COMPARATIVE EVALUATION OF GROWTH PERFORMANCE AND CARCASS TRAITS IN PUREBRED AND CROSSBRED PIGS UNDER COMMERCIAL PRODUCTION CONDITIONS

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Keywords: *pigs, lean meat content, back fat thickness, purebred, crossbred*

Abstract. *The study aimed to evaluate the productive performance of purebred and crossbred gilts under practical production conditions in Slovakia. A total of 164 gilts representing three pure breeds (Large White, Landrace, Duroc) and three hybrid combinations (LW×LA, LA×DU, LW×DU) were assessed for growth intensity, back fat thickness and lean meat content, with all traits standardised to a live weight of 100 kg. Significant differences (P < 0.001) were observed between purebred and crossbred groups. Crossbred pigs achieved faster growth (ADG_{100} 635.93 g/day) but showed higher back fat deposition, whereas purebreds exhibited superior carcass leanness (LMC_{100} 62.72%). Within purebreds, Duroc demonstrated the highest lean meat percentage and the lowest fat thickness, while among hybrids the LW×LA combination displayed the most favourable balance of growth and carcass traits. Correlation analysis confirmed strong biological relationships between growth and carcass parameters, particularly the antagonism between backfat and lean meat content. The findings emphasise the influence of a genetic background on production efficiency and highlight the advantages of specific crossbreeding strategies in optimising pig performance.*

Introduction

The production performance of pigs is strongly influenced by the genetic background of the population. Numerous studies demonstrate that purebred pig breeds differ significantly in growth rate, carcass characteristics, and overall productivity. Xie et al. (2023) reported that Yorkshire pigs exhibit faster growth and reach a market weight of 100 kg at an earlier age than Duroc pigs. Similar findings were observed by Adebambo (2021), who confirmed higher carcass yields in Large White and Hampshire breeds compared with hybrid pigs, although with increased back fat thickness. In addition, Babicz et al. (2020) highlighted that some native breeds, such as Puławska, may achieve competitive daily gains of approximately 569 g, while offering favourable meat quality traits.

A considerable part of the production efficiency is also associated with heterosis effects. Iversen et al. (2019) reported that heterozygosity has a particularly positive impact on maternal traits such as total number born and litter weight, and it also contributes to improved early growth performance. Therefore, crossbreeding programmes have become an essential component of modern pig production systems. Chen et al. (2018) demonstrated that hybrids such as Duroc × (Berkshire × Yanan) outperform traditional Chinese breeds in terms of growth rate and carcass traits. Wang et al. (2020) confirmed similar effects in Berkshire × Chenghua hybrids, which achieved higher lean meat content (50.76% vs. 42.58%) while maintaining desirable meat quality characteristics. Moreover, Elbert et al. (2020) showed that different terminal sire lines produce distinct results in growth performance and carcass traits, emphasising the importance of selecting appropriate genetic combinations.

Additional differences between genetic types were described by Christensen et al. (2019), who found genetic correlations between purebred and crossbred performance ranging from 0.75 to 0.96, indicating a strong predictive ability of purebred selection for hybrid performance. Voshchenko (2025) also confirmed that specialised terminal lines, such as PIC-337, can achieve higher live weight gains than traditional purebreds in intensive production systems. At the same time, Li et al. (2020) emphasised the role of environmental factors, showing that enriched housing conditions improve growth rates regardless of the genetic background.

Therefore, comparing the production performance of purebred and crossbred pigs is crucial for optimising growth, reproduction, and the economic efficiency of pig production. Analysing the genetic differences and performance outcomes of these breeding strategies represents an important basis for determining the most

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suitable breeds and genetic combinations for modern and alternative production systems. Accordingly, the aim of this study is to evaluate and compare the productive performance of purebred and hybrid pigs to determine their potential advantages and practical applicability in contemporary pig breeding systems.

Material and methods

Biological materianl

A total of 164 gilts were evaluated in the experiment, of which 90 were purebred pigs of the Large White (LW), Landrace (LA) and Duroc (DU) breeds, with 30 gilts selected from ea ch breed. The hybrid group consisted of 74 gilts of three genetic combinations: Large White × Landrace (LW×LA), Landrace × Duroc (LA×DU) and Large White × Duroc (LW×DU). For the first two combinations, 30 gilts were included, while the LW×DU group consisted of 14 gilts. All animals were selected within a live weight range of 80 to 120 kg. The productive performance of gilts was evaluated under practical production conditions on selected farms in Slovakia.

Ethical approval was not required because the data were collected from a commercial pig farm and no direct contact with live animals occurred.

Housing and feeding of pigs

The dataset was collected from commercial pig farms located in various regions of Slovakia. Since the animals originated from multiple production units, exact housing and feeding conditions could not be unified. All farms operated under standard intensive production practices routinely applied in Slovak pig industry. Animals were kept in groups and managed according to common farm protocols. Water was available ad libitum. Feeding was based on complete compound diets intended for growing pigs, with ration formulation determined individually by each farm. Although partial differences in feeding strategy and housing design may have occurred among farms, all pigs were reared under comparable practical production conditions.

Evaluated parameters

During pig performance testing, several production traits were recorded for each pig, including live weight (to the nearest 1 kg), age in days, average daily gain (g/day), back fat thickness (cm) and lean meat content. The values of average daily gain, back fat thickness and lean meat content obtained on the measurement day were subsequently standardised to a live weight of 100 kg using the corresponding calculation formulas. Back fat thickness and lean meat content were assessed using a Piglog 105 device (SFK Technology A/S, Denmark) (User's Manual Slovakia, 2006). For the measurements, pigs were positioned in a horizontal measuring crate on a solid floor, standing firmly on both front and hind limbs, with the head maintained in a straight horizontal position.

For the determination of back fat thickness, three measurement points (M_1, M_2 and M_3) were defined and used in conjunction with the Piglog 105 ultrasound device. All points were positioned along a straight longitudinal line on the left side of the animal, at 5–6 cm from the anatomical reference markers A_0, B_0 and C_0. Measurement point M_1 was established at the midpoint between the projected locations of A_0 and B_0. Point M_2 was placed halfway between M_1 and B_0, whereas M_3 was situated at the midpoint between B_0 and C_0 (Fig. 1). This standardised placement ensured consistent anatomical positioning for all examined animals.

To determine the proportion of muscle tissue, two measurement sites, designated M_1 and M_2M_3, were utilised. These points were located on a straight line positioned 7 cm laterally from the anatomical reference markers A_0, B_0 and C_0 on the left dorsal side of the animal. Measurement point M_1, used for assessing back fat thickness, was situated between the third and the fourth lumbar vertebrae. The combined measurement point M_2M_3, where both back fat thickness and the depth of the *Musculus longissimus dorsi* were recorded, was positioned between the third and the fourth ribs (Fig. 2).

Average daily gain (ADG), back fat thickness (BFT) and lean meat content (LMC) were recalculated to a standard live weight of 100 kg in accordance with the conversion procedure described by Řeháček et al. (2001). Standardisation was performed to enable objective comparison of animals with different body weights at the time of measurement. The adjusted traits were calculated using the following equations:

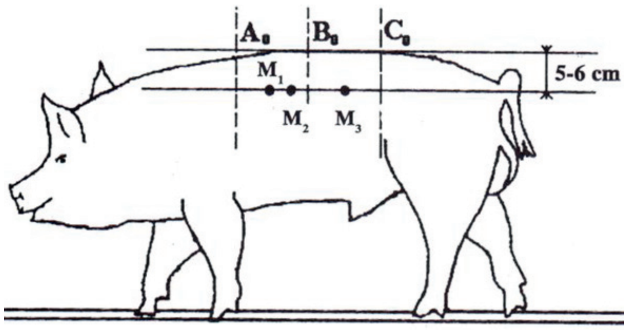

Fig. 1. Backfat thickness measurement points (Řeháček et al., 2001)

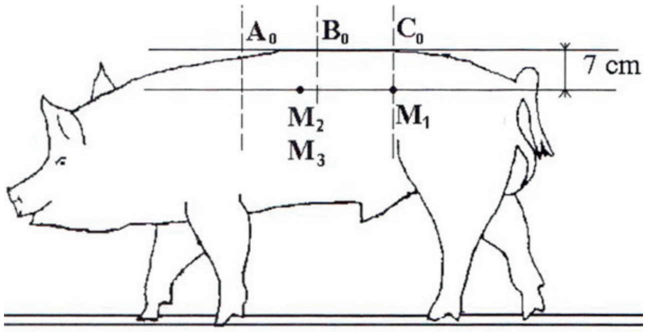

Fig. 2. Measurement points for the lean meat content (Řeháček et al., 2001)

Converted average daily gain on 100 kg live weight (ADG100):

$$ADG_{100} = ADG–GK*(LW–100)$$

where GK is conversion coefficient for gilts (2.58); LW is live weight of the gilts on the day of measurement; and ADG is the average daily gain on the day of measurement.

Converted back fat thickness on 100 kg live weight (BFT100):

$$BFT_{100} = BFT–GK*(LW–100)$$

where GK is conversion coefficient for gilts (0.017); LW is live weight of the gilts on the day of measurement; and BFT is the average back fat thickness on the day of measurement.

Converted lean meat content on 100 kg live weight (LMC100):

$$LMC_{100} = LMC+GK*(LW–100)$$

where GK is conversion coefficient for gilts (0.0859); LMC is lean meat content in % on the day of measurement; and LW is live weight of the gilts on the day of measurement (kg).

Standardisation to a live weight of 100 kg was applied to eliminate the influence of body weight variation among individuals and to ensure objective comparability of growth and body composition traits. Since pigs were measured at different ages and at slightly different body weights, direct comparison of raw values could lead to biased interpretation favouring heavier or older animals. Correcting ADG, BFT and LMC to a common reference weight enables evaluation of performance based on biological efficiency rather than body size, which is particularly important when comparing purebred and crossbred pigs with different growth dynamics. This approach is widely used in live pig evaluation and improves reliability when assessing genetic and performance differences between groups (Řeháček et al., 2001).

Statistical analysis

The results obtained were analysed using IBM SPSS Statistics 20. Comparisons between the groups were performed using one-factor ANOVA analysis of variance, while testing of contrasts was conducted using Scheffe's test at a significance level of $P < 0.05$.

The influence of monitored parameters was tested with the following model equations:

Effect of breed:

$$yij = \mu + gi + \varepsilon ij$$

where *yij* is respected dependent variable, μ is intercept, *gi* is effect of the breed *i* (*i* = 1: pure breed, *i* = 2: cross breed), and *εij* is residual error.

$$yij = \mu + sri + \varepsilon ij$$

where *yij* is respected dependent variable, μ is intercept, *sri* is effect of pure breed and cross breed *i* (*i* = 1: LW, *i* = 2: LA, *i* =3: DU, *i* = 4: LW×LA, *i* = 5: LA×DU, *i* = 6: LW×DU), and *εij* is residual error.

Results

Significant differences were found between purebred and crossbred groups in all evaluated traits ($P < 0.001$) (Table 1). Purebred gilts reached a higher final weight (111.29 ± 7.99 kg) and were measured at an older age (172.96 ± 12.14 days) compared with crossbred gilts (102.59 ± 11.51 kg vs. 159.77 ± 11.52 days) ($P < 0.001$). On the other hand, crossbred gilts achieved a significantly higher average daily gain recalculated to 100 kg live weight (635.93 ± 42.82 g/day) than purebreds (615.38 ± 35.54 g/day) ($P < 0.01$). Crossbreeds also showed greater back fat thickness (1.03 ± 0.29 cm vs 0.75 ± 0.20 cm), while purebred gilts had a higher lean meat content (62.72 ± 1.67% vs 60.55 ± 2.40%) ($P < 0.001$). The observed differences clearly indicate that hybrid gilts grow faster, but purebreds show better carcass leanness.

Within purebred groups, all evaluated traits also differed significantly ($P < 0.001$). Duroc gilts showed the highest final weight (114.57 ± 5.14 kg) and the greatest lean meat content (64.36 ± 0.8%) compared with Large White and Landrace (Table 2). However, Duroc had the lowest back fat thickness (0.58 ± 0.06 cm), which supports their well-known carcass quality characteristics. In terms of daily gain, values among purebred breeds were relatively close, with Large White reaching the highest ADG_{100} (619.17 ± 21.71 g/day), followed by Duroc (615.73 ± 50.47 g/day) and Landrace (611.23 ± 28.71 g/day) ($P < 0.001$). Landrace and Large White showed slightly lower meat content than Duroc but had higher back fat thickness

Table 1. Comparison of productive performance between purebred and crossbred gilts

Indicator (unit)	Purebred (X + SD) (n = 90)	Crossbred (X + SD) (n = 76)	*P* value
Age (days)	172.96 ± 12.14	159.77 ± 11.52	< 0.001
Weight (kg)	111.29 ± 7.99	102.59 ± 11.51	< 0.001
ADG_{100} (g/day)	615.38 ± 35.54	635.93 ± 42.82	0.01
BFT_{100} (cm)	0.75 ± 0.20	1.03 ± 0.29	< 0.001
LMC_{100} (%)	62.72 ± 1.67	60.55 ± 2.40	< 0.001

Legend: ADG_{100}: Average daily gain on 100 kg live weight; BFT_{100}: Back fat thickness on 100 kg live weight; LMC_{100}: Lean meat content on 100 kg live weight; SD: Standard deviation; X: Mean.

Table 2. Productive performance characteristics of Large White, Landrace and Duroc purebred gilts

Indicator (unit)	LW (X + SD) (n = 30)	LA (X + SD) (n = 30)	DU (X + SD) (n = 30)	*P* value
Age (days)	168.53 ± 10.99[a]	174.07 ± 7.79[b]	176.27 ± 15.43[b]	< 0.001
Weight (kg)	107.83 ± 9.47[a]	111.47 ± 7.50[b]	114.57 ± 5.14[b]	< 0.001
ADG_{100} (g/day)	619.17 ± 21.71[a]	611.23 ± 28.71[b]	615.73 ± 50.47[ab]	< 0.001
BFT_{100} (cm)	0.85 ± 0.21[a]	0.82 ± 0.17[a]	0.58 ± 0.06[b]	< 0.001
LMC_{100} (%)	61.98 ± 1.32[a]	61.81 ± 1.39[a]	64.36 ± 0.80[b]	< 0.001

Legend: ADG_{100}: Average daily gain on 100 kg live weight; BFT_{100}: Back fat thickness on 100 kg live weight; LMC_{100}: Lean meat content on 100 kg live weight; SD: Standard deviation; X: Mean; [a,b]: different letters in the same row indicate significant differences among the mean values (P< 0.001).

(P < 0.001). These results highlight the variability among pure breeds and confirm superiority of Duroc in carcass lean percentage.

Significant differences were also confirmed between hybrid combinations (P < 0.001) (Table 3). The highest average daily gain was found in LW×LA crosses (653.53 ± 33.16 g/day), followed by LA×DU (638.53 ± 45.67 g/day), while LW×DU exhibited the lowest growth intensity (592.64 ± 21.04 g/day) (P < 0.001). The LA×DU combination showed the greatest back fat thickness (1.19 ± 0.27 cm), but the lowest lean meat percentage (59.52 ± 1.71%). In contrast, LW×LA pigs achieved the best balance between growth and carcass traits, with relatively high lean content (61.62 ± 2.13%). LW×DU crosses had the highest weight at the day of measurement (107.86 ± 4.47 kg) and the oldest age (176.14 ± 2.57 days) (P < 0.001). Overall, the results show that crossbreeding significantly influences productive traits and confirms performance advantages of specific hybrid combinations, particularly LW×LA in growth rate.

Correlation analysis (Table 4) revealed significant relationships between age, live weight and production traits recalculated to 100 kg live weight. Age showed a strong positive correlation with live weight (r = 0.66; P < 0.001), indicating that older gilts were heavier at the time of measurement. At the same time, age was negatively correlated with ADG_{100} (r = –0.68; P < 0.001), suggesting that younger gilts achieved 100 kg of live weight faster, which supports our earlier findings showing that hybrid pigs reached higher growth rates than purebreds.

Live weight was positively associated with lean

Table 3. Productive performance parameters of hybrid gilts across three genetic combinations

Indicator (unit)	LW×LA (X + SD) (n = 30)	LA×DU (X + SD) (n = 30)	LW×DU (X + SD) (n = 17)	*P* value
Age (days)	154.80 ± 2.04[a]	157.10 ± 12.82[a]	176.14 ± 2.57[b]	< 0.001
Weight (kg)	101.93 ± 8.47[a]	100.80 ± 15.35[a]	107.86 ± 4.47[ab]	< 0.001
ADG_{100} (g/day)	653.53 ± 33.16[a]	638.53 ± 45.67[ab]	592.64 ± 21.04[c]	< 0.001
BFT_{100} (cm)	0.90 ± 0.26[a]	1.19 ± 0.27[b]	0.96 ± 0.27[a]	< 0.001
LMC_{100} (%)	61.62 ± 2.13[a]	59.52 ± 1.71[b]	60.46 ± 3.24[ab]	< 0.001

Legend: ADG_{100}: Average daily gain on 100 kg live weight; BFT_{100}: Back fat thickness on 100 kg live weight; LMC_{100}: Lean meat content on 100 kg live weight; SD: Standard deviation; X: Mean; [a–c]: different letters in the same row indicate significant differences among the mean values (P< 0.001).

Table 4. Correlation analysis of growth and live body composition traits in fattening gilts

Indicator	Age	Weight	ADG_{100}	BFT_{100}	LMC_{100}
Age		0.664**	–0.684**	–0.439**	0.375**
Weight			0.085	–0.631**	0.583**
ADG_{100}				–0.032	0.0688
BFT_{100}					–0.844**
LMC_{100}					

Legend: ADG_{100}: Average daily gain on 100 kg live weight; BFT_{100}: Back fat thickness on 100 kg live weight; LMC_{100}: Lean meat content on 100 kg live weight; * Correlation is significant at the 0.05 level (2-tailed). **; Correlation is significant at the 0.01 level (2-tailed).

meat content recalculated to 100 kg ($r = 0.58$; $P < 0.001$), meaning that animals with better growth ability tended to deposit more muscle tissue. On the contrary, a strong negative correlation was observed between weight and BFT_{100} ($r = -0.63$; $P < 0.001$), which confirms that heavier animals within our dataset generally presented a lower standardized back fat thickness.

A highly significant negative correlation was detected between BFT_{100} and LMC_{100} ($r = -0.84$; $P < 0.001$). This result demonstrates a clear antagonistic relationship between fat deposition and lean mass, meaning that individuals with lower back fat have a markedly higher lean content. This supports phenotypic differences previously observed between purebred and crossbred groups, where purebred pigs (especially Duroc) showed superior lean percentage, while hybrids grew faster but accumulated more back fat.

Overall, the correlation results confirm that:

- younger pigs exhibit faster growth (higher ADG_{100});
- higher body weight is associated with leaner carcass composition;
- fat depth and lean meat content are strongly inversely related;
- genotype influences these relationships significantly, as demonstrated by performance differences between purebreds and crossbreds.

Discussion

The results of this study clearly demonstrate statistically significant differences ($P < 0.001$) in production traits between purebred and crossbred pigs, supporting the general assumption that genotype plays a key role in growth performance and carcass quality. Crossbred animals achieved higher average daily gain recalculated to 100 kg live weight compared with purebreds, confirming the positive heterosis effect described by Iversen et al. (2019) and Chen et al. (2018). Faster growth observed in hybrid pigs is likely the result of complementary genetic traits of the parental breeds, which is consistent with previous reports indicating that crossbred combinations often outperform pure lines in growth intensity and efficiency. Similar conclusions were also reported by Elbert et al. (2020), who demonstrated that sire line significantly influences growth performance and carcass yield in hybrid pigs, supporting the observation that hybrid combinations tend to exhibit higher growth dynamics.

In contrast, purebred pigs in the present study achieved higher lean meat content and lower back fat thickness recalculated to 100 kg live weight compared with hybrids. Comparable findings were reported by Adebambo (2021), who observed that purebred pigs may excel in carcass quality traits despite exhibiting lower growth rates. The higher lean meat content observed in purebred gilts may reflect long-term selection pressure focused on carcass composition within commercial nucleus herds. This interpretation is consistent with Christensen et al. (2019), who reported high genetic correlations between purebred and crossbred performance, particularly for carcass traits. Similar conclusions were drawn by Esfandyari et al. (2020), who highlighted strong genetic correlations between purebred selection response and crossbred performance, indicating that selection in nucleus herds can effectively improve carcass traits expressed in hybrid populations.

These findings reinforce the close interrelationship between growth dynamics and carcass composition. The present results support the concept that crossbreeding strategies enhance growth rate through heterosis, whereas targeted within-breed selection in pure lines contributes to improved carcass leanness. This interpretation aligns well with conclusions drawn by Iversen et al. (2019), Wang et al. (2020) and Chen et al. (2018), who emphasised the complementary roles of hybrid vigour and purebred genetic improvement in modern pig production systems.

When individual purebred lines were compared, the Duroc breed exhibited superior lean meat content and the lowest back fat thickness recalculated to 100 kg live weight, while maintaining daily gain comparable with Large White and Landrace. These results are consistent with earlier reports describing Duroc as a breed characterised by favourable carcass composition and desirable meat quality traits (Xie et al., 2023; Babicz et al., 2020). A similar performance tendency was reported by Kim et al. (2020), who observed lower back fat thickness and improved carcass quality indicators in Duroc pigs and Duroc-based hybrids. The slightly higher body weight at measurement observed in Duroc pigs suggests a greater potential for muscle deposition at comparable ages. In contrast, Large White and Landrace pigs showed slightly higher growth dynamics but accumulated more back fat, which may be related to their maternal-oriented breeding background.

Among the crossbred groups, the LW×LA combination achieved the highest ADG100 while maintaining balanced carcass quality parameters, whereas LA×DU pigs exhibited the greatest back fat thickness and the lowest lean meat content recalculated to 100 kg live weight. The superior performance of LW×LA hybrids suggests strong genetic complementarity between the two maternal breeds, potentially enhancing growth metabolism. Conversely, the lower carcass leanness observed in LA×DU crosses, despite the inclusion of the Duroc breed known for lean tissue deposition, may indicate the influence of dominance effects or breed order within the cross. LW×DU gilts reached the highest body weight at measurement but exhibited lower ADG100 compared with LW×LA animals, suggesting a more prolonged rather than rapid growth pattern. These findings are consistent with reports by Wang et al. (2020) and Chen et al. (2020), who demonstrated that crossbreeding outcomes strongly depend on parental breed combinations and terminal sire selection. Similarly, Wang et al. (2021) reported that breed composition affects intramuscular fat content and meat quality, with traditional breeds often exhibiting superior meat quality despite slower growth, which partly reflects the pattern observed in pure Duroc pigs in the present study.

It should be noted that the animals included in this study originated from several commercial farms, where minor differences in housing conditions, feeding strategies and management practices may have occurred. Although all pigs were reared under standard intensive production systems typical for Slovak commercial pig farms, such environmental variation could have partially influenced growth performance and carcass traits. Previous studies have shown that feeding regime, housing conditions and management intensity can modulate carcass trait expression independently of genetic background (Li et al., 2019). Nevertheless, because all evaluated traits were standardised to a live weight of 100 kg, the influence of body weight differences was minimised, enabling a more objective comparison between purebred and crossbred pigs. Therefore, the observed performance differences can be attributed primarily to genetic effects, while the inclusion of animals from different farms reflects realistic commercial production conditions and enhances the practical relevance of the results.

Overall, the presented data confirm that hybrid pigs exhibit higher growth potential, whereas purebred lines provide advantages in carcass quality. The observed performance differences reflect heterosis effects, breed specialisation and selection orientation, which are consistent with modern crossbreeding strategies aimed at maximising growth efficiency through hybrid vigour while maintaining favourable carcass characteristics through purebred genetic improvement. The integration of the present findings with existing literature suggests that optimal breeding strategies may combine the growth advantages of hybrids with the superior carcass traits of selected pure lines, such as Duroc, particularly within terminal sire systems.

Conclusions

The study confirmed clear production differences between purebred and crossbred pigs. Crossbred gilts grew faster and reached market weight earlier, demonstrating the positive effect of heterosis on growth performance. However, this advantage was accompanied by increased back fat thickness. Purebred pigs, particularly Duroc, showed superior carcass leanness and the highest lean meat content. Among hybrid combinations, LW×LA displayed the most favourable balance between growth rate and carcass traits. Overall, the findings highlight the importance of selecting appropriate breed combinations to optimise growth efficiency and carcass quality in commercial pig production systems.

References

1. Adebambo, O. A. Comparative growth and carcass performance of progenies sired by purebred large white and hampshire boars and their crosses with the nigerian local breed. Nigerian Journal of Animal Production. 2021, 10, 124–129. https://doi.org/10.51791/njap.v10i.2723
2. Babicz, M., Hałabis, M., Skałecki, P., Domaradzki, P., Litwińczuk, A., Kropiwiec-Domańska, K., Łukasik, M. Breeding and performance Potential of Puławska pigs – a review. Annals of Animal Science. 2019., *20*(2), 343–354. https://doi.org/10.2478/aoas-2019-0073
3. Chen, C., Zhu, J., Ren, H., Deng, Y., Zhang, X., Liu, Y., Cui, Q., Hu, X., Zuo, J., Chen, B., Zhang, X., Wu, M., Peng, Y. Growth performance, carcass characteristi cs, meat quality and chemical composition of the Shaziling pig and its crossbreeds. Livestock Science. 2020. 244 p. https://doi.org/10.1016/j.livsci.2020.104342
4. Chen, Y., Wei, Y., Chen, J., Lv, D., Li, P., Zhu, L., Tang, G., Li, X., Jiang, Y. Growth, carcass characteristics and meat quality of Chinese indigenous Yanan pig crossbred with Duroc and Berkshire genotypes. Animal Production Science. 2018. 59(6), 1147–1154. https://doi.org/10.1071/an17450
5. Christensen, O. F., Nielsen, B., Su, G., Xiang, T., Madsen, P., Ostersen, T., Velander, I., Strathe, A. B. A bivariate genomic model with additive, dominance and inbreeding depression effects for sire line and three-way crossbred pigs. Genetics Selection Evolution. 2019. 51(1), 23 p. https://doi.org/10.1186/s12711-019-0486-2
6. Elbert, K., Matthews, N., Wassmuth, R., Tetens, J. Effects of sire line, birth weight and sex on growth performance and carcass traits of crossbred pigs under standardized environmental conditions. Archives Animal Breeding/Archiv Für Tierzucht. 2020. 63(2), 367–376. https://doi.org/10.5194/aab-63-367-2020
7. Esfandyari, H., Thekkoot, D., Kemp, R., Plastow, G., Dekkers, J. Genetic parameters and purebred–crossbred genetic correlations for growth, meat quality, and carcass traits in pigs. Journal of Animal Science. 2020. 98(12). https://doi.org/10.1093/jas/skaa379
8. IBM Corp. Released 2011. IBM SPSS Statistics for Windows, Version 20.0. Armonk, NY: IBM Corp.
9. Iversen, M. W., Nordbø, Ø., Gjerlaug-Enger, E., Grindflek, E., Lopes, M. S., Meuwissen, T. Effects of heterozygosity on performance of purebred and crossbred pigs. Genetics Selection Evolution. 2019. 51(1), 8. https://doi.org/10.1186/s12711-019-0450-1
10. Kim, J. A., Cho, E. S., Jeong, Y. D., Choi, Y. H., Kim, Y. S., Choi, J. W., Kim, J. S., Jang, A., Hong, J. K., Sa, S. J. The effects of breed and gender on meat quality of Duroc, Pietrain, and their crossbred. Journal of Animal Science and Technology. 2020. 62(3), 409–419. https://doi.org/10.5187/jast.2020.62.3.409
11. Li, J., Han, Q., Liu, R., Wen, P., Ji, W., Pan, L., Wang, C., Zhao, P., Liu, H., Bao, J. Effects of environment and breed on growth performance and meat quality of fattening pigs. Animal Welfare. 2020. 29(2), 177–184. https://doi.org/10.7120/09627286.29.2.177
12. Řeháček et al. Methodological guidelines for controlling the pig performance. Slovak Breeding Ltd. Nitra. 2001. 34 p. (In Slovak: Metodické pokyny pre kontrolu úžitkovosti ošípaných. Slovenský chov s.r.o. Nitra).
13. SFK Technology A/S, Dánsko. (2006). User Manual Slovakia. Edition 2.1. 25 p.
14. Ukraine, S. N. a. U. S., Voshchenko, I. Fattening qualities of pigs of various breeding directions in purebred breeding, crossing and hybridization in the conditions of modern pork production. The Scientific and Technical Bulletin of the Institute of Animal Science NAAS of Ukraine. 2025. 134, p. 208–227. https://doi.org/10.32900/2312-8402-2025-134-208-227

15. Wang, X., Gong, Z., Zou, Q., Zhu, L., Tang, G., Li, M., Li, X., Zhang, Z., Xu, Z., Sun, Y., Jiang, Y. Evaluation of Coat Color Inheritance and Production Performance for Cossbreed from Chinese Indigenous Chenghua Pig Crossbred with Berkshire. Research Square (Research Square). 2020. https://doi.org/10.21203/rs.3.rs-66096/v1
16. Wang, Y., Thakali, K., Morse, P., Shelby, S., Chen, J., Apple, J., Huang, Y. Comparison of Growth Performance and Meat Quality Traits of Commercial Cross-Bred Pigs versus the Large Black Pig Breed. Animals. 2021. 11(1), 200 p. https://doi.org/10.3390/ani11010200
17. Xie, Z., Gan, M., Du, J., Du, G., Luo, Y., Liu, B., Zhu, K., Cheng, W., Chen, L., Zhao, Y., Niu, L., Wang, Y., Wang, J., Zhu, L., Shen, L. Comparison of Growth Performance and Plasma Metabolomics between Two Sire-Breeds of Pigs in China. Genes. 2023. 14(9), 1706 p. https://doi.org/10.3390/genes14091706