

PROCESSING SUITABILITY OF PORK FROM DIFFERENT BREEDS REARED IN POLAND*

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Abstract. The principal objective of this study was to evaluate the processing value of pork obtained from different breeds reared in Poland. The research material consisted of a part of the m. longissimus thoracis obtained from pigs of different breeds: Duroc, Pietrain, Polish Large White, Polish Landrace and Line 990. It was found that the breed is responsible for significant differences in the quality features of pork. Among the samples analysed, meat from Duroc porkers proved to be of the highest, while that from Pietrain porkers of the lowest quality. Pork from the Duroc breed had the highest content of intramuscular fat, which affected the shear and compression force, two traits having a significant effect on sensory quality. Pork from Pietrain porkers was estimated to have a low processing as well as culinary quality. The significantly lower pH, observed in pork from this breed, resulted in a higher colour lightness and lower water holding capacity. Additionally, such pork demonstrated a hard texture (high shear and compression force). On the basis of the study results one may state that programmes aiming at the improvement of pork quality in Poland should include a wider use of the Duroc and limit the use of the Pietrain breed.

Key words: pig breed, pork, meat quality

INTRODUCTION

Many consumers consider that the quality of raw and processed meat has considerably deteriorated over the last years. Until recently, as there was meat shortage, it was necessary to process all the material available. However, currently the priorities existing in the production of slaughter animals must be subjected to the requirements of consumers and the meat industry.

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The quality of pork is formed at all stages of production, starting with animal breeding and ending with the culinary processing of the ready product. Accepting, that the production of a considerable majority of porkers designated for slaughter is based on cross-breeding, one may assume that the choice of animals for crossing is one of the most important factors affecting the quality of the pork produced. It is known that certain meat quality properties are linked to the pig breed, line or genotype. The occurrence of PSE meat is observed most often in animals burdened by gene RYR1^T (principally Pietrain pigs), while “acid” meat among carriers of gene RN⁻ (principally Hampshire pigs). Also, the content of intermuscular fat has been shown to be conditioned genetically [Rosenvold and Andersen 2003].

Currently, the decision about the choice of breeds for crossing is principally in the hands of the breeders themselves. As they are interested exclusively in the economic side of the venture, they choose animals of a high performance value, and pay no attention to the quality of the meat obtained. Thus including meat quality into the estimation of the carcass value (price) may prove a good inducement to the production of slaughter animals characterized by high quality meat [Borzuta 1998]. In a situation like that breeders would most probably pay more attention to the meat quality properties characterizing pure pig breeds. However, in the literature available, one may find only information about the few features of meat quality, principally pH, natural drip and colour lightness, but no comprehensive comparisons referring to Polish pig breeds. As the heritability of meat quality traits is considered to be high or medium [Koćwin-Podsiadła and Krzęcio 2005], a detailed understanding of the effect of genetic factors, including breed or line, on the quality of the meat obtained is necessary for the improvement of the quality of Polish pork. Thus the present work aimed at evaluating the technological value of meat from various pig breeds currently maintained in Poland. The information obtained may help breeders in making the correct decisions about selecting animals for crossing and thus producing meat of a high quality.

MATERIAL AND METHODS

The experimental material consisted of a section of the *musculus longissimus thoracis* obtained from sows of breeds currently bred in Poland: Duroc, Pietrain, Polish Landrace (PL), Polish Large White (PLW) and Line 990. A total of 91 meat samples was analysed (*i.e.* about 18 samples from each pig breed). The fattening and slaughter of the animals was performed at the Pig Progeny Testing Station, Pawłowice. The animals were maintained in the same environmental and nutrition conditions and were slaughtered after reaching a weight of 100 kg. The measurement of the pH₁ value was made on the *musculus longissimus thoracis* [PN-ISO 2917 2001], at the height of the last breast vertebra, 45 minutes after slaughter. Twenty four hours after slaughter a sample weighing about 700 g was cut out from the *musculus longissimus thoracis* of the right carcass side and stored in a chilling room for a further 24 hours. The measurement of colour values (using a Minolta CR-200 colorimeter) was made 48 hours *post mortem*. Next, in order to determine the texture parameters, *i.e.* shear and compressing force, a meat sample weighing about 300 g was placed in brine (1% solution of NaCl) for 24 hours, next heated in brine (74°C, 40 min) and cooled (2°C, 24 h). The texture measurement was performed using the ZWICKI type 1120 machine. The shear force was

determined using the Warner-Bratzler device on a cubic sample (20 mm), cut crosswise to the muscle fibres. The maximum force necessary to cut the sample constituted the result. The speed of the machine head movement reached 30 mm/min until an initial tension of 0.5 N, and 50 mm/min during the true measurement. The compressing force was measured on rectangular samples (20 mm), compressed between two parallel plates, longwise to the muscle fibres, until 50% of their original thickness. The speed of the machine head movement was the same as for the measurement of the shear force.

The remaining part of the chilled meat sample was ground twice in a laboratory grinder, using a plate with holes 5 mm in diameter and next carefully mixed to ensure a uniform sample. In samples thus prepared the content of the following chemical components was analysed: water [PN-ISO 1442 2000], protein [PN-75/A-04018], free fat [PN-ISO 1444 2000], total ash [PN-ISO 936 2000] and total heme pigments [Hornsey 1956]. The estimation of the technological value of meat included a measurement of pH₂ [PN-ISO 2917 2001], water holding capacity by the Grau and Hamm filter paper method [Ćwiczenia... 2000] and cooking loss (meat sample of 30 g heated in a covered beaker to 72°C for 30 minutes).

The results obtained were subjected to a statistical analysis based on one-way analysis of variance, and Tukey's test (Statgraphics 4.1. software).

RESULTS AND DISCUSSION

The pig breed proved to be a factor differentiating significantly the content of the basic chemical components in meat (*m. longissimus thoracis*). The lowest water content was recorded for meat of the Pietrain breed, while for the PL, PLW and Line 990 pigs the water content was significantly higher (Table 1). The meat of the Pietrain breed was marked also by a protein content significantly higher than that observed for the remaining breeds. In comparison to the meat of Duroc pigs this difference reached as much as 1.4 per cent unit. Such differences in the protein content are consistent with the results of earlier works reported by other authors, who also observed a lower protein content in the meat of Duroc animals or crosses with this breed [Armero et al. 1998, Lee et al. 2002], and higher in the meat of Pietrain pigs [Orzechowska et al. 1996].

The estimation of the content of intramuscular fat demonstrated that its lowest content was observed in the meat from the PL, PLW and Pietrain pigs, while the highest in the meat of the Duroc breed. The significant effect of the pig breed on the content of intramuscular fat has also been emphasised by other authors [Wood et al. 1994, Grześkowiak et al. 2001]. A majority of authors confirmed also that the meat of the Duroc pigs, or of crosses with this breed, are characterized by a high share of intramuscular fat [Čandek-Potokar et al. 1996, Wood et al. 1996, Orzechowska 1997, Armero et al. 1998, Grześkowiak et al. 1998, Grześkowiak 1999, Brewer et al. 2002, Lee et al. 2002, Pommier et al. 2004], while a low content of this component is characteristic of the Pietrain pigs [Orzechowska et al. 1996, Brewer et al. 2002, Pommier et al. 2004]. The results obtained in the present work are consistent with this opinion.

The analysis of the effect of pig breed on the chemical composition of meat demonstrated moreover, that breed was not a factor differentiating the content of ash in meat, but it did have a significant effect on the content of total heme pigment – a significantly highest quantity was observed in the meat of PLW pigs, the lowest in Pietrain pigs.

Table 1. Chemical composition of pork (*m. longissimus thoracis*)
 Tabela 1. Skład chemiczny mięsa (*m. longissimus thoracis*)

| Component Składnik | Pig breed / line Rasa / linia świń | | | | | P | |
|---|---------------------------------------|--------------------|---|---|-----------------------|--------------------|----------|
| | Duroc | Pietrain | Polish landrace polska biała zwijsłoucha | Polish large white wielka biała polska | Line 990 linia 990 | | |
| | n = 18 | n = 19 | n = 18 | n = 18 | n = 18 | | |
| Water, % Woda, % | \bar{x} | 74.4 ^{ab} | 74.1 ^a | 75.1 ^c | 75.1 ^c | 74.8 ^{bc} | < 0.0001 |
| | SD | 0.9 | 0.5 | 0.6 | 0.5 | 0.6 | |
| Protein, % Białko, % | \bar{x} | 21.3 ^a | 22.7 ^b | 21.8 ^a | 21.8 ^a | 21.8 ^a | < 0.0001 |
| | SD | 0.6 | 0.5 | 0.7 | 0.7 | 0.8 | |
| Fat, % Tuszczyz, % | \bar{x} | 2.9 ^c | 1.7 ^{ab} | 1.3 ^a | 1.4 ^{ab} | 1.8 ^b | < 0.0001 |
| | SD | 0.8 | 0.3 | 0.3 | 0.4 | 0.5 | |
| Ash, % Popiół, % | \bar{x} | 1.1 ^a | 1.1 ^a | 1.2 ^a | 1.2 ^a | 1.1 ^a | > 0.05 |
| | SD | 0.2 | 0.2 | 0.1 | 0.2 | 0.1 | |
| Hem pigments, ppm Barwniki hemowe, ppm | \bar{x} | 69.8 ^{ab} | 68.6 ^a | 72.1 ^{ab} | 75.8 ^b | 70.3 ^{ab} | < 0.05 |
| | SD | 5.2 | 7.8 | 7.3 | 9.4 | 7.4 | |

\bar{x} – mean values, SD – standard deviation.

Means with the same superscript do not differ significantly.

\bar{x} – wartość średnia, SD – odchylenie standardowe.

Średnie oznaczone tym samym symbolem literowym nie różnią się istotnie między sobą.

The pig breed significantly affected the technological quality of the meat obtained (*m. longissimus thoracis*). The lowest value for pH₁ was recorded for the meat of the Pietrain breed, while significantly higher values (by over 0.5 unit) were observed for the meat from animals of the PL breed and Line 990 (Table 2). Significantly lower values for pH₁ of meat from the Pietrain pigs, observed also by other authors [Orzechowska 1997, Pommier et al. 2004], could result from the fact that this breed is considerably burdened by gene RYR1^T, a factor significantly accelerating the post-slaughter metabolism in meat and thus also the rate of pH decrease [Koćwin-Podsiadła et al. 1995, Przybylski et al. 1996, Tam et al. 1998, Wicke et al. 1998, Fisher et al. 2000, Krzęcio et al. 2001, Fernandez et al. 2002].

Significant differences in pH, observed in meat of the pigs examined, were recorded also 48 hours after slaughter. The lowest values of pH₂ were observed for the meat of Pietrain pigs, while the highest for the meat of Line 990 and Duroc pigs. The low values of pH₂ in the meat of Pietrain pigs could result from the considerable burdening of this population by gene RYR1^T and thus the occurrence of PSE meat [Fernandez et al. 2002]. The significantly lower pH₁ and pH₂ in the meat of Pietrain pigs lead to a significantly lower water holding capacity, compared to the meat from the remaining pig breeds examined. Numerous authors indicate that the lower the pH values the poorer is

Table 2. Technological quality features of pork (*m. longissimus thoracis*)
 Tabela 2. Wyróżniki jakości technologicznej mięsa (*m. longissimus thoracis*)

| Feature Wyróżnik | Pig breed / line – Rasa / linia świń | | | | | P | |
|--|--------------------------------------|--------------------|---|---|-----------------------|--------------------|----------|
| | Duroc | Pietrain | Polish landrace polska biała zwijsłoucha | Polish large white wielka biała polska | Line 990 linia 990 | | |
| | n = 18 | n = 19 | n = 18 | n = 18 | n = 18 | | |
| pH ₁ | \bar{x} | 6.25 ^{ab} | 5.84 ^a | 6.43 ^b | 6.22 ^{ab} | 6.35 ^b | < 0.01 |
| | SD | 0.32 | 0.52 | 0.48 | 0.45 | 0.41 | |
| pH ₂ | \bar{x} | 5.66 ^c | 5.47 ^a | 5.52 ^{ab} | 5.54 ^{ab} | 5.58 ^{bc} | < 0.0001 |
| | SD | 0.10 | 0.13 | 0.10 | 0.12 | 0.13 | |
| Water holding capacity, cm ² /g Zdolność utrzymywania wody własnej, cm ² /g | \bar{x} | 25.6 ^a | 31.5 ^b | 26.0 ^a | 24.4 ^a | 23.9 ^a | < 0.0001 |
| | SD | 2.8 | 5.0 | 3.6 | 4.1 | 2.8 | |
| Cooking loss, % Ubytki termiczne, % | \bar{x} | 8.1 ^a | 7.2 ^a | 8.6 ^a | 8.3 ^a | 8.4 ^a | > 0.05 |
| | SD | 2.2 | 2.4 | 2.0 | 1.9 | 1.6 | |

\bar{x} – mean values, SD – standard deviation.

Means with the same superscript do not differ significantly.

\bar{x} – wartość średnia, SD – odchylenie standardowe.

Średnie oznaczone tym samym symbolem literowym nie różnią się istotnie między sobą.

the water holding capacity of meat [Koćwin-Podsiadła et al. 1998, Petričević et al. 1998]. The meat of the remaining breeds tested did not differ as regards this feature, which is in agreement with the earlier observations of other authors [Čandek-Potokar et al. 1996, Gajic et al. 1999, Wojciechowski et al. 2002]. For the economy of meat processing, beside water holding capacity, of importance is also cooking loss. It was not significantly influenced by the pig breed.

The pig breed affected significantly the colour values of the meat (Table 3). It was observed, that among the breeds examined, the meat of Pietrain pigs was characterized by the greatest colour lightness (L*). Moreover, this meat was marked by the highest values for colour values a* and b*. The significantly higher colour lightness of the meat (*m. longissimus*) from Pietrain pigs, observed in earlier studies by Orzechowska [1997] and Pommier et al. [2004], could be related to the considerable burdening of this breed by gene RYR1^T, as the frequency of homozygous carriers of the halothane gene among pigs of this breed reaches 90% [Hodowla... 1994, Janik and Kamyczek 2001] and the results of numerous authors indicate that animals homozygous as regards gene RYR1^T produce meat lighter in colour [Przybylski et al. 1996, Tam et al. 1998, Jeremiah et al. 1999, Fisher et al. 2000, Krzęcio et al. 2001, Fernandez et al. 2002]. This tendency is linked both to the rapid decrease of the pH values in meat directly after slaughter and to the low pH values of mature meat obtained from pigs susceptible to stress (TT), as it has

Table 3. The colour values of pork (*m. longissimus thoracis*)
 Tabela 3. Składowe barwy mięsa (*m. longissimus thoracis*)

| Colour values Składowa barwy | Pig breed / line – Rasa / linia świń | | | | | P | |
|---------------------------------|--------------------------------------|--------------------|---|---|-----------------------|--------------------|----------|
| | Duroc | Pietrain | Polish landrace polska biała zwijsłoucha | Polish large white wielka biała polska | Line 990 linia 990 | | |
| | n = 18 | n = 19 | n = 18 | n = 18 | n = 18 | | |
| L* | \bar{x} | 49.96 ^a | 56.74 ^b | 50.66 ^a | 50.81 ^a | 50.47 ^a | < 0.0001 |
| | SD | 2.54 | 5.33 | 2.47 | 4.02 | 3.31 | |
| a* | \bar{x} | 7.39 ^a | 9.56 ^b | 7.09 ^a | 6.82 ^a | 6.58 ^a | < 0.0001 |
| | SD | 1.43 | 1.34 | 1.17 | 1.15 | 1.72 | |
| b* | \bar{x} | 0.59 ^a | 2.99 ^b | 0.29 ^a | 0.02 ^a | -0.12 ^a | < 0.0001 |
| | SD | 0.77 | 1.68 | 0.75 | 1.20 | 0.97 | |

\bar{x} – mean values, SD – standard deviation.

Means with the same superscript do not differ significantly.

\bar{x} – wartość średnia, SD – odchylenie standardowe.

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been demonstrated that there exist significant relations between colour lightness and pH values [Koćwin-Podsiadła et al. 1998, Petričević et al. 1998, Pommier et al. 2004].

The breed of pigs influenced also significantly the meat texture parameters (Table 4). It was observed, that a significantly lowest shearing force was necessary to cut the meat of pigs from the Duroc breed and Line 990, while the values obtained for this parameter for the Pietrain and PL pigs was higher. A high shearing force for the meat of Pietrain pigs was recorded also by Brewer et al. [2002]. Differences similar to those observed for shearing force were recorded also for the compressing force – the highest values were obtained for meat samples of the Pietrain pigs, the lowest for Duroc and Line 990 pigs. The differences observed for the texture parameters analysed were probably the result of differences in the content of intramuscular fat in meat. The meat of PL and Pietrain pigs was characterized by a low content of intramuscular fat (1.4 and 1.7%), while for an optimum sensoric quality the fat content should be about 2.5-3.0% [Wood et al. 1994, Daszkiewicz et al. 2005]. Moreover, the values obtained for the shearing force for the Pietrain breed could be affected by the burdening of this population by gene RYR1^T. Numerous authors consider that the burdening of pigs by this gene has an unfavourable effect on meat tenderness [Schwägele 2001, Brewer et al. 2002, Fernandez et al. 2002, Moelich et al. 2003].

It is also probable that the high content of intramuscular fat in the meat of Duroc and Line 990 pigs is responsible for its greater tenderness, expressed by the lower shearing force and on the lower hardness, indicated by the lower values obtained for the compressing force. The positive effect of the level of intramuscular fat on meat texture, evaluated by instruments and by sensory panel, was reported also by other authors [Wood et al. 1994, Eikelenboom et al. 1996, Wood et al. 1996, Fernandez et al. 1999, Grześkowiak 1999, Brewer et al. 2001, Moelich et al. 2003, Aaslyng and Støier 2004].

Table 4. Texture parameters of pork (*m. longissimus thoracis*)
 Tabela 4. Parametry tekstury mięsa (*m. longissimus thoracis*)

| Parameters Parametr | Pig breed / line – Rasa / linia świń | | | | | P |
|---|--------------------------------------|--------------------|---|---|-----------------------|----------|
| | Duroc | Pietrain | Polish landrace polska biała zwijsłoucha | Polish large white wielka biała polska | Line 990 linia 990 | |
| | n = 18 | n = 19 | n = 18 | n = 18 | n = 18 | |
| Shear force, N Siła cięcia, N | \bar{x} 23.4 ^a | 32.4 ^b | 30.1 ^b | 27.9 ^{ab} | 23.3 ^a | < 0.0001 |
| | SD 6.0 | 7.8 | 5.6 | 6.0 | 8.0 | |
| Compressing force, N Siła ściskania, N | \bar{x} 88.1 ^a | 128.9 ^b | 102.9 ^a | 96.1 ^a | 84.4 ^a | < 0.0001 |
| | SD 20.3 | 27.2 | 29.5 | 26.8 | 22.9 | |

\bar{x} – mean values, SD – standard deviation.

Means with the same superscript do not differ significantly.

\bar{x} – wartość średnia, SD – odchylenie standardowe.

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Thus the results obtained in the present work confirm, that the intramuscular fat is a very important indicator of pork quality and point to a higher quality of meat obtained from pigs of the Duroc breed or Line 990 than the Pietrain breed. However, it is worth emphasising, that the values obtained for texture parameters of meat obtained from Duroc pigs were similar to those obtained for meat of Line 990 pigs, in which the content of intramuscular fat was lower by 1.1. per cent unit. Thus the results obtained point to the value of Line 990 for the production of lean pork of good sensoric properties. This is important, as pork is commonly considered fatty meat and is not accepted principally by those consumers, who pay considerable attention to the food properties related to health.

CONCLUSIONS

The observed significant effect of pig breed on numerous quality features of meat indicates that the correct selection of animals for crossing is of critical importance for the quality of pork. Among the analysed different pig breeds maintained in Poland the meat obtained from the Duroc porkers demonstrated more favourable, while the meat obtained from Pietrain pigs less favourable, quality properties. This indicated that the improvement of the Polish pork quality should be based on a wider use of the Duroc breed, while the use of the Pietrain breed should be limited. Irrespective of the observed significant effect of the pig breed on the quality indicators of the pork produced, it was ascertained that the meat of PLW and PL porkers did not differ significantly as regards any of the characteristics analysed. Thus both those breeds may be used as a maternal component, equally valuable from the point of view of the quality of pork produced.

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OCENA PRZYDATNOŚCI PRZETWÓRCZEJ MIĘSA RÓŻNYCH RAS ŚWIŃ HODOWANYCH W POLSCE

Streszczenie. Celem pracy była ocena przydatności przetwórczej mięsa różnych ras świń hodowanych w Polsce. Materiał badawczy stanowił wycinek mięśnia najdłuższego (*m. longissimus thoracis*) pozyskiwany od świń ras duroc, pietrain, polskiej białej zwisłouchej, wielkiej białej polskiej i linii 990. Stwierdzono, iż rasa świń jest czynnikiem istotnie różnicującym wiele wyróżników jakości pozyskiwanego mięsa. Wśród analizowanej populacji korzystniejszymi cechami jakości charakteryzowało się mięso tuczników rasy duroc, natomiast gorszymi rasy pietrain. Zaobserwowano, iż mięso świń rasy duroc cechowało się dużą zawartością tłuszczu śródmięśniowego, co miało wpływ na małą siłę jego cięcia i ściskania, a tym samym dobrą przydatność kulinarną. Natomiast mięso świń rasy pietrain cechowało się niską jakością zarówno technologiczną, jak i kulinarną. Istotnie niższe pH₁, obserwowane w mięsie świń tej rasy, skutkowało dużą jego jasnością (L*) i obniżoną wodochłonnością. Ponadto surowiec ten odznaczał się wysoką siłą cięcia i ściskania. Uzyskane wyniki wskazują, iż poprawę jakości krajowej wieprzowiny można uzyskać przez większe wykorzystanie świń rasy duroc, a ograniczenie wykorzystywania świń rasy pietrain.

Słowa kluczowe: rasa świń, wieprzowina, jakość mięsa

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