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Effect of boar line on fattening performance and carcass and meat quality of Zlotnicka White pigs

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ABSTRACT. The aim of this study was to analyse levels of fattening and slaughter traits of Zlotnicka White (ZW) pigs along with the basic quality and texture parameters of their meat. The experiment included 111 gilts of the ZW breed, which completed their control fattening from 25 to 100 kg body weight. The experimental material was divided into 6 groups, each from different boar. Levels of fattening and slaughter traits were assessed along with the basic quality and texture parameters of the *longissimuss lumborum* and *semimembranosus muscles*. Values of these traits were compared between the groups of fatteners sired by different boars. It was shown that ZW pigs exhibit average daily weight gains of 702 g, high feed conversion ratio (FCR = 3.36 kg), considerable backfat thickness (2.19 cm) and carcass leanness at approx. 53%. For values of these traits significant differences were found between the groups of fatteners after different sires. Meat was characterized by lightness (L* = 55.3) and a considerable share of the red colour (a* = 15.6). The observed acidification level was typical of high quality of meat. The intramuscular fat level was lower than previously recorded for this breed, while cooking loss was slightly higher. For muscle texture parameters in most cases no significant effect of the boar was found for the investigated traits, except for chewiness, which both for *musculus longissimuss lumborum* and *m. semimembranosus* were higher in the case of boar V compared to the other groups.

Introduction

The Zlotnicka White (ZW) breed is one of three native pig breeds bred in Poland. In order to preserve its valuable features and maintain variability within the population, it is covered by the Genetic Resources Protection Programme. ZW, like other native pig breeds, is characterized by average or low fattening and slaughter performance with very good meat quality (Grześkowiak et al., 2009; Migdał et al., 2017). Despite the fact that native breeds are currently used in mass production to a limited extent, they can be an excellent material for crossbreeding in order to obtain a population of pigs suitable for ecological breeding, giving products with high nutritional and taste values (Waraczewski et al., 2023).

Results of analyses conducted to date on quality and processability of meat from ZW pigs indicate its excellent quality. It needs to be stressed that most studies on ZW pigs were conducted in the 1980s and 1990s. Since 2000, analyses has been carried out only within a limited scope on a small number of animals (Grześkowiak et al., 2009; Migdał et al., 2017). This has resulted in a lack of current data concerning the level and variability of the abovementioned traits in the ZW pig population.

The aim of this study was to determine the effect of boar line on fattening performance and carcass and meat quality of ZW pigs. The ZW breed is covered by the genetic resources protection programme, which is particularly important for monitoring essential utility traits and maintaining the lowest possible inbred. For this reason, it is important to keep separate genetic lines of both boars and sows.

Material and methods

Ethical Review and Approval was waived for this study, as according to Polish law Ethical Approval is not required for services within the scope of the Act of 18 December 2003.

Experimental material

Data for analyses in this study were collected from testing records of ZW gilts. Performance testing was conducted at the Pig Slaughter Performance Testing Station (SKURTCh) in Chorzelowo as a standard measure in the execution of the breeding programme. The experiment covered 111 fatteners (gilts) of the ZW breed. The experimental material was divided into 6 groups, of which each was sired by a different boar. In the entire population of ZW pigs, the number of boars is about 40. Boars representing the 6 most numerous lines were selected for the study. Each line was represented by one boar from which the most offspring was obtained. A minimum number of 10 daughters (gilts) produced from minimum 5 matings by each sire were tested.

After rearing at the site where they were born, the animals were transferred before the 12th week of life to the Pig Slaughter Performance Testing Station (SKURTCh) in Chorzelowo. At the Station, the control fattening (from 25 to 100 kg body weight) was based on the methodology approved by the National Research Institute of Animal Production (Różycki and Tyra, 2010). In the fattening two all-mash feeds of different compositions were used (Table 1). Due to the fact that the fattened pigs were kept and slaughtered at the SKURTCh, the influence of transport on the examined traits was eliminated. After electric stunning, the fattened pigs were suspended by their legs and then slaughtered by severing the carotid arteries and jugular veins.

Table 1. Composition of compound feeds

Component	Feed I (body weight to 80 kg)	Feed II (body weight from 80 kg to slaughter)
Energy, MJ/kg	13.50	13.00
Crude protein, %	17–19	16–18
Crude fat, %	3–7	2–6
Crude fibre, %	2.5–4.5	3.0–5.0
Lysine, %	1.04	0.85
Methionine, %	0.32	0.26
Ca, %	0.7–0.9	0.8–1.0
P, %	0.60	0.65

Analysed traits and parameters

Carcass quality measurement

Fattening performance. For all the fatteners the following traits were assessed during the test fattening period (from 25 to 100 kg): daily weight gain during the fattening period (g); feed consumption per 1 kg weight gain (kg) was calculated from the amount of feed consumed (grower and finisher, (kg)) divided by the daily gain in the test.

Carcass quality measurement

After 24 h of cooling the carcasses at 4 °C, the right half-carcasses were dissected and evaluated. The following parameters were determined: cold carcass weight (kg); cold dressing percentage (%) calculated based on body weight before slaughter and the weight of both half-carcasses after slaughter; mean backfat thickness from 5 measurements (cm) (a/ the thickest point above the scapula; b/ between the last thoracic and first lumbar vertebra; c/ at three points on the sacrum: above the cranial edge, above the middle, caudal to the cross-section of the gluteus muscle) – the thickness of the fat was measured with a caliper (accuracy of 0.1 cm) (Accud 1601074, Conrad Electronic LLC, Kraków, Poland); weight of skinless trimmed ham (kg); weight of skinless trimmed loin (kg).

The loin was cut between the last thoracic vertebra and the first lumbar vertebra. Then, a complete cross-sectional outline was made on the cephalad plane (on foil or wax paper), the basis for planimetry of the loin's eye surface. The following data was obtained: loin eye thickness (cm); loin eye height (cm); loin eye area (cm^2), using planimeter HA-301 (Haff, Germany); carcass leanness (%) was evaluated according to the formula:

$$Y = (1.745x_1+0.836x_2+0.157x_3-1.884)/\text{chilled cold carcass weight};$$

where: y – calculated meat content (%); x_1 – rump ham without skin and bacon, (kg); x_2 – tenderloin without bacon + tenderloin (kg); x_3 – double width (A) + height (B) of the tenderloin eye (2A + B) (cm).

Meat quality evaluation

Samples (*longissimus lumborum* and *semimembranosus*) for meat quality were taken 24 h after slaughter. To determine the content of intramural fat in the meat, to assess the colour of the meat, and to determine its water absorption, a 200 g meat sample was taken from the section of the last three thoracic vertebrae of *musculus longissimus lumborum*. To determine the texture of the meat, 300 g samples of *longissimus lumborum* were taken from the area of subsequent thoracic vertebrae and the entire *semimembranosus* muscle. 300 g samples were vacuum packed and frozen at −20 °C. The following traits were determined: colour parameters (L, a, b) – meat colour was assessed in fresh samples (24 h after slaughter) using the *L*, a*,* b* system with a portable colourimeter (Minolta CR-310, Minolta camera Co. Ltd, Osaka, Japan) with tracking optics. Blooming time was 45 min. Meat acidity was measured with a Matthäus pH Star pH-meter twice: 45 min after slaughter (pH_{45}) and after 24 h of cooling at +4°C (pH_{24}).

Intramuscular fat (IMF) content (%) of meat samples was determined according to the NIRS methods, following the AOAC Official Method 2007.04 procedure. Cooking loss (%) was estimated based on the difference between the weight of the sample before and after cooking and cooling.

Texture of meat was analysed after 2-month frozen sample storage (−20 °C), at room temperature using a TA-XT plus Texture Analyser (Stable Micro Systems, Godalming, Great Britain). The Warner-Bratzler shear force (WBS; shear force and shear energy) was determined on cooked meat. Texture assessments were performed 24 h after cooking on one date for all samples (in one day) by the same people. Data were collected and processed using the Texture Expert ver. 1.20 software. The fallowing texture traits were evaluated: firmness – maximum cutting force and toughness – so-called strength.

Texture profile analyses with a roller attachment and the use of the double crush test (TPA): hardness – the force required to achieve a specific deformation; springiness – speed of return from a deformed state to the initial state; cohesiveness – the strength of internal bonds forming the product framework; chewiness – the energy required to break down – chew solid products; this is a calculable parameter related to hardness, cohesion, and elasticity and resilience – the ability of the product to return to its initial form after the first compression.

Statistical analysis

Data were gathered and analyzed in an MS Excel spreadsheet, and next subjected to statistical analysis using the SAS 9.4 software package (SAS, 2019). The data were analysed, taking into account the slaughter date and cooking batch as an additional random effects, which, however, turned out to be statistically insignificant. Therefore, these factors was not included in the statistical model. Data for each muscle (*m. longissimus lumborum* and *m. semimembranosus*) were analyzed separately. In order to compare boars a one-way analysis of variance ANOVA was applied. Significance of differences between means was verified using Fisher's test.

Results

General characteristic of fattening, slaughter performance, meat quality and texture parameters of *m. longissimus lumborum* and *semimembranosus*) in Zlotnicka White pigs were shown in Tables 2 and 3.

Among the analysed meat texture characteristics of both tested muscles (Table 3), the greatest variation was observed for hardness and chewiness (CV = 34.69–46.04%). In turn, the lowest variability of the trait was demonstrated in the case of springiness and cohesiveness (average CV = 7.07%).

Table 4 provides a comparison of fattening and slaughter performance traits considering the effect of the boar's line. The shortest time from the beginning of fattening to slaughter was recorded for groups II and III. Among animals from these groups significantly greater daily weight gains were also observed compared to groups I, V and VI. In the case of another trait, i.e. FCR, the lowest value of this trait was observed in pigs from group II. This group differed statistically from group V, where FCR was higher (by about 0.76 kg/kg). The thinnest backfat was produced by progeny from groups III and II. In turn, the greatest subcutaneous fat thickness was observed in pigs from groups V and VI. In the case of ham weight, the highest level was recorded for group III. Significantly lower value of

Table 2. General characteristic of fattening and slaughter performance of Zlotnicka White pigs

Trait	Min.	Max.	Mean	Standard deviation	SEM	Coefficient of variation
Daily weight gain during fattening, g	416	972	702	104	9.9	18.1
Feed consumption per 1 kg weight gain, kg	2.54	4.97	3.36	0.47	0.042	14.1
Cold carcass weight, kg	67.6	82.0	75.1	3.78	0.36	5.04
Cold dressing percentage, %	63.5	79.6	74.9	2.32	0.22	3.03
Mean backfat thickness from 5 measurements, cm[1]	1.10	3.62	2.19	0.49	0.058	23.9
Skinless, trimmed ham weight, kg	6.08	10.16	7.00	0.78	0.071	0.83
Skinless, trimmed loin weight, kg	2.96	6.07	4.48	0.52	0.054	15.0
Loin eye thickness, cm	8.00	11.70	9.81	0.75	0.072	7.46
Loin eye height, cm	4.60	8.20	6.16	0.75	0.077	12.0
Loin eye area, cm^2	31.1	68.8	44.9	6.01	0.57	12.8
Carcass leanness, %	42.7	63.3	53.0	4.14	0.39	8.15

[1] mean of 5 measurements; SEM – standard error of the mean

Table 3. General characteristic of meat quality and texture parameters for Zlotnicka White pigs (*musculus longissimuss lumborum* and *semimembranosus*)

Trait	Min.	Max.	Mean	Standard deviation	SEM	Coefficient of variation
Loin *m. longissimuss lumborum*						
*L**	47.8	64.5	55.3	3.81	0.38	6.24
*a**	13.1	19.6	15.6	1.13	0.11	7.17
*b**	0.40	6.40	2.90	1.31	0.137	38.0
pH^{45}	5.40	6.90	6.20	0.28	4.863	4.56
pH^{24}	5.20	5.80	5.50	0.01	2.019	1.73
IMF, %	0.81	2.31	1.37	0.28	0.033	18.9
cooking loss, %	29.3	37.5	33.3	2.04	0.21	6.05
firmness, N	39.3	114	65.7	15.8	1.59	25.7
toughness, N/s	75.3	246	134	33.7	3.4	26.5
hardness	3.28	15.1	7.51	2.62	0.284	34.9
springiness	0.61	0.84	0.73	0.05	0.014	6.69
cohesiveness	0.54	0.75	0.64	0.05	0.002	7.69
chewiness	1.29	7.16	3.52	1.22	0.128	34.7
resilience	0.20	0.35	0.27	0.03	0.001	10.0
Ham *m. semimembranosus*						
cooking loss, %	23.3	38.3	33.8	2.69	0.27	8.13
firmness, N	34.4	112	68.0	17.4	1.74	25.6
toughness, N/s	69.1	251	143	39.3	3.9	27.6
hardness	1.97	18.6	7.93	3.58	0.364	44.4
springiness	0.53	0.82	0.72	0.05	0.007	6.32
cohesiveness	0.53	0.76	0.64	0.04	0.002	7.61
chewiness	0.77	9.27	3.77	1.80	0.187	46.0
resilience	0.22	0.35	0.28	0.03	0.007	10.4

IMF – intramuscular fat, SEM – standard error of the mean

this trait was found in groups VI and V, as it was by 1.25 kg and 1.08 kg lower, respectively. Measurements taken of loin eye showed the greatest loin eye thickness in animals from group I. In turn, the greatest loin eye height was observed for animals from groups II and III, while it was smallest in pigs from group VI. An advantageous, large loin eye area was recorded for pigs from groups I, II and III. The smallest area of that muscle was found for group VI. For carcass leanness the highest value was observed in pigs from group III, while it was lowest for animals from group VI. The difference between these groups amounted to 5.96 percentage points.

The greatest colour lightness of loin was recorded for meat of fatteners from group IV (Table 5). That group differed significantly in terms of the values for this characteristic from group V. Between the groups differences were also found for the share of the red colour (*a**). In meat from fatteners in group II the lowest share of the red colour was recorded,

Table 4. Comparison of the level of fattening and slaughter performance characteristics of the studied population of Zlotnicka White gilts from different boar lines

Trait	Boar's line						SEM	*P*-value
	Group I (n=40)	Group II (n=13)	Group III (n=14)	Group IV (n=24)	Group V (n=10)	Group VI (n=10)		
The fattening duration, days	108^{bc}	92.3^{a}	92.1^{a}	96.7^{ab}	111^{c}	110^{c}	4.72	0.034
Daily weight gain during fattening, g	677^{b}	771^{a}	785^{a}	711^{ab}	651^{b}	630^{b}	30.5	0.002
Feed consumption per 1 kg weight gain, kg	3.46^{bc}	3.01^{a}	3.03^{ac}	3.42^{bcd}	3.77^{d}	3.31^{abc}	0.852	<0.001
Cold carcass weight, kg	76.7^{a}	75.6^{a}	76.3^{a}	72.0^{b}	73.8^{ab}	75.0^{ab}	0.76	0.017
Cold dressing percentage, %	75.3	75.3	75.2	73.7	74.6	75.4	0.43	0.070
Mean backfat thickness from 5 measurements, cm	2.20^{ab}	1.95^{a}	1.85^{a}	2.24^{ab}	2.48^{b}	2.57^{b}	0.125	<0.001
Weight of skinless trimmed ham, kg	8.17^{ab}	8.09^{ab}	8.47^{a}	7.50^{bc}	7.39^{c}	7.22^{c}	0.142	<0.001
Weight of skinless trimmed loin, kg	4.29	4.72	4.88	4.42	4.21	4.36	0.092	0.154
Loin eye thickness, cm	10.3^{b}	9.16^{a}	9.42^{a}	9.66^{ab}	9.79^{ab}	9.63^{ab}	0.115	0.002
Loin eye height, cm	6.08^{ab}	6.51^{a}	6.75^{a}	6.12^{ab}	6.11^{ab}	5.42^{b}	0.112	0.023
Loin eye area, cm^2	46.9^{a}	46.1^{a}	46.8^{a}	43.3^{ab}	42.4^{ab}	39.6^{b}	1.28	<0.001
Carcass leanness, %	53.1^{abc}	53.7^{ab}	55.6^{a}	53.2^{abc}	50.8^{bc}	49.7^{c}	0.86	0.004

Group I – gilts by a boar from the Asesor 1 line; Group II – gilts by a boar from the Asesor 2 line; Group III – gilts by a boar from the Asesor 3 line; Group IV – gilts by a boar from the Asesor 4 line; Group V – gilts by a boar from the Asesor 5 line; Group VI – gilts by a boar from the Asesor 6 line; ^{abcd} – values within the row with different superscripts are significantly different at $P \leq 0.05$; SEM – standard error of the mean

Table 5. Comparison of carcass quality characteristics of the studied population of Zlotnicka White gilts from different boar lines

Trait	Boar's line						SEM	*P*-value
	Group I	Group II	Group III	Group IV	Group V	Group VI		
Loin *musculus longissimuss lumborum*								
	n = 38	n = 10	n = 14	n = 24	n = 10	n = 10		
*L**	54.7^{ab}	54.6^{ab}	55.1^{ab}	57.3^{a}	52.7^{b}	56.7^{ab}	0.84	0.002
*a**	15.8^{ab}	14.9^{a}	15.5^{ab}	15.2^{b}	16.5^{b}	15.8^{ab}	0.37	0.001
*b**	2.62	2.55	2.83	3.72	2.30	3.04	0.221	0.078
	n = 40	n=13	n=14	n=24	n=8	n=9		
pH^{45}	6.14	6.32	6.17	6.11	6.23	6.12	0.053	0.089
pH^{24}	5.52^{b}	5.56^{b}	5.58^{ab}	5.61^{a}	5.54^{ab}	5.55^{ab}	0.021	<0.001
IMF	1.39	1.32	1.20	1.39	1.50	1.45	0.075	0.190
cooking loss, %	33.4^{ab}	33.3^{ab}	34.5^{a}	32.2^{ab}	32.6^{ab}	32.7^{b}	0.59	<0.001
firmness, N	63.6^{ab}	75.5^{a}	76.4^{a}	56.3^{b}	56.3^{b}	67.8^{ab}	4.08	<0.001
toughness, N/s	128^{ab}	158^{a}	155^{a}	113^{b}	117^{b}	140^{ab}	8.2	<0.001
hardness	7.55	7.21	8.91	6.48	7.63	7.05	0.752	0.059
springiness	0.72	0.74	0.75	0.72	0.72	0.74	0.012	0.091
cohesiveness	0.64	0.65	0.64	0.64	0.64	0.64	0.015	0.210
chewiness	3.52	3.47	4.33	3.11	3.60	3.39	0.340	0.198
resilience	0.28	0.28	0.27	0.27	0.29	0.28	0.011	0.061
Ham *m. semimembranosus*								
	n = 40	n = 12	n = 14	n = 16	n = 7	n = 10		
cooking loss, %	33.9^{ab}	32.7^{ab}	35.4^{a}	34.2^{ab}	33.8^{ab}	32.3^{b}	0.89	0.002
firmness, N	61.7	70.6	70.9	68.3	77.9	78.4	4.28	0.097
toughness, N/s	126^{b}	149^{ab}	156^{ab}	153^{ab}	154^{ab}	166^{a}	9.6	<0.001
hardness	7.03^{b}	7.55^{b}	8.38^{ab}	7.68^{b}	11.9^{a}	8.93^{ab}	1.252	<0.001
springiness	0.72^{ab}	0.74^{ab}	0.73^{ab}	0.70^{b}	0.76^{a}	0.75^{ab}	0.010	<0.001
cohesiveness	0.64	0.64	0.65	0.63	0.64	0.63	0.012	0.064
chewiness	3.34^{b}	3.65^{b}	3.97^{ab}	3.50^{b}	5.90^{a}	4.37^{ab}	0.483	0.006
resilience	0.29	0.27	0.28	0.28	0.27	0.26	0.032	0.082

IMF – intramuscular fat; Group I – gilts by a boar from the Asesor 1 line; Group II – gilts by a boar from the Asesor 2 line; Group III – gilts by a boar from the Asesor 3 line; Group IV – gilts by a boar from the Asesor 4 line; Group V – gilts by a boar from the Asesor 5 line; Group VI – gilts by a boar from the Asesor 6 line; ^{abcd} – values within the row with different superscripts are significantly different at $P \leq 0.05$; SEM – standard error of the mean while for group V the share of this colour was highest. The lowest pH_{24} ($P \leq 0.05$) was recorded for animals from groups I and II. In terms of values of this parameter these groups differed from group IV. The lowest cooking loss was found for loin in group IV, while it was greatest in group III.

The smallest ham cooking loss was recorded for muscles obtained from pigs in group VI (Table 5). It was significantly smaller than that observed for group III. The highest value of toughness was recorded in group VI, while it was lowest in group I. In terms of hardness, groups I and II differed significantly from group V, for which the highest value of this parameter was reported. Statistically significant differences were also observed for springiness and chewiness. For the former trait the highest level was found in group V. In turn, in the case of chewiness the highest value was recorded for group V, whereas it was lowest in group I.

Discussion

This study showed that ZW pigs exhibit average daily weight gains and high feed consumption per 1 kg weight gain. When comparing the results of this study with those obtained for other native pig breeds it may be stated that ZW pigs exhibit lower weight gains and higher feed consumption rates than the Pulawska breed (Piórkowska et al., 2019; Milczarek, 2021). However, they are characterised by a greater weight gain rate than the Zlotnicka Spotted (Szulc et al., 2012b; Szyndler-Nędza et al., 2021), the Lithuanian Indigenous Wattle breed (Razmaitė et al., 2021). For both parameters a significant diversity was observed between the investigated groups of animals. Superior performance was observed in fatteners from group II, in which the highest weight gain rate was recorded at the lowest feed consumption rate. Domański and Maruniewicz (1981) when comparing groups of ZW fatteners being progeny of 12 boars, observed significant differences between the groups. It needs to be stressed that the results of this study differed from those given previously for the ZW breed. Domański et al. (1999) recorded low weight gains. Slightly higher values (484 g) were given by Buczyński et al. (2005). Causes for the discrepancy in these results may be associated with differences concerning feeding intensity of pigs investigated by individual authors. Up to the 1990s feeding of studied ZW pigs was based on feeds prepared on the farms: potatoes, beets, and green forage from legumes with a small addition of concentrates. Extensively fed fatteners showed low daily weight gains at a high consumption of feed (Domański et al., 1999).

Cold dressing percentage for the investigated population was on average 74.88%, at a lack of significant differences between the compared groups. This result was higher than that observed previously for the ZW breed by Domański and Tratwal (1986), who for fatteners slaughtered at a body weight of 90–100 kg recorded dressing percentage of 71.6%. In turn, in a study by Grześkowiak et al. (2009) the value for this parameter for pigs with a slaughter weight of 105 kg was 80.17%. The average backfat thickness (2.19 cm) was similar to the results obtained for ZW pigs by Buczyński et al. (2005). Much greater fatness for the ZW breed was reported by Grześkowiak et al. (2009) and by Domański and Maruniewicz (1981). Between the groups of fatteners coming from different boars significant differences were found in subcutaneous fatness. Similar observations were made by Domański and Tratwal (1986), who also reported differences in backfat thickness between groups of ZW fatteners after different sires. The considerable backfat thickness found in this study was observed in many native breeds, for example: Pulawska (Babicz et al., 2009; Debrecéni et al., 2018), Zlotnicka Spotted (Grześkowiak et al., 2009; Szulc et al., 2012b; Debrecéni et al., 2018), Mangalitsa and Moravka breeds (Migdał et al., 2017; Debrecéni et al., 2018). Previous studies have shown that ZW pigs exhibit suitability for commercial crossbreeding (Ratajszczak, 1986; Strzelecki et al., 2006). Most research has focused on crossbreeding schemes where the ZW breed was the maternal component. However, there are also studies in which Zlotnicka White boars were used for commercial crossbreeding. As Ratajszczak (1986) indicated, the most favorable variant for improving fattening and slaughter traits was the crossbreeding of F1 sows Polish Large White (PLW)/Polish landrace (PL) and PL/PLW with ZW boars. Referring to the results of the research, it, therefore, seems possible to more widely utilize Zlotnicka White boars from lines with the highest levels of fattening and slaughter traits in crossbreeding programs.

Weight of skinless, trimmed ham and loin in the investigated ZW pigs was 7 kg and 4.48 kg, respectively. Differences between the investigated groups of fatteners were observed only in the case of ham. In earlier analyses for the ZW breed a greater ham weight was found (Domański and Maruniewicz, 1981; Domański and Tratwal, 1986; Domański et al., 1996). However, it resulted from a different carcass cutting method. In this study following the SKURTCh methodology the weight of ham was estimated for the muscles without the shank (Różycki and Tyra, 2010). In view of the differences in adopted methodology it may not be definitely stated whether the weight of ham and loin changed compared to the values observed in previous studies. Recorded results indicate that values shown for ZW pigs are lower than those recorded in Poland for other breeds – PL, PLW and Pulawska (Terman et al., 2021).

Meatiness is a highly significant trait, as it to a considerable extent determines the price obtained by the producer when selling fatteners. In this study for the ZW breed mean carcass leanness was 53%. This result is higher than that observed earlier for ZW pigs by Buczyński et al. (2005), where it amounted to 46.73%, and that given by Grześkowiak et al. (2009) at 46.33%. The low average meat content of the animals tested in this study is also characteristic of native pig breeds in other European countries. Examples include Italian breeds: Nero Siciliano, Casertana, and Mora Romagnola (Maiorano et al., 2013). It needs to be stressed here that in the case of meatiness significant differences were found between the analysed groups of animals.

This study investigated selected parameters of meat quality and texture in ZW pigs. In the case of colour parameters the results differed from those previously recorded for the ZW breed. Meat was characterised by a light colour (L^* = 55.62), at a significant variation between the investigated groups. Meat colour lightness in ZW pigs in studies conducted by Grześkowiak et al. (2009) and Migdał et al. (2017) was markedly lower, amounting to 43.88 and 49.54, respectively. The result recorded in this study was comparable to that given by some authors for the Pulawska breed (Piórkowska et al., 2019; Kasprzyk and Bogucka, 2020; Milczarek, 2021). The share of the red colour was high in the entire ZW population, at significant differences in values of this parameter between individual groups of fatteners sired by different boars. Different results were given by Grześkowiak et al. (2009), who observed for the ZW breed the share of the red colour at 6.27. In turn, Migdał et al. (2017) reported a higher value of a^* (14.23); nevertheless, it was lower than that recorded in this study. The last colour parameter analysed here was the share of the yellow colour. Values of this trait also differed from those given for the ZW breed by other authors, who recorded a greater share of the yellow colour in meat coming from ZW pigs (Grześkowiak et al., 2009; Migdał et al., 2017).

In relation to acidification mean pH_{45} and pH_{24} were typical of meat free from quality defects (Sieczkowska et al., 2019). These results confirmed earlier observations concerning appropriate meat acidification in the ZW breed after slaughter (Domański and Buczyński, 1995; Grześkowiak et al., 2009). Appropriate meat acidification is also observed for other native pig breeds, including the Zlotnicka Spotted (Grześkowiak et al., 2009; Szulc et al., 2012a and 2012b; Debreceni et al., 2018), Pulawska (Grześkowiak et al., 2009; Piórkowska et al., 2019; Milczarek, 2021), Mangalitsa and Moravka breeds (Migdał et al., 2017; Radović et al., 2017).

The IMF level for loin was on average 1.37%, with no significant differences observed in values of this trait between the investigated groups of animals. It was lower than that reported for the ZW breed by other authors (Grześkowiak et al., 2009; Migdał et al., 2017). Differences in the level of IMF are probably a consequence of different feeding regimes adopted for fatteners analysed by individual authors, as well as variations in slaughter weight of animals. It needs to be added here that on the one hand IMF for the ZW breed is lower than that recorded for the Zlotnicka Spotted breed (Szyndler-Nędza et al., 2021), or the Pulawska breed (Babicz et al., 2009; Kasprzyk and Bogucka, 2020). On the other hand, IMF content exceeded 1%. According to Schwörer et al. (1999) such a share of IMF should have no negative effect on meat quality, which was confirmed in this study.

Another trait included in the analyses was the volume of cooking loss measured both for loin and ham. Recorded values were higher than those reported previously for the ZW breed (Domański and Maruniewicz, 1981; Domański and Tratwal, 1986; Grześkowiak et al., 2009). In turn, a much lower volume of cooking loss (22.76%) for ZW fatteners was recorded by Migdał et al., 2017). It needs to be stressed here that in this study statistical differences were found between the groups in terms of cooking loss for loin and ham. Similar observations were made by Domański and Maruniewicz (1981), as ZW pigs investigated by those authors coming after different sires showed significant diversity in terms of this trait for loin.

Many studies have shown that meat texture is affected by breed, sex, body weight, feeding and type of muscle (Migdał et al., 2005; Florowski et al., 2006; Migdał et al., 2006; 2020). Values of muscle texture parameters evaluated in this study differed from those reported for other breeds. Firmness and toughness showed lower values than those given for the PL and PLW breeds by

Terman et al. (2021) both in the case of loin and ham. In turn, the value of firmness observed for loin (65.74) was comparable to that reported by those authors for the native Pulawska breed (69.4–75.4) (Terman et al., 2021). Also, Polasik et al. (2018) recorded higher values of firmness and toughness for loin from fatteners of the PL, PLW, as well as Pulawska breeds. Obtained results show that meat of ZW pigs is characterised by the levels of the abovementioned parameters advantageous both for meat processors and consumers.

Pork is perceived as a very delicate and very tender meat when hardness amounts to 4–5 kg/cm^2, while it is considered very hard, of low tenderness at 15 kg/m^2 (Kołczak, 2007). The mean values obtained in this study, indicated that meat of ZW pigs is tender. For this parameter statistical differences were recorded between the groups of animals in the case of ham. The result recorded in this study was more advantageous in terms of meat processability compared to those obtained for such breeds as PL, PLW and Pietrain for *m. longissimuss lumborum* (Polasik et al., 2018; Terman et al., 2021). In turn, it was less advantageous than that reported for the Pulawska breed (Polasik et al., 2018; Terman et al., 2021).

The value of springiness for loin (0.73) was comparable to that reported by Terman et al. (2021) for PLW (0.72–0.73) and Polasik et al. (2018) for the LW breed (0.71–0.73). In contrast, it was higher than that found in Pulawska pigs (Polasik et al., 2018; Terman et al., 2021). Significant differences in values of this characteristic between the investigated groups were recorded only in the case of ham. No such differences were observed for another of the analysed parameters, i.e. cohesiveness. The value for this characteristic showing strength of the internal bonds constituting the stroma of the product, was similar to that given for the Pulawska breed and lower than those for the PL and PLW breeds (Polasik et al., 2018; Terman et al., 2021).

This study showed that the group had a significant effect on chewiness. The highest level was recorded in meat obtained from fatteners from group V both in the case of loin and ham. It may possibly be connected with the slightly longer fattening period for fatteners coming from this crossing variant, as well as slightly lower daily weight gains and lower leanness. A relatively high standard deviation in this group (boar V) needs to be stressed in the case of the first two traits, which may indicate high individual variability and may hinder reliable inference concerning the other quality attributes, particularly concerning divergent values for meat tenderness parameters. The mean value of chewiness for loin in this study was higher than that given for the Pul breed by Terman et al. (2021) and Polasik (2018). In turn, for ham chewiness a lower value was obtained than that reported for the Puławska, PL and PLW breeds (Terman et al., 2021).

The last of the evaluated traits was resilience, describing the capacity of meat to return to the initial state after the first compression. No differences for this parameter were observed between the investigated groups. The obtained value was comparable to those given for the Pulawska breed in a study by Terman et al. (2021) and by Polasik et al. (2018). In turn, it exceeded that reported by those authors for the PL and PLW breeds (Polasik et al., 2018; Terman et al., 2021). Different results were presented by Migdał et al. (2020), who observed lower levels of resilience for the PL, PLW, Pietrain, Duroc, as well as Pulawska breeds.

Notably, native pig breeds are used in commercial crossbreeding to improve meat quality traits. Regarding the ZW breed, most studies have focused on scenarios where this breed served as the maternal component (Grześkowiak et al., 2006). In the available literature, there is only one study in which the ZW breed was used as the paternal component (Ratajszczak et al., 1978). Clear trends toward improved meat quality were observed in crossbreeds of F1 sows (PLW/PL and PL/PLW) with ZW boars. Considering the variation in meat quality traits among the boar lines we studied, it seems reasonable to expand research to include an evaluation of the crossbreeding suitability of individual lines for enhancing meat quality parameters in commercial production.

Conclusions

Obtained results show that for over 70 years of breeding Zlotnicka White (ZW) pigs have not changed in terms of levels of investigated parameters, while maintaining variability within the breed. It was shown that ZW pigs exhibit an average daily weight gain rate, high feed conversion ratio, considerable backfat thickness and low meatiness. For values of these traits significant differences were recorded between groups. Meat was characterised by colour lightness and a considerable share of the red colour. The observed acidification level was typical of high meat quality. In turn, the intramuscular fat was lower than that reported previously for this breed, whereas cooking loss was slightly higher.

For muscle texture traits based on the obtained results in most cases no statistically significant effect of the boar was confirmed for the investigated characteristics. An exception in this respect was found for significant differences in chewiness both for *m. longissimuss lumborum* and *semimembranosus.* Thus, no definite boar effect was shown for the texture parameters of tested meat, which underlines justification for further studies on meat from fatteners after selected boars. However, it needs to be stressed that all the investigated groups exhibited desirable meat texture traits, typical of pork from native breeds. The offspring of boars from the Asesor 2 and 3 lines showed higher values of slaughter and fattening traits while maintaining the meat's excellent quality and technological usability. As mentioned earlier, the issue of using ZW boars for commercial crossbreeding has been presented so far only in one scientific paper, many years ago. Therefore, the results seem to be an excellent reference point (contribution) for conducting further analyses in this area. As the studies have shown, it is worth focusing precisely on using boars from the Asesor 2 and 3 lines.

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Conflict of interest

The Authors declare that there is no conflict of interest.

References

Babicz M., Kamyk P., Stasiak A., Pastwa M., 2009. Opportunities to use Puławska pigs for heavy fattener production. Ann. Anim. Sci. 9, 259–268

Benito J., Vázquez C., Menaya C., Ferrera J.L., García-Casco J., Silió L., Rodrigáñez J., Rodríguez M.C., 2000. Evaluation of the productive parameters in different strains of Iberian pig. In: J.A. Almeida, J. Tirapicos Nunes J. (Editors). Tradition and innovation in Mediterranean pig production. Zaragoza: CIHEAM, Options Méditerranéennes: Série A. Séminaires Méditerranéens 41, 113–121

Buczyński J.T., Panek A., Luciński P., Skrzypczak E., Szulc K., 2005. The effect of genotype on fattening and slaughter performance in pigs. Ann. Anim. Sci., Suppl. 1, 11–15

Debrecéni O., Lípová P., Bučko O., Cebulska A., Kapelański W., 2018. Effect of pig genotype from Slovak and Polish breeds on meat quality. Arch. Anim. Breed. 61, 99–107, https://doi.org/10.5194/aab-61-99-2018

Domański J., Buczyński J., 1995. Zlotnicka White pigs as meat-and-ham slaughter material (in Polish). Rocz. AR w Poznaniu, CCLXXII, Zoot, 33–48

Domański J., Łyczyński A., Stanisławski D., Rzosińska E., Runowska G., Pietrzak M., 1999. Boars and mating strategies in shaping meatiness and fatness traits in Zlotnicka White pig carcasses (in Polish). Rocz. AR w Poznaniu, CCCXIX, Zoot. 51, 89–113

Domański J., Maruniewicz W., 1981. Assessment of slaughter value in Zlotnicka White pig offspring as a criterion for selection and breeding towards the development of a ham-type pig (in Polish). Rocz. AR w Poznaniu, CXXX, Zoot., 25–39

Domański J., Ratajszczak M., Stanisławski D., 1996. Development of slaughter traits in Zlotnicka White pigs in Sielinko from 1983 to 1989 (in Polish). Rocz. AR w Poznaniu, CCLXXXIX, Zoot., 48, cz.II, 89–103

Domański T., Tratwal R., 1986. The relationship between pre-slaughter body weight and carcass quality in meat-and-ham fatteners of the Zlotnicka White breed. Rocz. AR w Poznaniu, CLXXVI, Zoot., 21–38

Florowski T., Pisula A., Słowiński M., Orzechowska B., 2006. Processing suitability of pork from different breeds reared in Poland. Acta Sci. Pol. Technol. Aliment. 5, 55–64, https://www.food.actapol.net/pub/5_2_2006.pdf

Grześkowiak E., Borys A., Borzuta K., Buczyński J. T., Lisiak D., 2009. Slaughter value, meat quality and backfat fatty acid profile in Zlotnicka White and Zlotnicka Spotted fatteners. Anim. Sci. Pap. Rep. 27, 115–125

Grześkowiak E., Borzuta K., Strzelecki J., Buczyński J.T., Borys A., Lisiak D., Janiszewski P., 2006. Effect of crossing White Zlotnicka and Polish Large White Pigs on the quality of culinary meat and raw smoked loin. Ann. Anim. Sci, Suppl. 2/1, 267–270

Kasprzyk A., Bogucka J., 2020. Meat quality of Pulawska breed pigs and image of longissimus lumborum muscle microstructure compared to commercial DanBred and Naima hybrids. Arch. Anim. Breed. 63, 293–301, https://doi.org/10.5194/aab-63-293-2020

Kołczak T., 2007. Meat tenderness (in Polish). Gospodarka Mięsna 11, 8–11

Maiorano G., Gambacorta M., Tavaniello S., D'Andrea M., Stefanon B., Pilla F., 2013. Growth, carcass and meat quality of Casertana, Italian Large White and Duroc x (Landrace x Italian Large White) pigs reared outdoors. Ital. J. Anim. Sci. 12, e69, https://doi.org/10.4081/ijas.2013.e69

Migdał W., Orzechowska B., Różycki M., Tyra M., Wojtysiak D., Duda I., 2006. Chemical composition and texture parameters of loin from Polish Landrace, Polish Large White and Pietrain fatteners. Ann. Anim. Sci., Suppl 2, 375–378

Migdał W., Radović Č., Živković V., et al., 2017. Quality of meat from native pigs. Proceedings of the 11th International Symposium Modern Trends in Livestock Production, Belgrade, Serbia, October 11–13, 2017, 189–198

Migdał W., Różycki M., Mucha A., et al., 2020. Meat texture profile and cutting strength analyses of pork depending on breed and age. Ann. Anim. Sci. 20, 677–692, https://doi.org/10.2478/aoas-2019-0085

Milczarek A., 2021. Carcass composition and quality of meat of Pulawska and Pulawska x PLW crossbred pigs fed rations with naked oats. Animals 11, 3342, https://doi.org/10.3390/ani11123342

Ministerstwo Rolnictwa i Rozwoju Wsi. Departament Rynków Rolnych i Transformacji Energetycznej Obszarów Wiejskich Wydział Informacji Rynkowej. Available online: https://www.gov.pl/web/rolnictwo/rynek-porky---notowania-za-okres-26122022---01012023-r (accessed 13 January 2024)

Piórkowska K., Żukowski K., Tyra M., Szyndler-Nędza M., Szulc K., Skrzypczak E., Ropka-Molik K., 2019. The pituitary transcriptional response related to feed conversion in pigs. Genes 10, 712, https://doi.org/10.3390/genes10090712

Polasik D., Tyra M., Szyndler-Nędza M., Żak G., Lambert B., Terman A., 2018. Association of miR-208b polymorphism with meat quality traits and texture parameters in pigs. Czech J. Anim. Sci. 63, 435–442, https://doi.org/10.17221/31/2018-CJAS

Radović Č., Petrović M., Parunović N., Radojkivić D., Savić R., Stanišić N., Gogić M., 2017. Carcass and pork quality traits of indigenous pure breeds (Mangalitza, Moravka) and their crossbreeds. Indian J. Anim. Res. 51, 371–376, https://doi.org/10.18805/ijar.7496

Ratajszczak M., 1986. Suitability of Zlotnicka pigs for commercial crossbreeding. Trzoda chlewna 24, 9–11

Ratajszczak M., Domański J., Maruniewicz W., 1978. Results of bi- and tri-breed crossbreeding of Polish Large White, Polish White, and Zlotnicka White. Part III. Meat and backfat quality (in Polish). PTPN Wydziału Nauk Rolniczych i Leśnych, Prace Komisji Nauk Rolniczych i Komisji Nauk Leśnych, XLV, 237–246

Razmaitė V., Juška R., Leikus R., Jatkauskienė V., 2021. Pork quality of two Lithuanian breeds: Effects of breed, gender and feeding regimen. Animals 11, 1103, https://doi.org/10.3390/ani11041103

Roberts M.M., Perkins S.D., Anderson B.L., Sawyer J.T., Brandebourg T.D., 2023. Characterization of growth performance, pork quality, and body composition in Mangalica Pigs. Foods 12, 554, https://doi.org/10.3390/foods12030554

Różycki M., Tyra M., 2010. Methodology for assessing fattening and slaughter value of pigs conducted at the Pig Slaughter Utility Control Stations (SKURTCh). The state of breeding and evaluation results for pigs in 2009 (in Polish). Wydanie wł. IZ PIB ISSN 0239-5096. XXVIII, 93–117

SAS, 2019. Software package. Version 9.4. Institute Inc., Cary, NC

Schwörer D., Hofer A., Lorenz D., Rebsamen A., 1999. Selection progress of intramuscular fat in Swiss pig production. Conference paper on quality of meat and fat in pigs as affected by genetics and nutrition. EAAP Zurich, Switzerland, August 25, 69–72, https://doi.org/10.3920/9789086865048_008

Sieczkowska H., Nurzyńska A., Tarczyński K., Zybert A., Krzęcio-Nieczyporuk E., Antosik K., 2019. The frequency of occurrence of meat quality classes in fatteners from mass breeding herds (in Polish). Rocz. Nauk. PTZ, 15, 31–38, https://doi.org/10.5604/01.3001.0013.5063

Strzelecki J., Borzuta K., Grześkowiak E., Janiszewski P., Lisiak D., Buczyński J.T., 2006. Effect of cressbreeding Zlotnicka White pigs on carcass slaughter value. Ann. Anim. Sci., Suppl. 2/1, 287–290

Szulc K., Lisiak D., Grześkowiak E., Nowaczewski S., 2012a. The influence of cross-breeding Zlotnicka Spotted native breed sows with boars of Duroc and Polish Large White (PLW) breeds on meat quality. Afr. J. Biotechnol. 11, 4471–4477, https://doi.org/10.5897/AJB11.3504

Szulc K., Skrzypczak E., Buczyński J. T., Stanisławski D., Jankowska-Mąkosa A., Knecht D., 2012b. Evaluation of fattening and slaughter performance and determination of meat quality in Zlotnicka Spotted pigs and their crosses with the Duroc breed. Czech J. Anim. Sci. 57, 95–107, https://doi.org/10.17221/5561-CJAS

Szyndler-Nędza M., Świątkiewicz M., Migdał Ł., Migdał W., 2021. The quality and health-promoting value of meat from pigs of the native breed as the effect of extensive feeding with acorns. Animals 11, 789, https://doi.org/10.3390/ani11030789

Terman A., Woźniak-Męch K., Korpal K., Polasik D., Tyra M., Szyndler-Nędza M., Żak G., Rybarczyk A., Dybus A., 2021. Association between ATP citrate lyase (ACLY) gene polymorphism and fattening, slaughter and pork quality traits in Polish pigs. Ann. Anim. Sci. 21, 1301–1313, https://doi.org/10.2478/aoas-2021-0032

Waraczewski R., Bartoń M., Stasiak D.M., Sołowiej B.G., 2023. Long-matured cured meats from Poland and Europe compared - An overview. Meat Sci. 206, 109336, https://doi.org/10.3409/fb64_3.197