**102** ^{AC}	**104** ^{a}	**105**	**105**
	σ		*76.46*	*12.94*	*14.66*	*13.97*	*13.05*	*12.62*	*12.98*
Grupa E (25% najlepszych) Group E (25% of the best)	$\bar{x}$	1656	**689** ^{BDb}	**110** ^{A}	**101** ^{BD}	**102** ^{BD}	**104** ^{b}	**105**	**105**
	σ		*75.90*	*12.79*	*14.53*	*13.81*	*12.91*	*12.60*	*13,06*

W kolumnach / In columns: A,B,C,D…. - P≤ 0.1, a,b,c,d…. - P≤ 0.5.

Tabela 3. Średnie wartości cech użytkowych i indeksów selekcyjnych ojców potomstwa żeńskiego oraz potomstwa żeńskiego w przedziałach utworzonych ze względu przyrosty dzienne masy ciała

Table 3. Average values of performance traits and selection indices of sires of female offspring and female offspring in ranges of daily body weight gains

Grupa zwierząt Group of animals		Liczba sztuk Number of animals	Przyrost dzienny standaryzowany Standardized daily gain (g)	Aktualnie stosowany indeks oceny przyżyciowej Current performance test index (PD60%-ZM40%) (pkt / pts)	Indeks oceny przyżyciowej 1A/1B* Performance test index 1A/1B* (PD90%-ZM10%) (pkt / pts)	Indeks oceny przyżyciowej 2A/2B* Performance test index 2A/2B* (PD70%-ZM30%) (pkt / pts)	Indeks oceny przyżyciowej 3A/3B* Performance test index 3A/3B* (PD50%-ZM50%) (pkt / pts)	Indeks oceny przyżyciowej 4A/4B* Performance test index 4A/4B* (PD30%-ZM70%) (pkt / pts)	Indeks oceny przyżyciowej 5A/5B* Performance test index 5A/5B* (PD10%-ZM90%) (pkt / pts)
Ojcowie potomstwa żeńskiego / Sires of female offspring									
Grupa A (5% najlepszych) Group A (5% of the best)	$\bar{x}$	26	**916** ^{ABC}	**146**	**145** ^{ABa}	**144** ^{Aa}	**138**	**125**	**111**
	σ		*21.01*	*5.12*	*4.13*	*4.57*	*5.63*	*6.71*	*7.18*
Grupa B (10% najlepszych) Group B (10% of the best)	$\bar{x}$	50	**899** ^{D}	**144**	**142** ^{b}	**142**	**136**	**125**	**113**
	σ		*23.55*	*4.93*	*4.46*	*4.52*	*5.38*	*6.64*	*7.41*
Grupa C (15% najlepszych) Group C (15% of the best)	$\bar{x}$	72	**889** ^{A}	**143**	**140** ^{a}	**140**	**136**	**126**	**114**
	σ		*24.95*	*5.02*	*4.69*	*4.65*	*5.50*	*6.87*	*7.75*
Grupa D (20% najlepszych) Group D (20% of the best)	$\bar{x}$	94	**889** ^{A}	**142**	**139** ^{A}	**139** ^{a}	**135**	**126**	**115**
	σ		*24.95*	*5.00*	*5.06*	*4.81*	*5.42*	*6.75*	*7.73*
Grupa E (25% najlepszych) Group E (25% of the best)	$\bar{x}$	120	**871** ^{CD}	**142**	**137** ^{Bb}	**138** ^{A}	**135**	**126**	**116**
	σ		*29.32*	*5.01*	*5.42*	*4.98*	*5.36*	*6.69*	*7.79*
Potomstwo żeńskie / Female offspring									
Grupa A (5% najlepszych) Group A (5% of the best)	$\bar{x}$	1579	**644** ^{ABCD}	**109**	**104** ^{ABCa}	**105** ^{Aa}	**106**	**106** ^{ABCD}	**105** ^{ABCD}
	σ		*69.69*	*12.96*	*13.51*	*13.39*	*13.30*	*13.35*	*13.52*
Grupa B (10% najlepszych) Group B (10% of the best)	$\bar{x}$	3141	**640** ^{AEF}	**109**	**104** ^{Dab}	**105** ^{b}	**106**	**107** ^{A}	**107** ^{Aa}
	σ		*68.10*	*12.25*	*13.10*	*12.76*	*12.56*	*12.86*	*13.42*
Grupa C (15% najlepszych) Group C (15% of the best)	$\bar{x}$	4425	**638** ^{BG}	**109**	**103** ^{AE}	**105**	**106**	**107** ^{B}	**107** ^{BE}
	σ		*67.93*	*12.34*	*13.08*	*12.77*	*12.67*	*13.06*	*13.65*
Grupa D (20% najlepszych) Group D (20% of the best)	$\bar{x}$	6158	**636** ^{CE}	**109**	**103** ^{Bb}	**104** ^{a}	**106**	**107** ^{C}	**108** ^{CFa}
	σ		*65.72*	*12.12*	*12.63*	*12.37*	*12.51*	*13.27*	*14.07*
Grupa E (25% najlepszych) Group E (25% of the best)	$\bar{x}$	7559	**633** ^{DFG}	**109**	**102** ^{CDE}	**104** ^{Ab}	**106**	**108** ^{D}	**108** ^{DEF}
	σ		*66.42*	*12.30*	*12.79*	*12.56*	*12.69*	*13.36*	*14.06*

W kolumnach / In columns: A,B,C,D…. - P≤ 0.1, a,b,c,d…. - P≤ 0.5. * indeks 1B-5B dla potomstwa żeńskiego/index 1B-5B for female offspring

Analysis of the boar results showed significant differences in three analysed traits: standardized daily gain, and selection indices calculated according to formulae 1A and 2A. Standardized daily gain was highest in the group of A boars (915 g) and lowest for E boars (870 g), with highly significant differences (P≤0.01).
Also for standardized daily gain, a difference (P≤0.05) was observed between group A (915 g) and group D (878 g). In turn, the trait "selection index calculated according to formula 1A" differed significantly between group A (145 pts) and groups D (138 pts) and E (137 pts). Significant differences were also noted between group A (145 pts) and group E (138 pts) for the trait "selection index calculated according to formula 2A" (P≤0.05)
The performance analysis of the male progeny of the herd boars revealed differences in performance traits in the groups except for the selection index calculated according to formulae 4A and 5A. When analysing standardized daily gain, highly significant (P≤0.01) differences were found between group A (706 g) and groups D (691 g) and E (689 g). Significant (P≤0.01) differences in standardized daily gain were established between group B (702 g) and groups D (691 g) and E (689 g). Furthermore, standardized daily gain differed significantly (P≤0.05) between group C (697 g) and groups A (706 g) and E (689 g). The current performance test index showed a difference (P≤0.01) between group A (112 pts) and group E (110 pts). At the same time, group A (112 pts) differed significantly (P≤0.05) in the current performance test index from group D (110 pts). A difference was also found between group B (111 pts) and group D (110 pts).
The performance test index, calculated according to formula 1A in group A was 104 pts and differed significantly (P≤0.01) from the indices determined for groups D (101 pts) and E (101 pts). Identical relationships (P≤0.01) were confirmed for group B (104 pts), which differed in the performance test index from groups D (101 pts) and E (101 pts). A statistically significant difference in the performance test index calculated according to formula 1A (P≤0.05) was also found between groups A (104 pts) and C (103 pts).
Also highly significant were the differences (P≤0.01) for the performance test index calculated according to formula 2A. In this case, the index for group A (105 pts) differed significantly from the indices for groups D (102 pts) and E (102 pts). Likewise, the performance test index calculated according to formula 2A for group B (104 pts) differed from the indices for groups D (102 pts) and E (102 pts).
The performance test index calculated according to formula 3A for group A was 105 pts and differed from the indices for groups D and E, the value of which was 104 pts (P≤0.05)

Table 3 presents mean values of the performance traits for the groups of the boars (sires) and their female progeny, which were selected based on standardized daily gain. In the case of herd boars, significant (P≤0.01; P≤0.05) differences were observed between the mean values of the traits: "selection index determined according to formula 1A" and "selection index determined according to formula 2A". The trait "selection index determined according to formula 1A" differed significantly (P≤0.01) between group A (145 pts) and groups D (139 pts) and E (137 pts). At the same time, the selection index for group A (145 pts) differed significantly (P≤0.05) from that of group C (140 pts), and the selection index for group B (142 pts) from that of group E (137 pts).
Also the "selection index calculated according to formula 2A" for group A (144 pts) differed (P≤0.01) from the index for group E (138 pts). The selection index for group A (144 pts) was at the same time significantly different (P≤0.05) from that for group D (139 pts).

The highest standardized daily gains were found in the group of boars A (916 g) and they were significantly higher than the gains for the boar groups C (889 g), D (880 g) and E (871 g). Also for this trait, a difference (P≤001) was observed in gains between group B (899 g)

and group E (871 g). Analysis of the performance traits of the female progeny of herd boars showed significant differences between the groups for all the analysed traits except for the traits “current selection index” and the “selection index calculated according to formula 3B”. The presence of highly significant differences (P≤0.01) was established between most of the animal groups for the traits “standardized daily gain” and “selection index calculated according to formula 4B”. Highly significant (P≤0.01) and significant (P≤0.05) differences were noted between most of the animal groups for the three selection indices calculated according to formulae 1B, 2B and 5B. For standardized daily gains, highly significant (P≤0.01) differences were found between group A (644 g) and all the other groups: groups B (640 g), C (638 g), D (636 g) and E (633 g). At the same level of significance, daily gains of female progeny obtained in group B (640 g) differed from the gains in groups D (636 g) and E (633 g), while daily gains in group C (638 g) differed from the gains in group E (633 g).

Analysis of the female progeny trait, “selection index calculated according to formula 4B” revealed significant differences (P≤0.01) between the index for group A (106 pts) and the other indices in groups B (107 pts), C (107 pts), D (107 pts) and E (108 pts). The “selection index determined according to formula 1B” differed for the groups at both P≤0.01 and P≤0.05. In this case, differences (P≤0.01) were found between the selection index determined for group A (104 pts) and the indices for groups C (103 pts), D (103 pts) and E (102 pts). Also significant were the differences (P≤0.01) in the selection index values obtained for groups B (104 pts) and E (102 pts), and the indices for groups C (103 pts) and E (102 pts). There were also differences in the selection indices (P≤0.05) between group B (104 pts) and groups A (104 pts) and D (103 pts).

The selection index calculated according to formula 2B for group A was 105 pts and it differed significantly (P≤0.01) from the index for group E (104 pts). Significant differences (P≤0.05) were also noted in the selection indices between groups A (105 pts) and D (104 pts), and between groups B (105 pts) and E (104 pts).
When analysing the “selection index calculated according to formula 5B” for female progeny, highly significant differences (P≤0.01) were observed between the index for group A (105 pts) and all the other groups: B (107 pts), C (107 pts), D (108 pts) and E (108 pts). At the same level of significance, differences were noted in the selection index of female progeny between group E (108 pts) and groups C (107 pts) and D (108 pts). A difference (P≤0.05) in the index was also found between group B (107 pts) and group D (108 pts).

Discussion

The rate of growth was and is one of the major determinants of pig production profitability. Therefore, in the national models for evaluation of maternal pig breeds, such as the Polish Landrace, daily body weight gain has a high weighting. It is 50% in the classical selection index and 24% in the model of aggregate breeding value that combines 4 traits (Blicharski and Hammermeister, 2013; Blicharski et al. 2018; Eckert and Szyndler-Nędza, 2019). In the models used to evaluate the breeding value of pigs in Bavaria, fattening traits account for as much as 51%, including 20% for daily body weight gain (EGZH, 2020). Similarly, considerable emphasis on fattening traits is placed in the breeding programmes for maternal lines in the DanBred breeding company, where it accounts for 28% in the evaluation model, including 3% for daily gains from birth to 30 kg, and 25% for daily gains from 30 to 100 kg (DanBred, 2020). In Norway, fattening traits account for 19% in the general evaluation model (Norsvin, 2016). The cited data show the importance of fattening traits. In the breeding programme implemented in Poland for Polish Landrace pigs, daily body weight gains for live

animals are specified as 750 g for boars and 680 g for gilts (Blicharski et al. 2018). In the present study, the mean values of this trait for the offspring of the herd boars were 675 g in boars and 625 g in gilts. This means that it is necessary to further improve daily gains in both sexes through targeted breeding work while ensuring optimal environmental factors such as nutrition and housing conditions. Progress in fattening performance of Polish Landrace pigs in the years 1995 - 2018 was evident. During this period daily gains increased by an average of 44 g for boars and 94 g for gilts (Eckert and Szyndler-Nędza, 2006, 2019; Żak and Eckert, 2019). The data reported here indicate that progress in this trait was uneven between barrows and gilts and it needs to be accelerated, especially for males. Our study showed that this effect can be achieved through breeding work with the use of properly modified equations of the indices used to determine the genetic value of pigs. These activities are necessary not only from a breeding perspective, but also due to profitability of live pig production, because, as has been repeatedly stated here, fattening traits have a substantial effect on the ultimate economic effect. When converting the results for the growth rate of gilts from 30 to 100 kg of body weight in Poland, it was found that during the comparable period Danish breeding gilts of the Landrace breed had 27 g higher standardized weight gains compared to the Polish gilts (SEGES, 2016; Tyra and Eckert, 2016). On the other hand, breeding Landrace pigs from Germany had lower growth rate than Polish Landrace pigs. In Poland, the average weight gains were lower by 84 g for boars and by 96 g for gilts compared to the Landrace breed (Eckert and Szyndler-Nędza, 2016; Eckert et al., 2016; LfL, 2016).

When analysing values of the indices differing in the weighting for daily gains, it can be observed that in male progeny most differences between the groups from which the sires originated, occurred for the index in which daily gain is 70 and 90%. However, it should be noted that a deterioration in meatiness would be expected for the index in which daily gain accounts for 90%; therefore, a more reasonable variant would be where the gain to meatiness is 70:30% (index 2A). In the case of female progeny, the situation is similar and the optimal solution would be index 2B with a similar ratio of the traits as in the barrows. It should be also noted that daily gains of barrows differ by 17 g between groups A-E (from 689 g to 706 g), and by 11 g in gilts (from 633 g to 644 g) (Tables 2 and 3). It can therefore be stated that in the case of barrows, efforts should be made to select breeding stock from group A, and in the case of gilts animals can be also chosen from outside group A and this will not significantly disrupt breeding work on improving the growth rate.

The discussed selection indices, in addition to the trait daily gain, contain a second trait, namely carcass meat percentage. When constructing the optimal variants of the indices, attention should therefore be given to the mutual correlations between these traits. Research results indicate that these correlations are generally negative and amount to $r = -0.19$ in Landrace pigs (Stage et al., 2011). In the other pig breeds and crossbreds, correlations between carcass meat percentage and body weight gains were found to range from $r = -0.14$ to $r = -0.44$ (Stage et al., 2011; Shirali et al., 2018).

Our analysis showed the need to further improve the growth rate of Polish Landrace pigs. Boars need 75 g and gilts need 55 g on average to attain the threshold values set for pigs of this breed in the national breeding programme. Considering the rate at which this trait was improved in previous years, special attention should be paid to the intensification of breeding work in this area. Our study showed the potential for effective regulation of the rate at which fattening traits are improved. This should form a basis for modifying breeding methods and for adjusting them to the current genetic value of the active population of the pigs.

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