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# MEAT QUALITY OF CROSSBRED PIGS WITH VARIOUS PERCENTAGE OF PIETRAIN AND DUROC BREEDS (E AND U CLASSES IN THE EUROP SYSTEM)

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**ABSTRACT**

This study comprised 160 meat samples (*m. longissimus lumborum*) from 160 abattoir carcasses of pigs representing 4 groups of crossbreeds: group I – ♀ (Deutsche Landschwein × Deutsche Edelschwein) × ♂ (Pietrain), group II – ♀ (Polish Large White × Polish Landrace) × ♂ (Duroc × Pietrain), group III – ♀ (Polish Landrace) × ♂ (Duroc × Pietrain), group IV – ♀ (Landrace × Yorkshire) × ♂ (Duroc). Each group consisted of 40 carcasses (20 of which were each class E and U). After slaughter, hot carcass weight, backfat thickness, longissimus lumborum muscle thickness, and the percentage of meat in the carcass (Sydel CGM) were determined on the processing line, and after 48 hours in the laboratory – the colour characteristics of the meat (lightness – $L^*$, redness – $a^*$, yellowness – $b^*$, chroma – $C^*$, and hue angle – $h°$), water holding capacity (WHC), $pH_{48}$, and the percentage of dry matter, total protein, fat, and ash. The highest $a^*$, $b^*$ and $C^*$, the lowest $pH_{48}$, and the highest level of dry matter were found in meat from group I (50% Pietrain pigs). The lowest $L^*$, lowest WHC, and the highest $pH_{48}$ were found in meat from group IV (50% Duroc pigs). No significant differences were found between E and U classes in $L^*$, $h°$ , WHC, $pH_{48}$, nor in the percentage of dry matter, total protein, fat, or ash in meat. In conclusion, meat quality characteristics were mainly significantly influenced by the type of commercial cross-breeding, and the influence of the class of carcass was mostly insignificant.

**Key words:** pork quality, crossbred pigs, Pietrain, Duroc, meatiness

## INTRODUCTION

Crossbred pigs delivered to abattoirs from large farms are characterized by a varied percentage of meat in the carcasses and the quality of their meat. The most important factor shaping the quality of the carcass and meat are the breeds and lines of pigs used in the crossbreeding and their contribution to the genotype of the pigs [Brewer et al. 2002, Florowski et al. 2006, Krasnowska and Salejda 2008, Pugliese and Sirtori 2012, Ruusunen et al. 2012, Alonso et al. 2015]. The quality of meat often deteriorates with the growth of the muscle, which is particularly evident in carcasses with the highest percentage of meat. For example, the presence of Pietrain breed in crossbreeds (especially 50%) leads to an increase in the amount of meat in the carcasses, but often causes a deterioration in meat quality, including its pH, WHC, and colour [Florowski et al. 2006]. On the other hand, the use of the Duroc breed in commercial cross-breeding (especially at 50%) reduces the proportion of meat in the carcasses and increases the backfat thickness [Blanchard et al. 1999, Edwards et al. 2003, Šimek et al. 2004, Li et al. 2013], and has a positive effect on the quality of meat, most often as an increase in intramuscular fat [Jandásek et al. 2004] and, as a result, an improvement in meat tenderness, greater WHC, and a darker colour [Šimek et al. 2004], often accompanied by a higher pH.

The aim of the study was to evaluate selected meat quality traits in four pig cross-breeds (both E and U classes in the EUROP classification system), with different proportions of Pietrain and Duroc breeds in the genotype.

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## MATERIAL AND METHODS

### Material

The study material consisted of 160 meat samples (*m. longissimus lumborum* – LL) from 160 carcasses of an equal proportion of E and U EUROP system of carcass classification (i.e. 80 carcasses each). The carcasses comprised four cross-breeds of pigs; Group I – the offspring of Deutsche Landschwein × Deutsche Edelschwein sows and Pietrain boars [(DL × DE) × P]; group II – the offspring of Polish Large White × Polish Landrace sows and Duroc × Pietrain boars [(PLW × PL) × (D × P)]; group III – offspring of Polish Landrace sows and Duroc × Pietrain boars [PL × (D × P)]; and group IV – offspring of Landrace × Yorkshire sows and Duroc boars [(L × Y) × D]. Forty carcasses were obtained for each group, 20 of each E and U classes in the EUROP system.

### Methods

The test material was obtained from the carcasses of pigs stunned and slaughtered on a processing line in accordance with applicable EU and national laws on animal protection.

The pigs were stunned by carbon dioxide and slaughtered according to normal commercial slaughter procedures. At the technological line, backfat thickness and longissimus muscle thickness were measured at the point $C_7$ (at the last thoracic vertebra) using a Sydel CGM apparatus, and the percentage of meat in the carcass was determined in accordance with the EUROP system. Before the carcasses were cooled, their warm mass was determined. After the two-step cooling of the half-carcasses (cooled for 60 min at –20°C and then stored for 24 hours at 4°C), 1 kg samples of meat (meat with bone) were taken from the segment between the 1st and 4th lumbar vertebrae on the right half-carcass. The meat samples were then packed in foil and transported in a thermos to the laboratory where they were stored at 4°C until the following day.

About 48 hours after slaughter, the meat was separated from the bones and the external fat removed, then minced twice using a 4 mm meat grinder mesh. Measurements of colour, WHC and $pH_{48}$ of the meat were then made, followed by determination of the percentage of dry matter, crude protein, intramuscular fat, and ash.

Meat colour measurements were carried out using a Mini Scan XE Plus 45/0, with an aperture of 31.8 mm, adapted to colour measurements of minced meat. Standardization of the apparatus was carried out using a black standard and white standard with coordinates X = 78.5, Y = 83.3, and Z = 87.8 (for illuminant D65 and standard 10° observer). The colour parameters of individual samples on the CIELAB and CIELCh scales [CIE 1976; CIE 1978] were determined using the D65/10° recommended for meat colour measurements [Honikel 1998]. The colour measurements were made after placing the meat in the measuring vessel, smoothing the surface, and keeping it for 20 minutes at 4°C in order to oxidize the myoglobin in the surface layer of the meat. Color measurements in CIELAB and CIELCh scales were performed using duplicate standards, obtaining all the parameters of the sample's colour from only one measurement.

The water holding capacity (WHC) of meat was determined using the Grau and Hamm method [Grau and Hamm 1952] as modified by Pohja and Niinivaara [1957], as the percentage of bound water in total water.

The $pH_{48}$ was measured using a combined glass electrode ERH-12–6 (HYDROMET S.C.) and CyberScan 10 pH meter (Eutech Cybernetics Pte Ltd., Singapore) in water extract (distilled water) with a 1:1 meat to water ratio, after one hour of extraction.

The levels of the primary chemical components in the meat were determined in accordance with AOAC [2003].

The obtained results were analyzed using Statistica 13 (TIBCO Software Inc.). Averages and standard deviations were calculated, as well as one-factor analysis of variance for the examined traits between the groups and within each group – between averages for traits in E and U classes. The significance of differences between the averages was estimated by Duncan's test, with levels of significance $P \leq 0.05$ and $P \leq 0.01$.

## RESULTS AND DISCUSSION

Table 1 shows the average carcass weight, backfat thickness, muscle thickness and percentage of meat in the carcass in the examined groups.

The average carcass weight in groups I and II was significantly higher than in groups III and IV. The mean LL muscle thickness in group II was significantly lower than in groups I and III. However, there were no significant differences between the groups in backfat thickness or percentage of percentage of meat in the carcass.

The average carcass weight in class E was significantly higher in groups I, II and IV than in group III. In class U, the carcass weight was significantly higher in groups I and II than in groups III and IV. In class E, backfat thickness in group II was significantly lower than in group III, the thickness of muscle in class II was significantly lower than in groups I, III and IV, and the percentage of carcass meat in group I was significantly higher than in groups II and III. On the other hand, in the U class, backfat thickness and muscle thickness in group I were significantly higher than in group IV, while backfat thickness in group I was also significantly higher than in group II. However, there were no significant differences in the percentage of meat in the carcass.

**Table 1.** The results of the slaughter value

**Tabela 1.** Wyniki oceny wartości rzeźnej

| Trait<br>Cecha | I (DL × DE) × P (n = 40) x̄ | s | II (PLW × PL) × (D × P) (n = 40) x̄ | s | III PL × (D × P) (n = 40) x̄ | s | IV (L × Y) × D (n = 40) x̄ | s | Statistical significance<br>Istotność statystyczna |
|---|---|---|---|---|---|---|---|---|---|
| **Group – Grupa** | | | | | | | | | |
| Warm carcass weight, kg<br>Masa tuszy ciepłej, kg | 93.73 | 6.67 | 92.20 | 6.32 | 85.40 | 6.93 | 87.82 | 7.97 | I > III**, IV**;<br>II > III**, IV* |
| Backfat thickness, mm<br>Grubość słoniny, mm | 17.60 | 4.18 | 16.40 | 3.66 | 17.55 | 3.33 | 16.60 | 3.16 | |
| Muscle LL thickness, mm<br>Grubość mięśnia LL, mm | 60.88 | 4.70 | 55.90 | 5.59 | 59.52 | 6.18 | 57.85 | 6.02 | II ** < I, III |
| Meat percentage in the carcass, %<br>Procent mięsa w tuszy, % | 55.56 | 2.90 | 54.96 | 2.47 | 55.22 | 2.44 | 55.35 | 2.48 | |
| **Class E – Klasa E** | (n = 20) | | (n = 20) | | (n = 20) | | (n = 20) | | |
| Warm carcass weight, kg<br>Masa tuszy ciepłej, kg | 95.41 | 7.04 | 91.36 | 5.60 | 85.12 | 7.06 | 91.09[a] | 7.24 | I, II, IV > III ** |
| Backfat thickness, mm<br>Grubość słoniny, mm | 14.20[A] | 2.50 | 13.60[A] | 1.93 | 15.45[A] | 2.14 | 14.40[A] | 1.39 | II < III* |
| Muscle LL thickness, mm<br>Grubość mięśnia LL, mm | 62.65[a] | 4.28 | 57.15 | 4.79 | 62.20[A] | 5.74 | 60.50[A] | 3.68 | II < I**, III**, IV* |
| Meat percentage in the carcass, %<br>Procent mięsa w tuszy, % | 58.16[A] | 1.28 | 57.06[A] | 1.27 | 57.25[A] | 1.31 | 57.46[A] | 1.18 | I* > II, III |
| **Class U – Klasa U** | (n = 20) | | (n = 20) | | (n = 20) | | (n = 20) | | |
| Warm carcass weight, kg<br>Masa tuszy ciepłej, kg | 92.05 | 5.97 | 93.06 | 7.01 | 85.68 | 6.97 | 84.75[b] | 7.54 | I, II > III**, IV** |
| Backfat thickness, mm<br>Grubość słoniny, mm | 21.00[B] | 2.29 | 19.20[B] | 2.71 | 19.65[B] | 2.98 | 18.80[B] | 2.89 | I* > IV |
| Muscle LL thickness, mm<br>Grubość mięśnia LL, mm | 59.10[b] | 4.52 | 54.65 | 6.15 | 56.85[B] | 5.51 | 55.20[B] | 6.79 | I* > II, IV |
| Meat percentage in the carcass, %<br>Procent mięsa w tuszy, % | 52.95[B] | 1.16 | 52.87[B] | 1.30 | 53.19[B] | 1.37 | 53.25[B] | 1.37 | |

Means in columns with different superscript letters differ significantly: lower case at $P \le 0.05$, upper case at $P \le 0.01$; $^*P \le 0.05$, $^{**}P \le 0.01$.
Średnie w kolumnach oznaczone różnymi literami różnią się istotnie: małymi przy $P \le 0,05$, dużymi przy $P \le 0,01$; $^*P \le 0,05$, $^{**}P \le 0,01$.

As expected, in each group, the percentage of meat in the carcass and the thickness of the LL muscle in class E was significantly higher, and backfat thickness significantly lower than in class U, apart from group II where the difference in muscle thickness was not statistically significant. Moreover, in group IV, the mean warm carcass weight in class E was significantly greater than in class U.

Table 2 shows how parameters ($L^*$, $a^*$, $b^*$, $C^*$, $h°$), WHC and $pH_{48}$ were shaped in the studied groups. The results indicate that the development of these meat quality traits was mainly influenced by the type of crossbreeding of the pigs, while the influence of the classes of carcass (apart from some colour parameters ($a^*$, $b^*$, $C^*$) in groups I and II) was statistically insignificant.

The influence of the breed mix on the colour of the meat was seen in the levels of pigments, basic chemical components, the glycolytic potential and the rate and extent of decrease in muscle pH after slaughter. For example, muscles from pigs of the Pietrain and the crossbreds with a high proportion of Pietrain are often characterized by a lower pH and high lightness in meat colour. The muscles of Duroc pigs and their crossbreds mixes (e.g. Landrace or Yorkshire) often have a darker colour [Blanchard et al. 1999] associated with a higher pH [Newcom et al. 2004]. This is confirmed by the results discussed in this paper. Meat obtained from the pigs in group I (50% Pietrain boar) had a significantly lower $pH_{48}$ than the other groups, and a significantly higher lightness ($L^*$) than groups II and IV (50% Duroc boar). Also after dividing the material into E and U classes, meat lightness ($L^*$) in group I was significantly higher than in group IV (in both classes).

The chromatic parameters of pork color depend on the amount of pigments in the meat and its structure, and on the relative amounts of the three chemical forms

**Table 2.** Physicochemical property of the *m. longissimus lumborum* (LL)

**Tabela 2.** Właściwości fizykochemiczne *m. longissimus lumborum* (LL)

| Trait<br>Cecha | Group – Grupa | | | | | | | | Statistical significance<br>Istotność statystyczna |
|---|---|---|---|---|---|---|---|---|---|
| | I (DL × DE) × P | | II (PLW × PL) × (D × P) | | III PL × (D × P) | | IV (L × Y) × D | | |
| | (n = 40) | | (n = 40) | | (n = 40) | | (n = 40) | | |
| | x̄ | s | x̄ | s | x̄ | s | x̄ | s | |
| *L**– lightness<br>*L**– jasność | 54.68 | 2.08 | 53.54 | 2.36 | 53.99 | 2.47 | 52.72 | 2.17 | I > II*, IV**; III > IV* |
| *a**– redness<br>*a**– czerwoność | 8.86 | 0.91 | 7.86 | 1.02 | 7.78 | 0.85 | 7.57 | 1.12 | I** > II, III, IV |
| *b**– yellowness<br>*b**– żółtość | 16.44 | 0.80 | 15.10 | 0.83 | 15.34 | 0.83 | 15.27 | 0.75 | I** > II, III, IV |
| *C**– chroma<br>*C**– nasycenie | 18.69 | 0.98 | 17.05 | 0.95 | 17.22 | 0.91 | 17.07 | 0.93 | I** > II, III, IV |
| *h*°– hue angle<br>*h*°– ton | 61.71 | 2.19 | 62.53 | 3.09 | 63.11 | 2.54 | 63.70 | 3.27 | I < III*, IV** |
| WHC, % | 74.62 | 2.74 | 72.86 | 5.54 | 76.52 | 4.58 | 81.23 | 4.80 | I, II, III < IV**; II** < III |
| $pH_{48}$ | 5.49 | 0.07 | 5.63 | 0.18 | 5.71 | 0.23 | 5.76 | 0.13 | I** < II, III, IV; II < III*, IV** |
| | Class E – Klasa E | | | | | | | | |
| | (n = 20) | | (n = 20) | | (n = 20) | | (n = 20) | | |
| *L**– lightness<br>*L**– jasność | 54.94 | 2.43 | 53.49 | 2.33 | 53.71 | 2.92 | 52.51 | 2.36 | I > IV** |
| *a**– redness<br>*a**– czerwoność | 8.53$^{a}$ | 0.83 | 7.62 | 0.74 | 7.75 | 1.04 | 7.47 | 1.22 | I > II**, III*, IV** |
| *b**– yellowness<br>*b**– żółtość | 16.16$^{a}$ | 0.76 | 14.75$^{A}$ | 0.76 | 15.18 | 0.97 | 15.14 | 0.69 | I** > II, III, IV |
| *C**– chroma<br>*C**– nasycenie | 18.29$^{A}$ | 0.76 | 16.62$^{A}$ | 0.71 | 17.07 | 1.09 | 16.91 | 0.92 | I** > II, III, IV |
| *h*°– hue angle<br>*h*°– ton | 62.17 | 2.59 | 62.65 | 2.74 | 62.99 | 3.05 | 63.85 | 3.56 | |
| WHC, % | 74.88 | 2.28 | 73.77 | 6.12 | 76.57 | 5.25 | 80.03 | 5.51 | I**, II**, III* < IV |
| $pH_{48}$ | 5.49 | 0.07 | 5.64 | 0.19 | 5.73 | 0.23 | 5.73 | 0.12 | I** < II, III, IV |
| | Class U – Klasa U | | | | | | | | |
| | (n = 20) | | (n = 20) | | (n = 20) | | (n = 20) | | |
| *L**– lightness<br>*L**– jasność | 54.43 | 1.68 | 53.60 | 2.45 | 54.27 | 1.95 | 52.92 | 2.01 | I > IV* |
| *a**– redness<br>*a**– czerwoność | 9.19$^{b}$ | 0.89 | 8.10 | 1.22 | 7.82 | 0.64 | 7.67 | 1.04 | I** > II, III, IV |
| *b**– yellowness<br>*b**– żółtość | 16.72$^{b}$ | 0.76 | 15.45$^{B}$ | 0.76 | 15.50 | 0.63 | 15.39 | 0.81 | I** > II, III, IV |
| *C**– chroma<br>*C**– nasycenie | 19.09$^{B}$ | 1.03 | 17.48$^{B}$ | 0.98 | 17.37 | 0.68 | 17.22 | 0.94 | I** > II, III, IV |
| *h*°– hue angle<br>*h*°– ton | 61.25 | 1.65 | 62.41 | 3.46 | 63.23 | 1.96 | 63.55 | 3.04 | I* < III, IV |
| WHC, % | 74.37 | 3.18 | 71.96 | 4.89 | 76.48 | 3.93 | 82.44 | 3.73 | I, II, III < IV**; II** < III |
| $pH_{48}$ | 5.49 | 0.06 | 5.61 | 0.17 | 5.70 | 0.23 | 5.79 | 0.13 | I** < II, III, IV; II** < IV |

Means in columns with different superscript letters differ significantly: lower case at $P \leq 0.05$, upper case at $P \leq 0.01$; $^{*}P \leq 0.05$, $^{**}P \leq 0.01$.
Średnie w kolumnach oznaczone różnymi literami różnią się istotnie: małymi przy $P \leq 0,05$, dużymi przy $P \leq 0,01$; $^{*}P \leq 0,05$, $^{**}P \leq 0,01$.

of myoglobin present in raw meat, i.e.: oxymyoglobin, deoxymyoglobin and metmyoglobin. The same muscles from pigs of similar age but different breeds generally do not show large variations in pigment amounts, although some studies do indicate significant differences [Lindahl et al. 2001, Newcom et al. 2004]. However, the differences in the content of pigments in pork is only reflected to a small extent in the colour characteristics [Feldhusen 1994, Newcom et al. 2004] due to the significant influence of the structure of the meat determining the thickness of the surface layer which light can penetrate and thus the amount of pigments reached by light.

The redness (*a**) of pork depends mainly on the amount of pigments reached by light and the proportion of three chemical forms of myoglobin, while the yellowness ($b^*$) depends almost exclusively on the relative amount of chemical forms of myoglobin [Lindahl et al. 2001, Karamucki et al. 2013].

In the analyzed material the greatest redness ($a^*$) was characteristic for meat from group I, with significantly more red ($a^*$) than the other groups, even after separately considering E and U classes. Meat colour from group I was also characterized by significantly higher yellowness ($b^*$) in comparison with meat colour from groups II, III and IV, also after division of material into E and U classes. The highest $a^*$ and $b^*$ in group I (50% Pietrain) were probably caused by the highest amount of oxymyoglobin in meat samples in this group, which also had the lowest $pH_{48}$. As it is known, low pH levels of fresh meat are conducive to the oxidation of myoglobin [Karamucki et al. 2013] and its bright red chemical form. Oxymyoglobin has the highest redness ($a^*$) and yellowness ($b^*$) among the three previously mentioned chemical forms of myoglobin [Lindahl et al. 2001, Karamucki et al. 2013]. Brewer et al. [2002] report that chops from Pietrain carcasses had the highest $a^*$ while chops from Duroc carcasses had the lowest. The influence of the Pietrain and Duroc genotypes on the redness ($a^*$) of pork was also confirmed in the discussed material – the colour of meat obtained from pigs with 50% Pietrain (group I) was characterized by significantly higher redness ($a^*$), yellowness ($b^*$), and chroma ($C^*$) than from pigs with 25% and especially 50% share of the Duroc breed. Also, the hue angle ($h°$) of meat in group I was most red (the lowest $h°$) – significantly more red than groups III and IV, with no significant differences in hue angle ($h°$) between groups in class E. Hue angle ($h°$) and chroma ($C^*$) are calculated on the basis of $a^*$ and $b^*$ – and so they depend both on the amount of pigments reached by light and on the relative number of individual chemical forms of myoglobin. The highest colour chroma ($C^*$) of meat in group I was therefore the result of the highest $a^*$ and $b^*$ in this group.

The highest WHC, significantly higher than in the other groups, was characteristic of meat from the pigs with 50% Duroc genotype (group IV). At the same time, meat from group III had significantly higher WHC than meat from group II, which was not recorded in class

**Table 3.** Basic chemical composition of the *m. longissimus lumborum* (LL)

**Tabela 3.** Podstawowy skład chemiczny *m. longissimus lumborum* (LL)

| Trait<br>Cecha | Group – Grupa | | | | | | | | Statistical significance<br>Istotność statystyczna |
|---|---|---|---|---|---|---|---|---|---|
| | I (DL × DE) × P | | II (PLW × PL) × (D × P) | | III PL × (D × P) | | IV (L × Y) × D | | |
| | (n = 40) | | (n = 40) | | (n = 40) | | (n = 40) | | |
| | x̄ | s | x̄ | s | x̄ | s | x̄ | s | |
| Dry matter, %<br>Sucha masa, % | 25.67 | 0.75 | 25.00 | 0.88 | 24.91 | 0.67 | 25.05 | 0.58 | I** > II, III, IV |
| Crude protein, %<br>Białko ogólne, % | 22.55 | 0.43 | 22.27 | 0.54 | 21.93 | 0.66 | 22.31 | 0.56 | I > II*, III**; III < II**, IV* |
| Intramuscular fat, %<br>Tłuszcz śródmięśniowy, % | 2.05 | 0.79 | 1.69 | 0.56 | 1.89 | 0.57 | 1.82 | 0.66 | I > II* |
| Ash, % – Popiół, % | 1.08 | 0.08 | 1.05 | 0.07 | 1.12 | 0.05 | 1.10 | 0.09 | I < III*; II < III**, IV* |
| | Class E – Klasa E | | | | | | | | |
| | (n = 20) | | (n = 20) | | (n = 20) | | (n = 20) | | |
| Dry matter, %<br>Sucha masa, % | 25.89 | 0.68 | 24.74 | 0,89 | 24.93 | 0.67 | 25.09 | 0.70 | I** > II, III, IV |
| Crude protein, %<br>Białko ogólne, % | 22.60 | 0.43 | 22.15 | 0.59 | 21.91 | 0.67 | 22.48 | 0.55 | I > II*, III**; III** < IV |
| Intramuscular fat, %<br>Tłuszcz śródmięśniowy, % | 2.22 | 0.83 | 1.57 | 0.55 | 1.92 | 0.62 | 1.69 | 0.70 | I > II**, IV* |
| Ash, % – Popiół, % | 1.10 | 0.07 | 1.04 | 0.08 | 1.13 | 0.04 | 1.08 | 0.04 | II < I **, III**, IV*; III* > IV |
| | Class U – Klasa U | | | | | | | | |
| | (n = 20) | | (n = 20) | | (n = 20) | | (n = 20) | | |
| Dry matter, %<br>Sucha masa, % | 25.45 | 0.77 | 25.26 | 0.80 | 24.89 | 0.69 | 25.00 | 0.45 | I* > III |
| Crude protein, %<br>Białko ogólne, % | 22.49 | 0.44 | 22.40 | 0.46 | 21.94 | 0.67 | 22.14 | 0.52 | I > III**, IV* |
| Intramuscular fat, %<br>Tłuszcz śródmięśniowy, % | 1.89 | 0.73 | 1.81 | 0.55 | 1.85 | 0.53 | 1.94 | 0.60 | |
| Ash, % – Popiół, % | 1.07 | 0.08 | 1.07 | 0.05 | 1.11 | 0.06 | 1.12 | 0.12 | |

*P ≤ 0.05, **P ≤ 0.01.

E. The favorable influence of the Duroc genotype on WHC was recorded by Florowski et al. (2006), with better WHC, significantly higher $pH_1$ and $pH_u$, and lower lightness ($L^*$) than from the Pietrain breed, as well as the highest content of intramuscular fat and the best tenderness.

The level of $pH_u$ has a significant influence on the quality of pork [Bidner et al. 2004; Czarnecka-Skubina et al. 2010] and is related to other quality characteristics of that meat such as colour and WHC, with higher $pH_u$ usually accompanied by lower colour lightness ($L^*$) and higher WHC. As mentioned earlier, the lowest average $pH_{48}$, significantly lower than in the other groups, was found in the case of meat obtained from pigs with 50% Pietrain genotype (group I), which was also noted in the classification of carcasses into E and U classes. On the other hand, the highest mean $pH_{48}$ was found in meat with 50% Duroc genotype (group IV), being significantly higher than group I and also (apart from class E) group II. These results confirm the significant influence of the Pietrain breed [Florowski et al. 2006] and Duroc breed [Blanchard et al. 1999, Florowski et al. 2006, Li et al. 2013] on meat $pH_u$.

Between Class E and Class U crossbreeds, there were no significant differences in lightness ($L^*$) or hue angle ($h°$) of meat colour, WHC, or $pH_{48}$. In group I the meat colour obtained from class E carcasses was characterized by significantly higher redness ($a^*$), yellowness ($b^*$), and chroma ($C^*$), and in groups I and II, significantly higher yellowness ($b^*$) and chroma ($C^*$) than meat colour in class U.

Table 3 shows how the percentages of dry matter, crude proteins, intramuscular fat, and ash in the meat were shaped in the studied groups. The results indicate that the percentage of meat was mainly influenced by the type of crossbreeding, while the influence of the muscle class was statistically insignificant. The highest dry matter content was recorded in group I (50% Pietrain). In this group the highest content of intramuscular fat was also recorded, with a significant difference recorded only between groups I and II, and between groups I and II and IV in class E. Also, Daszkiewicz et al. [2005] stated that an increase in the fat content in the meat was accompanied by an increase in its dry matter content. At the same time, these authors noted a decrease in the concentrations of crude protein and ash, which was not found in this study. The content of crude protein in meat in group I was significantly higher than in groups II and III and significantly lower in group III than in II and IV. In class E, the content of crude proteins was significantly higher in group I than in II and III and significantly lower in group III than in IV. On the other hand, in class U, the crude protein content was significantly higher in group I than in III. On the other hand, ash content was significantly lower in group I than in III and significantly lower in group II than in III and IV. In class E ash content was significantly lower in group II than in the other groups and significantly higher in group III than in IV. In class U, however, no significant differences in ash content between the groups were observed.

As mentioned in the introduction, studies by other authors [Blanchard et al. 1999, Laube et al. 2000, Alonso et al. 2015] indicate that the Duroc genotype in crossbreeding increases the intramuscular fat content of their offspring. The appropriate content of that fat in pork has a positive influence on its sensory and technological quality [Fernandez et al. 1999, Fortin et al. 2005, Czarnecka-Skubina et al. 2010]. In this study, the intramuscular fat content in meat was not high in all groups, and in group I, the highest, it was 2.05%, while in group IV (50% Duroc) it was only 1.82%. Fortin et al. [2005] reported that 1.5% of intramuscular fat was the minimum level necessary to ensure a pleasing eating experience. In contrast, Daszkiewicz et al. [2005] found that only an IMF (intramuscular fat) level above 3% had a positive effect on the palatability, juiciness, and tenderness of pork.

In all groups of crossbreeds, no significant differences in the percentage of dry matter, crude protein, intramuscular fat or ash were found between class E and class U.

The development of meat quality traits in the examined pork meat was mainly influenced by the type of cross-breeding, while the influence of the class (E and U) was most often insignificant.

## CONCLUSIONS

It was found that the highest redness ($a^*$), yellowness ($b^*$), and chroma ($C^*$), the lowest $pH_{48}$, and the highest dry matter level were characteristic for meat obtained from the carcasses of 50% Pietrain crossbreed pigs, while the lowest lightness ($L^*$), the highest WHC and the highest $pH_{48}$ were characteristic for meat obtained from the crossbreed carcasses of the Duroc breed. No significant differences were found in any of the groups of crossbred pigs between the E and U classes in lightness ($L^*$) and hue angle ($h°$), WHC, $pH_{48}$, percentage of dry matter, crude protein, intramuscular fat or ash content in the meat. The quality features of the examined meat were influenced mainly by the type of commercial crossbreeding, while the influence of the class (E, U) was usually insignificant. The obtained results confirm the results of other authors' research indicating the significant influence on the quality of the pork meat by the different proportions of Pietrain and Duroc genotypes in commercial cross-breeding.

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## JAKOŚĆ MIĘSA TUCZNIKÓW MIESZAŃCÓW Z RÓŻNYM UDZIAŁEM RAS PIETRAIN I DUROC SKUPOWANYCH W KLASACH E I U SYSTEMU EUROP


### STRESZCZENIE

Badaniami objęto 160 prób mięsa (*m. longissimus lumborum*) pobranych ze 160 tusz tuczników mieszańców reprezentujących cztery krzyżówki międzyrasowe: grupa I – ♀ (deutsche landschwein × deutsche edelschwein) × ♂ pietrain, grupa II – ♀ (wbp × pbz) × ♂ (duroc × pietrain), grupa III – ♀ pbz × ♂ (duroc × pietrain), grupa IV – ♀ (landrace × yorkshire) × ♂ duroc. Każda grupa liczyła 40 tusz (po 20 zaliczonych do klas E i U). Po uboju na linii technologicznej określono masę tuszy ciepłej, grubość słoniny i mięśnia longissimus oraz procentową zawartość mięsa w tuszy (aparat Sydel CGM), a po 48 godzinach w laboratorium – barwę mięsa ($L^*$, $a^*$, $b^*$, $C^*$, $h°$), WHC, $pH_{48}$ oraz procentową zawartość w mięsie suchej masy, białka ogólnego, tłuszczu i popiołu. Stwierdzono, że największą czerwonością ($a^*$), żółtością ($b^*$) i nasyceniem ($C^*$), najniższym $pH_{48}$ oraz największą zawartością suchej masy cechowało się mięso tusz z grupy I, natomiast najmniejszą jasnością ($L^*$) barwy, największą wodochłonnością i najwyższym $pH_{48}$ – mięso tusz z grupy IV. Nie stwierdzono w żadnej z grup tuczników mieszańców istotnych różnic między klasą E a U w jasności ($L^*$) i tonie ($h°$) barwy, WHC, $pH_{48}$, procentowej zawartości w mięsie suchej masy, białka ogólnego, tłuszczu i popiołu. Na kształtowanie się cech jakościowych mięsa istotny wpływ miał przede wszystkim rodzaj krzyżówki towarowej, natomiast wpływ klasy mięsności (E, U) był najczęściej nieistotny.


**Słowa kluczowe:** jakość mięsa wieprzowego, tuczniki mieszańce, pietrain, duroc, mięsność

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