# Evaluation of fattening and slaughter performance and determination of meat quality in Złotnicka Spotted pigs and their crosses with the Duroc breed

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**ABSTRACT**: The study aimed at an evaluation of fattening and slaughter performance as well as meat quality of the native Złotnicka Spotted (ZS) pigs and its crosses with Duroc pigs. The experimental material comprised 60 fatteners, divided into three genetic groups of 20 animals (100% ZS, 75% ZS and 50% ZS). The specific character of conservative breeding results in low values of fattening and slaughter performance traits observed in ZS breed. Among the analysed groups, animals with 100% share of ZS genes in their genotype were characterised by low daily weight gains (0.59 kg), considerable backfat thickness (34.96 mm), slight muscle thickness (48.05 mm), and low leanness (41.83%). These parameters were higher in both groups of crosses. Differences between the 100% ZS group and the 50% ZS group were significant for backfat thickness and highly significant for leanness. Acidity and colour parameters analysis showed that meat from all the genetic groups analysed was characterised by a good quality. The highest $pH_{45}$ values were in the 75% ZS group, and meat from this group had the darkest colour ($L^*$ = 49.73) and the highest red colour share ($a^*$ = 5.11). Statistical analyses showed that ZS breed retained its original traits through the years of breeding. It was confirmed that meat of Złotnicka Spotted breed is characterised by excellent quality. The results indicate that ZS and Duroc breeds crossing improves fattening and slaughter performance, while maintaining good meat quality in their crosses. Results of this study may also be used by breeders. They indicate that crosses of both the breeds kept in extensive breeding may be successfully used in high quality meat production. Pork from such animals may be a raw material for market niche production, such as regional products. The use of meat from crosses in meat processing may improve both quality of the processed products and efficiency of production based on the native Złotnicka Spotted breed.

**Keywords**: native pig; slaughter and carcass traits; meat quality; correlations

Breeding of pigs and dairy cattle are two main branches of animal production in the Czech Republic (CR) and throughout the entire European Union (EU). In the longer time perspective, by the year 2013 the consumption of pork in the EU is expected to increase by 3–4% (Kvapilík et al., 2009). Also in Poland, due to the national culinary traditions, pork is the staple meat. The increase in pork consumption in the EU was obviously affected by the introduction of objective methods of porcine carcass classification in the 1980's (Vítek et al., 2008). This has contributed to an increased leanness of pigs.

In high-meat producing pig breeds a negative correlation is frequently observed between lean content and meat quality traits (Wood et al., 1999; Newcom et al., 2004; Buczyński et al., 2005; Świtoński et al., 2010). At the same time the consumers are increasingly more often searching for good quality products. This forces meat processing plants to search for adequate slaughter material. In many countries such material is provided by native breeds (Barone et al., 2003; Franci and Pugliese, 2007; Serrano et al., 2008).

In Poland, one of the three native pig breeds is the Złotnicka Spotted breed (Krupiński, 2008). The base population for the Złotnicka Spotted pigs (ZS) comprised animals in the type of the native lop-eared pigs with evidently primitive traits (Alexandrowicz et al., 1954). Research on native breeds was initiated in Poland immediately after WWII. In 1984 the breed was covered by conservative breeding (Ratajszczak, 1986; Ratajszczak and Buczyński, 1997).

From the first years of this breeding the ZS pigs exhibited low daily weight gains, considerable feed conversion rates as well as high fatness and low leanness (Alexandrowicz et al., 1954). As it was shown by the investigations conducted in recent years (Buczyński et al., 2005; Kapelański et al., 2006; Szulc et al., 2006a, b), the situation has not changed.

An advantageous trait of breed is the excellent quality of meat (Janicki and Kortz, 1973; Florowski et al., 2005; Grześkowiak et al., 2009). *In situ* protection provided for this breed (Hiemstra and Woelders, 2007) facilitates its utilisation in commercial production. The Złotnicka Spotted (ZS) breed, as most native breeds, is characterised by high fatness and low leanness (Buczyński et al., 2001; Szulc et al., 2006b). Improved productivity may be obtained by crossing (Buczyński et al., 1997; Szulc et al., 2006b). In order to retain quality attributes of meat coming from crosses it is essential to appropriately select the breeds. Due to the advantageous quality parameters of its meat the Duroc breed may be used in commercial crossing with the Złotnicka breed (Brewer et al., 2002; Pommier et al., 2004; Florowski et al., 2006).

The aim of this study was to evaluate fattening and slaughter value as well as meat quality of Złotnicka Spotted pigs and their crosses with the Duroc breed.

## MATERIAL AND METHODS

The experimental material consisted of 60 fatteners, divided into three genetic groups with 20 animals in each. The first group comprised fatteners of the Złotnicka Spotted breed (100% ZS). The second group consisted of crosses with a 75% share of the Złotnicka Spotted genes in their genotype (75% ZS). They were produced by crossing Złotnicka Spotted sows with crossbred boars of the Złotnicka Spotted and Duroc breeds. The third group comprised crossbred fatteners with a 50% share of the Złotnicka Spotted genes in their genotype (50% ZS), produced by crossing Złotnicka Spotted sows with Duroc boars. In all these groups the ratio of gilts to barrows was 1:1.

Fatteners within each group were kept in collective pens and fed *ad libitum*. Feeding as well as hygienic conditions were identical for all the animal groups and met the requirements of breeding and production standards. Fattening was conducted from a body weight of approx. 30 kg to 115–120 kg and it was divided into two stages. Animals were weighed twice, at birth and at slaughter.

Daily weight gains (ADG) in kg and age at slaughter (AS) in days were recorded. Slaughter was performed in accordance with the technology binding in meat industry using the electric shock stunning method. Carcass quality was classified using the loin method. Measurements were taken on left, warm, hanging half-carcasses using the IM03 device certified for use by the European Commission Decision (2005/683/EC). The IM03 apparatus is equipped in the needle-optical plummet (Single Line Scanner SLS01) with diameter of 7 mm. The plummet consists of contact sensors of the picture (CIS) and also green electro-luminescent diodes. The measurement sector ranges from 0 to 132 mm. Lean meat content in the carcass (LM) is calculated in % according to the formula

$$y = 45.07537 - 0.52724x_1 + 0.31380x_2$$

where:

$y$ = estimated content (in %) of lean meat in the carcass

$x_1$ = thickness of the back fat FT (inclusively with skin) in mm measured 6 cm from central line, between the third and the fourth ribs from the end

$x_2$ = thickness of the muscle MT in mm, measured in the same time and at the same place as $x_1$

The above formula regards the carcasses of weights from 60 to 120 kg. The parameters evaluated were carcass weight (CW) (in kg) and dressing percentage (DP) (in %). Cooled half-carcasses were dissected into primal joints using the method adopted in the meat industry in accordance with the Polish Standard (PN-86-A/82002). Weight and percentages of the following primal joints were determined: the weight of ham (WH) in kg and the share of ham (SH) in %, the weight of loin (WL) in kg and the share of loin (SL) in % as well as the weight of shoulder (WS) in kg and the share of shoulder (SS) in %.

In the *longissimus dorsi* (LD) muscle at the last rib, pH was measured 45 min after slaughter ($pH_{45}$) and 24 h after slaughter ($pH_{24}$) using a Radiometer PHM 80 portable pH-meter (Radiometer, Copenhagen, Denmark) with a coupled electrode. Samples were collected from the lumbar section of the LD muscle for colour analysis performed after 45 min blooming time using a Minolta Chroma Meter CR–300 camera (Minolta, Tokyo, Japan), determining the following colour parameters ($colour_{45}$): $L^*$ = lightness, $a^*$ = the share of the red colour, and $b^*$ = the share of the yellow colour.

In order to estimate the significance of the difference between the experimental groups, the two-way analysis of variance was applied according to the following model:

$$y_{ijk} = \mu + r_i + p_j + e_{ijk}$$

where:

$y_{ijk}$ = phenotypic value of a trait
$\mu$ = grand mean
$r_i$ = fixed effect of the $i^{th}$ genotype (1 = 100% ZS, 2 = 75% ZS, 3 = 50% ZS)
$p_j$ = fixed effect of the $j^{th}$ sex (1 = barrows, 2 = gilts)
$e_{ijk}$ = effect of random error

A detailed comparison of mean squares was performed for individual objects with the use of the LSMEANS test. Dependencies between fattening and slaughter performance traits were expressed as Pearson's correlations according to PROC CORR Pearson procedure. Statistical calculations were performed using the SAS statistical software package (SAS, 2009).

## RESULTS AND DISCUSSION

Due to the specific character of conservative breeding, including practically no selection, low values of fattening and slaughter performance traits are observed in European native pig breeds such as Cinta Senese and Nero Siciliano in Italy (Acciaioli et al., 2002; Pugliese et al., 2003) or the Spanish Iberian breed (Serrano et al., 2008). This has been confirmed in the results of our studies, presented in Table 1.

Daily weight gain recorded in animals from the 100% ZS group was only 0.59 kg. Slightly higher weight gains were found in crossbred animals. In terms of the analysed parameter in animals with a 75% and a 50% share of ZS genes in their genotypes this trait was observed to show similar values amounting to 0.64 and 0.62 kg, respectively. Between the investigated groups, the observed differences were not statistically significant. The lowest age at slaughter was found for the 50% ZS group which was approximately 185 days. In terms of this trait crossbred pigs with 50% ZS differed significantly from purebred animals (100% ZS group), in which age at slaughter was approximately 202 days.

Crosses with a 50% share of Duroc genes in their genotype had significantly thinner backfat than 100% ZS animals. In crosses from both groups higher muscle thickness was found in comparison to purebred animals; however, these differences were not statistically significant.

As it was mentioned above, ZS pigs are characterised by low lean meat content in the carcass. According to different authors it ranges from approx. 44 to 49% (Kapelański et al., 2006; Szulc et al., 2006b). Similarly, leanness found in this study for 100% ZS animals was low (41.83%). Many authors indicated that crossing of ZS sows with boars of high meat-producing breeds results in an increase of the lean meat content and a reduced carcass fatness in crossbred animals (Buczyński et al., 1997, 2001; Szulc et al., 2006b). In this study it was found that 75% ZS and 50% ZS crossbred animals had higher lean meat contents in the carcasses than animals from the 100% ZS group. However, only statistically significant difference was found between the pig carcasses from the 100% ZS (41.83%) and 50% ZS (45.89%) group.

Positive results of the use of the Duroc breed as a paternal component in crossing with sows of native breeds were recorded by Carrapiso et al. (2003) and Tejeda et al. (2002). They observed that crossing of Duroc boars with Iberian sows reduces production costs and thus produced fatteners are characterised by higher lean meat contents in the carcass and a higher share of primal joints in the carcass. The data presented in Table 1 demonstrated the significantly

Table 1. The effect of the genetic group on fattening and slaughter performance traits as well as meat quality (*musculus longissimus dorsi*) for both sexes

| Traits | Group | | | | | |
|---|---|---|---|---|---|---|
| | 100% ZS | | 75% ZS | | 50% ZS | |
| | LSM | SE | LSM | SE | LSM | SE |
| Lifetime weight gain (kg) | 0.59 | 0.01 | 0.64 | 0.02 | 0.62 | 0.01 |
| Age at slaughter (days) | 202.55$^{a}$ | 4.82 | 193.70 | 5.23 | 185.20$^{b}$ | 4.95 |
| Weight at slaughter (kg) | 119.20 | 1.79 | 122.37$^{A}$ | 1.95 | 114.10$^{B}$ | 1.84 |
| Carcass weight (kg) | 93.00 | 1.28 | 90.34 | 1.38 | 90.11 | 1.31 |
| Dressing percentage (%) | 78.20$^{a}$ | 1.13 | 73.99$^{Ab}$ | 1.23 | 79.20$^{B}$ | 1.16 |
| Backfat thickness (mm) | 34.96$^{a}$ | 1.74 | 34.56 | 1.89 | 29.67$^{b}$ | 1.78 |
| Muscle thickness (mm) | 48.05 | 1.58 | 50.34 | 1.71 | 52.35 | 1.62 |
| Lean meat content (%) | 41.83$^{A}$ | 1.06 | 42.66$^{a}$ | 1.15 | 45.89$^{Bb}$ | 1.09 |
| Weight of ham (kg) | 10.21 | 0.21 | 10.42$^{a}$ | 0.23 | 9.79$^{b}$ | 0.22 |
| Weight of loin (kg) | 3.52 | 0.11 | 3.67 | 0.12 | 3.62 | 0.11 |
| Weight of shoulder (kg) | 5.26$^{a}$ | 0.11 | 5.62$^{Ab}$ | 0.12 | 5.05$^{B}$ | 0.11 |
| Share of ham (%) | 10.98 | 0.21 | 11.54 | 0.23 | 10.89 | 0.22 |
| Share of loin (%) | 3.78 | 0.09 | 4.06 | 0.10 | 4.01 | 0.09 |
| Share of shoulder (%) | 5.67$^{A}$ | 0.13 | 6.22$^{B}$ | 0.14 | 5.63$^{A}$ | 0.13 |
| $pH_{45}$ | 6.15 | 0.08 | 6.19 | 0.08 | 6.18 | 0.08 |
| $pH_{24}$ | 5.42$^{a}$ | 0.03 | 5.44 | 0.03 | 5.51$^{b}$ | 0.03 |
| Colour$_{45}$ $L^*$ | 50.46 | 1.74 | 49.73 | 1.74 | 51.25 | 1.74 |
| $a^*$ | 4.06 | 0.49 | 5.11 | 0.49 | 4.47 | 0.49 |
| $b^*$ | 7.89 | 0.66 | 8.03 | 0.66 | 8.19 | 0.66 |

100% ZS = Złotnicka Spotted/Złotnicka Spotted, 75% ZS = Złotnicka Spotted × Złotnicka Spotted/Duroc, 50% ZS = Złotnicka Spotted/Duroc, LSM = least square mean, SE = standard error

$^{A,B}P \leq 0.01$, $^{a,b}P \leq 0.05$

higher ham mass in 75% ZS animals (10.42 kg) in comparison with 50% ZS crosses (9.79 kg).

The highest weights of the ham, loin and shoulder were recorded for carcasses obtained from 75% ZS group animals. The average weight of the ham obtained for this genetic group stated 10.42 kg. With regard to this trait the 75% ZS group differed statistically significantly from 50% ZS group. However, the average shoulder weight observed for carcasses of 75% ZS group stated 5.62 kg. This group differed highly significantly from group 50% ZS and also significantly from 100% ZS group.

Good meat quality in pigs from native breeds, including Złotnicka Spotted, is confirmed by studies conducted by many authors (Pugliese et al., 2004; Franci et al., 2005; Florowski et al., 2006; Kapelański et al., 2006; Serrano et al., 2008). Złotnicka Spotted pigs are lard-type animals (Ratajszczak and Buczyński, 1997; Buczyński et al., 2001). Probably the relatively slow growth and late somatic maturity have an advantageous effect on the muscle tissue (Kapelański et al., 2006). Analysis of acidity and colour parameters presented in Table 1 indicates that meat produced by animals from all the investigated genetic groups was characterised by good quality.

For all the groups the $pH_{45}$ and $pH_{24}$ values were typical of normal meat, with no quality defects. Slightly higher values of $pH_{45}$ than those recorded in this study were reported for meat of ZS pigs by

Table 2. The effect of the genetic group on fattening and slaughter performance traits as well as meat quality (*musculus longissimus dorsi*) for barrows

| Traits | Group | | | | | |
|---|---|---|---|---|---|---|
| | 100% ZS | | 75% ZS | | 50% ZS | |
| | LSM | SE | LSM | SE | LSM | SE |
| Lifetime weight gain (kg) | $0.57^{a}$ | 0.03 | $0.64^{b}$ | 0.02 | 0.62 | 0.01 |
| Age at slaughter (days) | 204.60 | 9.37 | 190.60 | 6.62 | 185.20 | 7.63 |
| Weight at slaughter (kg) | 116.60 | 4.11 | 122.40 | 2.91 | 114.00 | 2.90 |
| Carcass weight (kg) | 94.00 | 2.40 | 89.50 | 1.76 | 90.10 | 2.49 |
| Dressing percentage (%) | $80.92^{A}$ | 1.79 | $73.19^{B}$ | 1.24 | $79.19^{A}$ | 1.70 |
| Backfat thickness (mm) | 40.27 | 3.48 | 32.51 | 2.46 | 33.16 | 3.46 |
| Muscle thickness (mm) | 48.39 | 3.11 | 52.30 | 2.19 | 50.75 | 2.29 |
| Lean meat content (%) | $39.02^{a}$ | 2.02 | $44.36^{b}$ | 1.43 | 43.52 | 2.13 |
| Weight of ham (kg) | 9.47 | 0.34 | 10.10 | 0.24 | 9.54 | 0.25 |
| Weight of loin (kg) | 3.58 | 0.20 | 3.66 | 0.14 | 3.48 | 0.17 |
| Weight of shoulder (kg) | 5.12 | 0.21 | $5.50^{a}$ | 0.16 | $4.97^{b}$ | 0.22 |
| Share of ham (%) | $10.58^{a}$ | 0.28 | $11.28^{b}$ | 0.20 | $10.61^{a}$ | 0.21 |
| Share of loin (%) | 3.80 | 0.16 | 4.09 | 0.13 | 3.84 | 0.11 |
| Share of shoulder (%) | $5.46^{A}$ | 0.21 | $6.14^{Ba}$ | 0.16 | $5.52^{b}$ | 0.21 |
| $pH_{45}$ | 6.24 | 0.10 | 6.18 | 0.11 | 6.12 | 0.15 |
| $pH_{24}$ | 5.43 | 0.58 | 5.44 | 0.04 | 5.48 | 0.05 |
| $Colour_{45}$ $L^*$ | 51.83 | 3.60 | 48.27 | 2.57 | 53.46 | 3.62 |
| $a^*$ | 4.85 | 0.95 | 5.00 | 0.68 | 4.07 | 0.67 |
| $b^*$ | 8.85 | 1.20 | 7.78 | 0.90 | 7.35 | 1.27 |

100% ZS = Złotnicka Spotted/Złotnicka Spotted, 75% ZS = Złotnicka Spotted × Złotnicka Spotted/Duroc, 50% ZS = Złotnicka Spotted/Duroc, LSM = least square mean, SE = standard error

$^{A, B}P \leq 0.01$, $^{a, b}P \leq 0.05$

Grześkowiak et al. (2009), as the mean $pH_{45}$ recorded in the *longissimus dorsi* muscle was 6.32. Higher $pH_{45}$ values for 100% ZS pigs were also found by Kapelański et al. (2006), as it was 6.52 on the average. In this study the highest $pH_{45}$ value was found in the meat of 75% ZS crosses. In turn, the highest $pH_{24}$ was recorded in the meat of 50% ZS crosses, with this group differing statistically significantly from the 100% ZS group.

No statistically significant differences regarding to colour parameters were observed between the groups. The value of $L^*$ oscillated from 49.73 for 75% ZS to 51.25% for 50% ZS. For 100% group, the average value of $L^*$ was 50.46.

Similar results were reported by Grześkowiak et al. (2009). The mean $L^*$ value observed for 100% ZS fatteners was 47.97, while the $a^*$ value was 4.73. In turn, Florowski et al. (2005) observed a similar colour lightness ($L^*$ = 49.29) and a higher share of the red colour ($a^*$ = 12.13) for meat of 100% ZS animals. Similarly, good values of colour parameters are found for Italian native pigs breeds, i.e. Nero Siciliano and Cinta Senese (Pugliese et al., 2004; Franci et al., 2005). It is worth to emphasize that the colour is one of the most important criteria used by the consumers in pork meat assessment (Faustman and Cassens 1990). As it was demonstrated in the study, some consumers prefer the

Table 3. The effect of the genetic group on fattening and slaughter performance traits as well as meat quality (*musculus longissimus dorsi*) for gilts

| Traits | Group | | | | | |
|---|---|---|---|---|---|---|
| | 100% ZS | | 75% ZS | | 50% ZS | |
| | LSM | SE | LSM | SE | LSM | SE |
| Lifetime weight gain (kg) | 0.61 | 0.03 | 0.64 | 0.02 | 0.63 | 0.02 |
| Age at slaughter (days) | 200.50 | 9.85 | 192.20 | 6.69 | 185.20 | 9.45 |
| Weight at slaughter (kg) | 121.80 | 3.30 | 121.00 | 2.33 | 115.80 | 3.31 |
| Carcass weight (kg) | 92.00 | 2.63 | 90.50 | 1.86 | 91.10 | 2.60 |
| Dressing percentage (%) | 75.48 | 2.58 | 75.10 | 1.82 | 78.99 | 1.84 |
| Backfat thickness (mm) | 29.64[a] | 2.98 | 35.30[b] | 2.11 | 27.33[a] | 2.19 |
| Muscle thickness (mm) | 47.72 | 3.06 | 49.20 | 2.16 | 53.77 | 3.10 |
| Lean meat content (%) | 44.64[a] | 1.95 | 41.94[b] | 1.37 | 47.59[a] | 1.94 |
| Weight of ham (kg) | 10.47 | 0.46 | 10.66 | 0.33 | 10.07 | 0.47 |
| Weight of loin (kg) | 3.47 | 0.21 | 3.67 | 0.15 | 3.84 | 0.14 |
| Weight of shoulder (kg) | 5.41 | 0.23 | 5.65 | 0.16 | 5.18 | 0.23 |
| Share of ham (%) | 11.39 | 0.53 | 11.80 | 0.38 | 11.11 | 0.37 |
| Share of loin (%) | 3.77 | 0.16 | 4.06 | 0.14 | 4.21 | 0.17 |
| Share of shoulder (%) | 5.89 | 0.29 | 6.26 | 0.21 | 5.72 | 0.30 |
| $pH_{45}$ | 6.06 | 0.14 | 6.19 | 0.11 | 6.23 | 0.15 |
| $pH_{24}$ | 5.42 | 0.05 | 5.43 | 0.04 | 5.53 | 0.06 |
| $Colour_{45}$ $L^*$ | 49.09 | 3.29 | 51.20 | 2.33 | 49.04 | 3.20 |
| $a^*$ | 3.27 | 0.97 | 5.22 | 0.69 | 4.88 | 0.90 |
| $b^*$ | 6.93 | 0.91 | 8.28 | 0.90 | 9.03 | 1.27 |

100% ZS = Złotnicka Spotted/Złotnicka Spotted, 75% ZS = Złotnicka Spotted × Złotnicka Spotted/Duroc, 50% ZS = Złotnicka Spotted/Duroc, LSM = least square mean, SE = standard error
[a,b]$P \leq 0.05$

pork of a darker colour, and such was observed in all analysed groups of pigs (Newcom et al. 2004).

For a more complete characteristics of the investigated population the results of fattening and slaughter performance traits as well as meat quality, taking into consideration the sex of the analysed animals, are presented in Tables 2 and 3.

Analogously as for the entire population, both for barrows and gilts, the smallest daily weight gains were found in the 100% ZS group (0.57 vs. 0.61 kg), while they were the highest in the 75% ZS group, amounting to 0.64 kg for both sexes. When comparing weight gains for both sexes we may observe an advantage of gilts over barrows.

When analysing backfat thickness it may be observed that barrows from all the groups were characterized by thicker backfat than gilts (100% ZS 40.27 vs. 29.64 mm, 75% ZS 32.51 vs. 35.30 mm, 50% ZS 33.16 vs. 27.33 mm). Similar results were reported by Bahelka et al. (2007). In their study backfat thickness of 29.01 mm was recorded for castrates and that of 25.56 mm was found for gilts. The observed differences between the sexes were statistically significant. Within the same sex, barrows from both groups of crossbreds had a thinner backfat than 100% ZS animals. In turn, in gilts the thinnest backfat was recorded in the 50% ZS group (27.33 mm), a slightly thicker backfat was found in

Table 4. Pearson's correlation coefficients Prob > |*r*| with H0:Ro = 0 for both sexes (fattening and slaughter performance traits) at different shares of the Duroc breed (100% ZS, 75% ZS, 50% ZS)

| Traits | Shares of the Duroc breed (% ZS) | Lifetime daily weight gain (kg) | Age at slaughter (days) | Weight at slaughter (kg) | Carcass weight (kg) | Dressing percentage (%) | Backfat thickness (mm) | Muscle thickness (mm) | Lean meat content (%) | Weight of ham (kg) | Weight of loin (kg) | Weight of shoulder (kg) | Share of ham (%) | Share of loin (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Age at slaughter (days) | 100 | −0.78** | | | | | | | | | | | | |
| | 75 | −0.79** | | | | | | | | | | | | |
| | 50 | −0.79** | | | | | | | | | | | | |
| Weight at slaughter (kg) | 100 | 0.31 | 0.35 | | | | | | | | | | | |
| | 75 | 0.55* | 0.07 | | | | | | | | | | | |
| | 50 | 0.22 | 0.37 | | | | | | | | | | | |
| Carcass weight (kg) | 100 | 0.22 | 0.16 | 0.61** | | | | | | | | | | |
| | 75 | −0.37 | 0.61* | 0.29 | | | | | | | | | | |
| | 50 | −0.05 | 0.41 | 0.58* | | | | | | | | | | |
| Dressing percentage (%) | 100 | −0.12 | −0.25 | −0.52* | 0.36 | | | | | | | | | |
| | 75 | −0.75** | 0.35 | −0.74** | 0.48 | | | | | | | | | |
| | 50 | −0.37 | −0.04 | −0.61** | 0.29 | | | | | | | | | |
| Backfat thickness (mm) | 100 | −0.15 | 0.29 | 0.22 | 0.37 | 0.11 | | | | | | | | |
| | 75 | −0.43 | 0.71** | 0.26 | 0.60** | 0.18 | | | | | | | | |
| | 50 | 0.21 | 0.10 | 0.53 | 0.63** | 0.01 | | | | | | | | |
| Muscle thickness (mm) | 100 | 0.26 | −0.16 | 0.16 | 0.32 | 0.17 | −0.06 | | | | | | | |
| | 75 | 0.11 | 0.01 | 0.12 | 0.14 | −0.05 | 0.38 | | | | | | | |
| | 50 | 0.05 | 0.06 | 0.18 | 0.07 | −0.17 | −0.20 | | | | | | | |
| Lean meat content (%) | 100 | 0.20 | −0.25 | −0.07 | −0.13 | −0.03 | −0.84** | 0.53* | | | | | | |
| | 75 | 0.52* | −0.76** | −0.20 | −0.57** | −0.23 | −0.88** | 0.11 | | | | | | |
| | 50 | −0.25 | −0.02 | −0.47 | −0.57** | −0.03 | −0.85** | 0.20 | | | | | | |
| Weight of ham (kg) | 100 | 0.17 | 0.36 | 0.80** | 0.63** | −0.27 | 0.17 | 0.26 | 0.05 | | | | | |
| | 75 | 0.21 | 0.13 | 0.48* | 0.35 | −0.20 | 0.23 | 0.12 | −0.19 | | | | | |
| | 50 | −0.07 | 0.57** | 0.74** | 0.25 | −0.63** | 0.05 | 0.13 | 0.15 | | | | | |
| Weight of loin (kg) | 100 | −0.07 | 0.42 | 0.56** | 0.56** | −0.04 | 0.29 | 0.43 | 0.09 | 0.71** | | | | |
| | 75 | 0.17 | 0.11 | 0.44 | 0.38 | −0.13 | 0.06 | −0.06 | −0.11 | 0.57* | | | | |
| | 50 | −0.11 | 0.31 | 0.63** | 0.73** | −0.04 | 0.34 | 0.23 | −0.25 | 0.43 | | | | |
| Weight of shoulder (kg) | 100 | 0.21 | 0.27 | 0.73** | 0.49* | −0.33 | 0.01 | 0.13 | 0.11 | 0.81** | 0.61** | | | |
| | 75 | 0.27 | 0.12 | 0.74** | 0.12 | −0.57** | 0.25 | 0.02 | −0.27 | 0.67** | 0.50* | | | |
| | 50 | 0.09 | 0.43 | 0.79** | 0.20 | −0.15 | 0.14 | 0.24 | 0.01 | 0.87** | 0.52* | | | |
| Share of ham (%) | 100 | 0.01 | 0.34 | 0.49* | −0.07 | −0.66** | −0.10 | 0.05 | 0.17 | 0.73** | 0.43 | 0.61** | | |
| | 75 | 0.43 | −0.20 | 0.36 | −0.20 | −0.48* | −0.10 | 0.04 | 0.12 | 0.82** | 0.37 | 0.62* | | |
| | 50 | 0.01 | 0.21 | 0.29 | −0.47* | −0.80** | −0.39 | 0.08 | 0.51* | 0.73** | −0.12 | 0.66** | | |
| Share of loin (%) | 100 | −0.23 | 0.44 | 0.32 | 0.11 | −0.25 | 0.13 | 0.32 | 0.18 | 0.51* | 0.88** | 0.47* | 0.57** | |
| | 75 | 0.39 | −0.23 | 0.33 | −0.17 | −0.41 | −0.27 | −0.15 | 0.21 | 0.41 | 0.85** | 0.46* | 0.52** | |
| | 50 | −0.18 | 0.16 | 0.49* | 0.34 | −0.26 | −0.04 | 0.28 | 0.05 | 0.44 | 0.89** | 0.59** | 0.16 | |
| Share of shoulder (%) | 100 | 0.03 | 0.17 | 0.29 | −0.31 | −0.68** | −0.30 | −0.13 | 0.23 | 0.37 | 0.21 | 0.68** | 0.74** | 0.43 |
| | 75 | 0.51* | −0.15 | 0.61** | −0.30 | −0.75** | 0.01 | −0.04 | −0.01 | 0.51 | 0.32 | 0.91** | 0.71** | 0.51* |
| | 50 | 0.13 | 0.11 | 0.34 | −0.48 | −0.86** | −0.29 | 0.18 | 0.36 | 0.61** | −0.02 | 0.76** | 0.90** | 0.32 |

**significant at $P \le 0.01$; *significant at $P \le 0.05$

Table 5. Pearson's correlation coefficients Prob > |r| with H0:Ro = 0 for barrows (fattening and slaughter performance traits) at different shares of the Duroc breed (100, 75, 50)

| Traits | Shares of the Duroc breed (% ZS) | Lifetime daily weight gain (kg) | Age at slaughter (days) | Weight at slaughter (kg) | Carcass weight (kg) | Dressing percentage (%) | Backfat thickness (mm) | Muscle thickness (mm) | Lean meat content (%) | Weight of ham (kg) | Weight of loin (kg) | Weight of shoulder (kg) | Share of ham (%) | Share of loin (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Age at slaughter (days) | 100 | −0.70* | | | | | | | | | | | | |
| | 75 | −0.84** | | | | | | | | | | | | |
| | 50 | −0.67* | | | | | | | | | | | | |
| Weight at slaughter (kg) | 100 | 0.24 | 0.53 | | | | | | | | | | | |
| | 75 | 0.35 | 0.21 | | | | | | | | | | | |
| | 50 | 0.29 | 0.52 | | | | | | | | | | | |
| Carcass weight (kg) | 100 | 0.16 | 0.32 | 0.68* | | | | | | | | | | |
| | 75 | −0.39 | 0.50 | 0.16 | | | | | | | | | | |
| | 50 | 0.25 | 0.49 | 0.94** | | | | | | | | | | |
| Dressing percentage (%) | 100 | −0.15 | −0.42 | −0.69* | 0.06 | | | | | | | | | |
| | 75 | −0.42 | −0.12 | −0.98** | 0.03 | | | | | | | | | |
| | 50 | −0.20 | −0.31 | −0.58 | −0.27 | | | | | | | | | |
| Backfat thickness (mm) | 100 | −0.05 | 0.49 | 0.60 | 0.38 | −0.47 | | | | | | | | |
| | 75 | −0.31 | 0.29 | −0.02 | 0.63* | −0.15 | | | | | | | | |
| | 50 | 0.33 | 0.29 | 0.80** | 0.91** | −0.02 | | | | | | | | |
| Muscle thickness (mm) | 100 | 0.46 | −0.29 | −0.18 | 0.31 | 0.14 | −0.24 | | | | | | | |
| | 75 | −0.47 | 0.13 | 0.60 | 0.34 | 0.67* | 0.78** | | | | | | | |
| | 50 | 0.39 | −0.29 | −0.06 | −0.14 | −0.51 | −0.08 | | | | | | | |
| Lean meat content (%) | 100 | 0.24 | −0.51 | −0.40 | −0.16 | 0.43 | −0.90** | 0.63* | | | | | | |
| | 75 | −0.05 | −0.31 | −0.66* | −0.65* | 0.54 | −0.68* | −0.07 | | | | | | |
| | 50 | 0.19 | −0.36 | −0.73** | −0.92** | −0.13 | −0.95** | 0.38 | | | | | | |
| Weight of ham (kg) | 100 | 0.11 | 0.57 | 0.91** | 0.68* | −0.58 | 0.62* | 0.16 | −0.42 | | | | | |
| | 75 | −0.08 | 0.42 | 0.59 | 0.55 | −0.49 | 0.75* | 0.29 | −0.86** | | | | | |
| | 50 | −0.03 | 0.73* | 0.89** | 0.77** | −0.69** | 0.54 | 0.02 | −0.50 | | | | | |
| Weight of loin (kg) | 100 | 0.37 | 0.18 | 0.70* | 0.60 | −0.34 | 0.28 | 0.55 | 0.02 | 0.64* | | | | |
| | 75 | 0.51 | −0.05 | 0.85** | −0.03 | −0.86** | 0.03 | −0.54 | −0.67* | 0.44 | | | | |
| | 50 | 0.39 | 0.33 | 0.89** | 0.85** | −0.47 | 0.82** | 0.20 | −0.70* | 0.69* | | | | |
| Weight of shoulder (kg) | 100 | 0.19 | 0.45 | 0.85** | 0.47 | −0.68* | 0.56 | 0.27 | −0.33 | 0.75* | 0.75* | | | |
| | 75 | 0.01 | 0.47 | 0.83** | 0.53 | −0.74* | 0.41 | −0.11 | −0.79** | 0.89** | 0.54 | | | |
| | 50 | 0.24 | 0.50 | 0.91** | 0.75** | −0.78** | 0.60 | 0.36 | −0.45 | 0.89** | 0.88** | | | |
| Share of ham %) | 100 | 0.01 | 0.48 | 0.51 | −0.03 | −0.84** | 0.47 | −0.10 | −0.42 | 0.71* | 0.30 | 0.56 | | |
| | 75 | −0.04 | 0.38 | 0.68* | 0.46 | −0.53 | 0.72* | 0.27 | −0.83** | 0.99** | 0.47 | 0.88** | | |
| | 50 | −0.37 | 0.39 | 0.01 | −0.27 | −0.59 | −0.53 | 0.26 | −0.57 | 0.40 | −0.16 | 0.29 | | |
| Share of loin (%) | 100 | 0.34 | 0.04 | 0.44 | 0.11 | −0.48 | 0.09 | 0.47 | 0.13 | 0.38 | 0.86** | 0.61* | 0.41 | |
| | 75 | 0.54 | −0.09 | 0.83** | −0.13 | −0.86** | −0.03 | −0.57 | −0.61* | 0.39 | 0.99** | 0.49 | 0.43 | |
| | 50 | 0.40 | 0.14 | 0.61* | 0.52 | −0.55 | 0.53 | 0.47 | 0.33 | 0.47 | 0.89** | 0.81** | 0.01 | |
| Share of shoulder (%) | 100 | 0.06 | 0.22 | 0.32 | −0.36 | −0.78** | 0.27 | −0.02 | −0.23 | 0.23 | 0.28 | 0.66* | 0.65* | 0.58 |
| | 75 | 0.02 | 0.45 | 0.84** | 0.49 | −0.76** | 0.39 | −0.14 | −0.78** | 0.88** | 0.55 | 0.98** | 0.88** | 0.51 |
| | 50 | 0.02 | 0.05 | 0.04 | −0.27 | −0.76** | −0.40 | 0.73* | 0.60 | 0.23 | 0.12 | 0.43 | 0.77** | 0.47 |

*significant at $P \leq 0.05$, **significant at $P \leq 0.01$

females from the 100% ZS group (29.64 mm), while the thickest backfat was observed in gilts from the group with a 75% share of ZS genes (35.30 mm).

For both groups of sexes in crossbred animals (75% ZS and 50% ZS) a bigger muscle thickness was observed in comparison with 100% ZS animals. Barrows from the 100% ZS group were characterised by the lowest lean meat content in the carcass, amounting to only 39.02%. In turn, the lowest leanness in gilts was recorded for the 75% ZS group (41.94%). Differences indicated here were statistically significant. The 100% ZS and 50% ZS genetic groups of barrows were characterised by a lower lean meat content in the carcass than the analogous groups of gilts (100% ZS 39.02 vs. 44.64%, 50% ZS 43.52 vs. 47.59%). This result is consistent with the earlier studies by other authors (Cassady et al., 2004; Bahelka et al., 2007). In their study Bahelka et al. (2007) recorded lean meat content in barrows to be 52.77%, while for gilts it was 57.69%.

Values of $pH_{45}$ and $pH_{24}$ observed for both sexes in all the groups were typical of normal meat, with colour parameters also being advantageous. Differences in the values of meat quality attributes observed between the groups for both sexes were statistically non-significant.

Correlations between individual fattening and slaughter performance traits for the entire analysed population are presented in Table 4. In all the genetic groups highly significant negative correlations were found between age at slaughter and lifetime daily weight gain. They amounted to –0.78** for the 100% ZS group, –0.79** for the 75% ZS, and –0.79** for the 50% ZS crosses. Moreover, highly significant negative correlations were found between dressing percentage and slaughter weight for the 75%ZS group, amounting to –0.74** and for the 50% ZS group to –0.61**, respectively, and a significant correlation for 100% ZS animals at –0.52**. In the entire population positive correlations were found between slaughter weight and the weight of primal cuts. They were highly significant in the 100% ZS group. This result was similar to that reported by Stupka et al. (2008). For the analysed fatteners they found a highly significant positive correlation of 0.57** between slaughter weight and the weight of ham. Also the correlation between slaughter weight and the weight of shoulder was statistically highly significant, amounting to 0.65**. Positive highly significant correlations between weights of individual joints were observed in all the groups.

Highly significant negative correlations between lean meat content and backfat thickness were recorded for all the groups. They amounted to –0.84** for 100% ZS, –0.88** for 75% ZS, and –0.85** for the 50% ZS group, respectively. It corresponds with the generally accepted dependence models. Similar results were recorded by Pulkrábek et al. (2004) and Bahelka et al. (2007), as in their studies the correlation coefficient for these traits was slightly lower, amounting to –0.50*, and it turned out to be statistically significant.

For barrows (Table 5) negative correlations were found between age at slaughter and lifetime daily weight gain. They amounted to –0.70* in the 100% ZS group, –0.84** in the group of 75% ZS crosses and –0.67* in the 50% ZS crosses. A highly significant negative correlation was recorded between dressing percentage and slaughter weight for the 75% ZS group (–0.98**) and a significant correlation for the 100% ZS group (–0.69*). Highly significant negative correlations were observed between lean meat content in the carcass and backfat thickness in the 100% ZS group (–0.90**) and in the 50% ZS group (–0.95**), as well as significant correlation in the 70% ZS group (–0.68*). Bahelka et al. (2007) found a significant negative correlation of –0.46* between carcass leanness and backfat thickness in barrows.

For gilts (Table 6), analogously as for barrows, negative correlations were found between age at slaughter and lifetime daily weight gain. They were highly significant for all the genetic groups. A highly significant negative correlation between lean meat content and backfat thickness was recorded only for the 75% ZS group (–0.95**). For the 50% ZS group the correlation between these traits was significant (–0.70*), while for the 100% ZS animals this dependence was insignificant. Similar correlations were shown in their study by Bahelka et al. (2007). For gilts they recorded a correlation coefficient of –0.31.

## Concluding remarks

As it was already mentioned, the *in situ* protection, which is applied for the ZS breed, results in the animals being managed under natural conditions. However, we need to remember that financial resources (subsidies) allocated for such protection are limited. Costs of *in situ* protection generally correspond to the difference between income from

Table 6. Pearson's correlation coefficients Prob > |r| with H0:Ro = 0 for gilts (fattening and slaughter performance traits) at different shares of the Duroc breed (100% ZS, 75% ZS, 50% ZS)

| | Shares of the Duroc breed (% ZS) | Lifetime daily weight gain (kg) | Age at slaughter (days) | Weight at slaughter (kg) | Carcass weight (kg) | Dressing percentage (%) | Backfat thickness (mm) | Muscle thickness (mm) | Lean meat content (%) | Weight of ham (kg) | Weight of loin (kg) | Weight of shoulder (kg) | Share of ham (%) | Share of loin (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lifetime weight gain (kg) | 100 | −0.90** | | | | | | | | | | | | |
| | 75 | −0.78** | | | | | | | | | | | | |
| | 50 | −0.90** | | | | | | | | | | | | |
| Age at slaughter (days) | 100 | 0.26 | 0.19 | | | | | | | | | | | |
| | 75 | 0.59 | 0.03 | | | | | | | | | | | |
| | 50 | 0.29 | 0.16 | | | | | | | | | | | |
| Weight at slaughter (kg) | 100 | 0.40 | −0.02 | 0.87** | | | | | | | | | | |
| | 75 | −0.39 | 0.68* | 0.27 | | | | | | | | | | |
| | 50 | −0.47 | 0.32 | −0.35 | | | | | | | | | | |
| Carcass weight (kg) | 100 | 0.42 | −0.25 | 0.42 | 0.81** | | | | | | | | | |
| | 75 | −0.81** | 0.46 | −0.70* | 0.49 | | | | | | | | | |
| | 50 | 0.46 | 0.08 | −0.85** | 0.78** | | | | | | | | | |
| Dressing percentage (%) | 100 | 0.21 | −0.05 | 0.32 | 0.33 | 0.26 | | | | | | | | |
| | 75 | −0.46 | 0.87** | 0.37 | 0.66* | 0.15 | | | | | | | | |
| | 50 | 0.26 | −0.19 | 0.17 | 0.22 | −0.01 | | | | | | | | |
| Backfat thickness (mm) | 100 | 0.13 | −0.04 | 0.22 | 0.29 | 0.28 | 0.12 | | | | | | | |
| | 75 | 0.48 | −0.10 | 0.61* | 0.27 | −0.33 | 0.23 | | | | | | | |
| | 50 | −0.22 | 0.35 | 0.30 | 0.30 | −0.06 | −0.09 | | | | | | | |
| Muscle thickness (mm) | 100 | −0.25 | 0.29 | 0.13 | 0.09 | 0.01 | −0.41 | 0.72* | | | | | | |
| | 75 | 0.63* | 0.92** | −0.18 | −0.59 | −0.27 | −0.95** | 0.10 | | | | | | |
| | 50 | −0.44 | 0.30 | −0.38 | −0.36 | 0.06 | −0.70* | −0.15 | | | | | | |
| Lean meat content (%) | 100 | 0.08 | 0.25 | 0.76* | 0.72* | 0.44 | 0.19 | 0.37 | 0.33 | | | | | |
| | 75 | 0.31 | 0.05 | 0.54 | 0.34 | −0.26 | 0.04 | 0.24 | 0.03 | | | | | |
| | 50 | −0.18 | 0.46 | 0.57 | −0.62* | −0.72* | −0.31 | 0.05 | 0.51 | | | | | |
| Weight of ham (kg) | 100 | −0.34 | 0.64* | 0.66* | 0.52 | 0.19 | 0.33 | 0.33 | 0.38 | 0.85** | | | | |
| | 75 | 0.07 | 0.18 | 0.34 | 0.46 | 0.02 | 0.07 | 0.36 | 0.04 | 0.64* | | | | |
| | 50 | −0.27 | 0.34 | 0.10 | 0.55 | 0.22 | 0.03 | 0.08 | −0.20 | −0.11 | | | | |
| Weight of loin (kg) | 100 | 0.07 | 0.20 | 0.63* | 0.66* | 0.45 | −0.17 | 0.07 | 0.32 | 0.83** | 0.65* | | | |
| | 75 | 0.60 | −0.11 | 0.83** | 0.11 | −0.67* | 0.13 | 0.30 | −0.03 | 0.66* | 0.50 | | | |
| | 50 | −0.06 | 0.40 | 0.71* | −0.61* | 0.81** | −0.21 | 0.06 | 0.18 | 0.83** | −0.02 | | | |
| Weight of shoulder (kg) | 100 | −0.29 | 0.40 | 0.22 | 0.04 | −0.19 | −0.06 | 0.22 | 0.39 | 0.72* | 0.71* | 0.54 | | |
| | 75 | 0.55 | −0.37 | 0.37 | −0.28 | −0.57 | −0.37 | 0.06 | 0.40 | 0.81** | 0.36 | 0.60 | | |
| | 50 | 0.11 | 0.16 | 0.57 | 0.85** | 0.81** | −0.29 | −0.09 | 0.45 | 0.94** | −0.33 | 0.83** | | |
| Share of ham (%) | 100 | −0.60 | 0.76* | 0.33 | 0.10 | −0.20 | 0.20 | 0.22 | 0.39 | 0.63* | 0.90** | 0.43 | 0.82** | |
| | 75 | 0.35 | −0.28 | 0.18 | −0.19 | −0.31 | −0.38 | 0.21 | 0.46 | 0.48 | 0.78** | 0.48 | 0.61* | |
| | 50 | −0.05 | 0.22 | 0.31 | 0.08 | −0.31 | −0.08 | −0.08 | −0.03 | 0.22 | 0.88** | 0.32 | 0.10 | |
| Share of loin (%) | | −0.31 | 0.28 | −0.06 | −0.19 | −0.29 | −0.55 | −0.21 | 0.32 | 0.34 | 0.32 | 0.62* | 0.68* | 0.47 |
| | | 0.76* | −0.49 | 0.59 | −0.46 | 0.87** | −0.26 | 0.12 | 0.31 | 0.41 | 0.19 | 0.83** | 0.71* | 0.53 |
| | | 0.16 | 0.15 | 0.67* | 0.82** | 0.89** | −0.22 | −0.08 | 0.23 | 0.83** | −0.25 | 0.95** | 0.93** | 0.18 |

*significant at $P \leq 0.05$, **significant at $P \leq 0.01$

breeding a commercial breed of medium productivity and an endangered breed. In the analysed population, purebred animals (100% ZS) were characterised by low daily weight gains and lean meat content in the carcass, a slight muscle thickness, and a considerable backfat thickness. In the free market economy these animals have no chance to meet the competition of meat-purpose breeds. Thus the Program for the protection of genetic resources of Złotnicka Spotted pigs adopts the development of schemes for the use of ZS pigs in commercial crossing as one of its goals.

In this study crosses with the Duroc breed (75% ZS and 50% ZS) had better weight gains, thinner backfat and higher lean meat contents in the carcass than purebred animals. Moreover, in fatteners from all the analysed groups the $pH_{45}$ and $pH_{24}$ values were typical of normal meat, with no quality defects. Also colour parameters were advantageous. Meat from all the animals was characterised by an intensive colour, with the darkest meat being observed in animals from the 75% ZS group.

Statistical analyses showed that throughout the years of breeding the Złotnicka Spotted (ZS) breed has not lost its original traits. It was confirmed that meat coming from Złotnicka Spotted pigs is characterised by excellent quality. Recorded results indicate that the use of crossing of the ZS and Duroc breeds improves fattening and slaughter performance, at the simultaneous maintenance of good quality of meat in crossbred animals.

Summing up, we need to state that the results of this study are useful also for the breeders. They indicate that crosses of both breeds kept in the extensive breeding system may be successfully used in the production of high-quality meat. Pork coming from such animals may constitute raw material for a niche production, e.g. regional products. The use of meat, coming from crossbred animals, in meat processing may improve not only the quality of products, but also efficiency of production based on a native breed such as the Złotnicka Spotted breed.

## CONCLUSIONS

(1) In the 75% ZS and 50% ZS crosses higher daily weight gains were observed, amounting to 0.64 and 0.62 kg in comparison to 0.59 kg in the 100% ZS animals. Crossbred pigs were characterised by thinner backfat of 34.56 and 29.67 mm than the 100% ZS animals. They also had a bigger muscle thickness amounting to 50.34 and 52.34 mm in comparison to 48.05 mm in purebred animals, and they had higher lean meat content of 42.66 and 45.89% vs. 41.83%.

(2) For animals with a 50% share of Duroc genes in their genotype dressing percentage in the analysed population turned out to be the highest, amounting to 79.21%. In comparison with the 75% ZS animals with the value of 73.99%, it turned out to be statistically highly significant.

(3) The weight of shoulder in the analysed population was the highest in the 75% ZS group (5.62 kg) and it differed statistically highly significantly in comparison to the group of animals with a 50% share of Duroc genes in their genotype, as the value of this parameter was 5.05 kg in hat group.

(4) In relation to meat quality, including the pH values and colour parameters, the population was characterised by advantageous results. The $pH_{45}$ and $pH_{24}$ values were 6.15 and 5.42, respectively, and they were typical of meat with quality defects. Meat produced by the 100% ZS fatteners was characterised by a dark colour of $L^*$ = 50.46, at the share of the red colour being $a^*$ = 4.06.

(5) When analysing selected fattening and slaughter performance traits in barrows and gilts it was found that barrows from all the genetic groups were characterised by a thicker backfat than gilts (100% ZS 40.27 vs. 29.64 mm, 75% ZS 32.51 vs. 35.30 mm, 50% ZS 33.16 vs. 27.33 mm). The 100% ZS and 50% ZS genetic groups of barrows had lower lean meat contents in the carcass than the groups of gilts (100% ZS 39.02 vs. 44.64%, 50% ZS 43.52 vs. 47.59%).

(6) Highly significant negative correlations between lean meat content and backfat thickness were found in all the genetic groups. They amounted to –0.84** for the 100% ZS group, –0.88** for 75% ZS and to –0.85** for the 50% ZS group, respectively. For barrows highly significant negative correlations were recorded in the 100% ZS group (–0.90**) and in the 50% ZS group (–0.95**), as well as a significant correlation for the 70% ZS group (–0.68*). In turn, for gilts a highly significant negative correlation was found between lean meat content in the carcass and backfat thickness only for the 75% ZS group (–0.95**). For the 50% ZS group the correlation between these traits was significant

(–0.70*), while for the 100% ZS animals the observed dependence was non-significant.

## REFERENCES

Acciaioli A., Pugliese C., Bozzi R., Campodoni G., Franci O., Gandini G. (2002): Productivity of Cinta Senese and Large White × Cinta Senese pigs reared outdoor on woodlands and indoor. 1. Growth and somatic development. Italian Journal of Animal Science, 6, 663–671.

Alexandrowicz S., Czubak J., Ratajszczak M. (1954): Utilisation of crosses of native pig breeds to create breed groups of meat and meat-lard performance. Roczniki Nauk Rolniczych, 68, B-4, 369–395. (in Polish)

Bahelka I., Hanusková E., Peškovičová D., Demo P. (2007): The effect of sex and slaughter weight on intramuscular fat content and its relationship to carcass traits of pigs. Czech Journal of Animal Science, 52, 122–129.

Barone C.M.A., Castelano N., Colatruglio P., Occidente M., Zullo A., Matassino D. (2003): Preliminary results on some "typified" traditional products obtained from Casertana pig autochthonous genetic type. In: Proc. 6$^{th}$ Int. Symp. on Livestock Forming Systems (EAAP). Benevento, Italy, 165–167.

Brewer M.S., Jansen J., Sośnicki A., Fields B., Ailson E., McKeith F.K. (2002): The effect of pig genetics on palatability, colour and physical characteristics of fresh pork loin chops. Meat Science, 61, 249–256.

Buczyński J.T., Zaborowski T., Szulc K. (1997): Fattening and slaughter of meat-type crossbred porkers with a share of Złotnicka Spotted pig. Animal Science Papers and Reports, 15, 3, 149–154.

Buczyński J.T., Borzuta K., Szulc K. (2001): Carcass quality in Złotnicka Spotted hybrid pigs. Annals of Animal Science, 1, 13–17.

Buczyński J.T., Swulińska-Katulska A., Chojnacka R., Szulc K. (2005): Assessment of eating quality of meat from Złotnicka White and Złotnicka Spotted pigs. Annals of Animal Science, 1, 7–10.

Carrapiso A.I., Bonilla F., García C. (2003): Effect of crossbreeding and rearing system on sensory characteristics of Iberian ham. Meat Science, 63, 523–629.

Cassady J.P., Robison O.W., Johanson R.K., Mabry J.W., Christian L.L., Tokach M.D., Miller R.K., Goodwinn R.N. (2004): National pork producers council maternal line genetic evaluation: A comparison of growth and carcass genetic in terminal progeny. Journal of Animal Science, 82, 3482–3485.

Faustman C., Cassens R.G. (1990): The biochemical basis for discoloration in fresh meat: A review. Journal of Muscle Foods, 1, 217–243.

Florowski T., Pisula A., Kurela W., Buczyński J.T. (2005): Assessment of processability of meat coming from the native Złotnicka Spotted pigs. Mięso i Wędliny, 6, 38–40.

Florowski T., Pisula A., Buczyński J.T., Orzechowska B. (2006): Frequency of meat defects in different breeds kept in Poland. Zeszyty Naukowe PTZ, 2, 91–97. (in Polish)

Franci O., Pugliese C. (2007): Italian autochthonous pigs: Progress report and research perspectives. Italian Journal of Animal Science, 6, 663–671.

Franci O., Bozzi R., Pugliese C., Acciaioli A., Campodoni G., Gandini G. (2005): Performance of Cinta Senese pigs and their crosses with Large White. 1. Muscle and subcutaneous organeous fat characteristics. Meat Science, 69, 545–550.

Grześkowiak E., Borys A., Borzuta K., Buczyński J.T., Lisiak D. (2009): Slaughter value, meat quality and backfat fatty acid profile in Złotnicka White and Złotnicka Spotted fatteners. Animal Science Papers and Reports, 27, 115–125.

Hiemstra S.J., Woelders H. (2007): Balancing conservation objectives and methods for animal genetic resources: the emerging role of ex situ in vitro conservation. Annals of Animal Science, 7, 125–136.

Janicki M.A., Kortz J. (1973): Exudative character of meat coming from Pietrain and Złotnicka Spotted crossbred pigs. Zeszyty Problemowe Postępów Nauk Rolniczych, 139, 185–192. (in Polish)

Kapelański W., Buczyński J.T., Bocian M. (2006): Slaughter value and meat quality in the Polish native Złotnicka Spotted pig. Animal Science Papers and Reports, 24, 7–13.

Krupiński J. (2008): Protection of genetic resources of farm animals in Poland. Wiadomości zootechniczne, 46, 1, 1–10. (in Polish)

Kvapilík J., Přibyl J., Růžička Z., Řehák D. (2009): Results of pig carcass classification according to SEUROP in the Czech Republic. Czech Journal of Animal Science, 54, 217–228.

Newcom D.W., Stalder K.J., Baas T.J., Goodwin R.N., Parrish F.C., Wiengand B.R. (2004): Breed differences and genetic parameters of myoglobin concentration in porcine longissimus muscle. Journal of Animal Science, 82, 2264–2268.

PN-86/A-82002 (1997): Pork. Carcass joint. Decree of Ministry of Agriculture and Food Management of 27$^{th}$ June 1997 concerning an obligation of Polish standards application. Journal of Laws, 7. (in Polish)

Pommier S.A., Murray Y.A., Robertson W., Aalhus J., Gibson L., Sośnicki A., Klont R. (2004): Effects of genetics on meat quality and sensory properties of pork. In: Proc. 50$^{th}$ ICoMST. Helsinki, Finland, 544–547.

Pugliese C., Madonia G., Chiofalo V., Margiotta S., Acciaioli A., Gandini G. (2003): Comparison of the performance of Nero Siciliano pigs reared indoors and outdoor. 1. Growth and carcass composition. Meat Science, 65, 825–831.

Pugliese C., Calagna G., Chiofalo V., Morreti V., Margiota S., Franci O., Gandini G. (2004): Comparison of the performance of Nero Siciliano pigs reared indoors and outdoor. 2. Joints composition, meat and fat traits. Meat Science, 68, 523–528.

Pulkrábek J., Pavlík J., Vališ L. (2004): Pig carcass quality and $pH_1$ values of meat. Czech Journal of Animal Science, 49, 38–42.

Ratajszczak M. (1986): Suitability of Złotnicka pigs for commercial crossing. Trzoda chlewna, 7, 9–11.

Ratajszczak M., Buczyński J.T. (1997): Origins and development of the Polish indigenous Złotnicka Spotted Pig. Animal Science and Reports, 15, 137–148.

SAS Institute Inc. (2009): User's Guide. SAS Institute Inc. Cary, USA.

Serrano M.P., Valencia D.G., Nieto M., Lazaro R., Mateos G.G. (2008): Influence of sex and terminal sire line on performance and carcass and meat quality of Iberian pigs reared under intensive production system. Meat Science, 78, 420–428.

Stupka R., Čítek J., Šprysl M., Okrouhlá M., Kureš D., Líkař K. (2008): Effect of weight and sex on intramuscular fat amounts in relation to the formation of selected carcass cuts in pigs. Czech Journal of Animal Science, 53, 506–514.

Świtoński M., Stachowiak M., Cieślak J., Bartz M., Grześ M. (2010): Genetics of FAT tissue accumulation in pigs: a comparative approach. Journal of Applied Genetics, 51, 153–168.

Szulc K., Buczyński J.T., Skrzypczak E. (2006a): Breeding performance of złotnicka spotted sows in pure breeding and in two-breed crossing. Annals of Animal Science, 2, 55–59.

Szulc K., Buczyński J.T., Skrzypczak E., Panek A. (2006b): Live testing results of złotnicka spotted (ZS), ZS × Polish Large White and ZS × Hampshire fatteners. Animal Science Papers and Reports, 24, 65–69.

Tejeda J.F., Gandemer G., Antequera T., Viau M., García C. (2002): Lipid traits of muscles as related to genotype and fattening diet in Iberian pigs. Total intramuscular lipids and triacylglycerols. Meat Science, 60, 357–363.

Vítek M., Pulkrábek J., Vališ L., David L., Wolf J. (2008): Improvement of accuracy in the estimation of lean meat content in pig carcasses. Czech Journal of Animal Science, 53, 204–211.

Wood J.D., Enser M., Fisher A.V., Nute G.R., Richardson R.I., Sheard P.R. (1999): Manipulating meat quality and composition. Proceedings of the Nutrition Society, 58, 363–370.

2005/683/EC (2005): Commission Decision of 30th September 2005 amending Decision 2005/240/EC authorising methods for grading pig carcases in Poland (notified under document No. C(2005)3646).

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