

Fattening performance, carcass traits, and meat quality of pigs from DanBred sows and Topigs Norsvin boars

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The study evaluated fatteners produced by crossing DanBred Yorkshire-Landrace (YL) sows with purebred Landrace, Pietrain, and Duroc boars from Topigs Norsvin. Approximately 200 pigs were assessed per crossbred group. From each group, 60 carcasses were analysed for lean meat content using the AutoFom device, and *longissimus lumborum* (LL) muscles from 30 carcasses were collected for meat quality evaluation. Pigs sired by Duroc boars exhibited significantly higher average daily gain (ADG) than Pietrain-sired pigs, while feed intake and feed conversion efficiency did not differ among groups. Carcasses from Landrace- and Pietrain-sired pigs contained more lean meat than those from Duroc-sired pigs. Across individual cuts (ham, loin, shoulder, and belly), Pietrain-sired pigs showed the highest lean meat content, followed by Landrace, with the lowest values observed in the Duroc group. Meat quality traits were most favourable in Duroc-sired pigs, as indicated by higher pH values and lower drip and thawing losses in both fresh and frozen meat. Their LL muscles also contained higher dry matter and intramuscular fat (IMF) levels compared with those of Landrace- and Pietrain-sired pigs. These attributes translated into superior sensory quality, reflected in higher scores for aroma, tenderness, juiciness, and flavour, as well as lower shear force values.

KEY WORDS: crossbred / fatteners / pork quality / slaughter value

Despite the high content of lean meat in modern pig carcasses, the meat industry continues to show strong interest in pig breeds and genetic lines with an even higher proportion of lean tissue. This interest is largely driven by a substantial segment of European Union consumers who prefer lean, high-quality pork for both health-related and sensory reasons [Gjerlaug-Enger *et al.* 2010].

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Achieving high production efficiency and pork quality depends largely on careful breed selection for crossbreeding, particularly regarding the paternal component. Duroc, Landrace, and Pietrain breeds have long been used in breeding programmes throughout Europe [Franco *et al.* 2014]. Among these breeds, Duroc is the most widely used terminal sire in pork production systems due to its excellent fattening efficiency, characterized by low feed intake and high daily weight gain [Martinsen *et al.* 2015, Chernenko *et al.* 2022], as well as its favourable meat quality.

Duroc's meat quality is primarily attributed to the breed's high intramuscular fat (IMF) content, which positively influences both technological properties and sensory attributes of pork [Koćwin-Podsiadła *et al.* 2004a, Grześ *et al.* 2005, Juárez *et al.* 2009, Nakev and Popova 2020]. Consequently, the use of purebred Duroc boars is recommended in crosses with breeds known for low IMF content. However, carcass and meat quality traits in Duroc-sired pigs may vary depending on the specific breeding programme from which the animals originate [Cilla *et al.* 2006, Serrano *et al.* 2008, Sieczkowska *et al.* 2010]. A similar pattern of origin-related variation has been reported in other breeds. For instance, a study by Kowalski *et al.* [2020] found that fattening performance and carcass and meat quality of Pietrain pigs varied depending on their country of origin (Belgium vs. France).

Among the three sire breeds analysed, Pietrain pigs display the lowest fattening efficiency, while exhibiting the highest lean meat content in the carcass. Their IMF content is also the lowest, which may negatively affect meat quality and increase the likelihood of producing pale, soft, exudative (PSE) meat [Migdał *et al.* 2020]. In contrast, Landrace pigs offer good production performance, although results may vary under different environmental conditions. Compared to Duroc, Landrace meat generally exhibits lower quality, reflected by lower pH, higher drip loss, paler colour, and lower IMF content – traits associated with reduced sensory appeal [Gjerlaug-Enger *et al.* 2010].

The use of Yorkshire-Landrace (YL) crossbred sows is a common strategy in pig production to enhance performance traits through hybrid vigour. These crossbreds are highly fertile, as indicated by large litter sizes and high piglet survival rates [Kasprzyk and Łucki 2014]. Although the available evidence limited, existing studies suggest that YL crossbreds from DanBred exhibit good carcass lean meat content and satisfactory meat quality [Koćwin-Podsiadła *et al.* 2004ab, Rybarczyk *et al.* 2018, Zhang *et al.* 2018].

To date, no studies have evaluated the potential of producing high-quality pork from fatteners derived from crosses between YL sows from the Danish company DanBred and purebred boars from the Dutch-Norwegian company Topigs Norsvin. Therefore, the aim of this study was to assess carcass value as well as the technological and sensory quality of the *longissimus lumborum* (LL) muscle in fatteners derived from DanBred (YL) sows crossed with purebred Duroc, Landrace, and Pietrain boars from Topigs Norsvin.

Material and methods

Animals

The study was conducted in 2015 at a single commercial pig farm after approval was obtained from the Local Ethical Review Committee for Animal Experiments in Szczecin, Poland (protocol no. 20/2015). All procedures complied with European Union regulations and national animal welfare standards.

The experiment involved three groups of crossbred finishing pigs supplied by a producer located in the Pomeranian Voivodeship (Poland). The pigs were progeny of DanAvl Hybrid sows (Yorkshire-Landrace; YL) from DanBred International crossed with purebred boars: Landrace (group YLL, $n = 5$), Pietrain (group YLP, $n = 5$), and Duroc (group YLD, $n = 5$) from Topigs Norsvin (Dutch-Norwegian breeding company). All animals were housed under identical environmental conditions in pens with fully slatted floors with free access to drinking water and a complete fattening diet (Tab. 1).

Table 1. Composition of the experimental diets

Items	Rosta	Finish
	20-50 kg body weight	45-100 kg body weight
Ingredient (g/kg on a DM basis)		
wheat grain	116.0	116.0
barley grain	106.0	106.0
triticale grain	106.0	106.0
wheat bran	-	156.0
NaCl	7.0	6.1
complementary feed	12.5	10.0
other ¹	652.5	499.9
Chemical composition		
metabolizable energy (MJ/kg)	11.80	11.60
net energy (MJ/kg)	9.74	9.51
crude protein (g/kg)	174.2	158.8
total fibre (g/kg)	38.0	46.6
crude fat (g/kg)	33.8	30.3
calcium (g/kg)	7.7	5.8
total phosphorous (g/kg)	6.0	4.5
lysine (g/kg)	12.6	9.8
methionine (g/kg)	3.9	2.8
methionine + cysteine (g/kg)	7.5	6.6
threonine (g/kg)	8.0	6.4
tryptophan (g/kg)	2.4	1.9
isoleucine (g/kg)	6.6	5.8
valine (g/kg)	7.9	7.2

¹Other: toasted post-extraction soybean meal, post-extraction rapeseed meal, rapeseed EP-100, narrow-leaved lupine, animal fat, finely ground chalk ($\text{CaCO}_3 \geq 94\%$, Ca – 37.6%), phosphate 1-CA2 (additive containing $\geq 22\%$ P and 15% Ca); protected feed formulation.

Norsvin Duroc is a purebred Duroc sire line established in 1986 in Norway. Since the beginning, the selection focus has been on a combination of production, carcass, and meat quality traits. Norsvin Landrace is a purebred Landrace established in 1958 in Norway. The line was initially selected for terminal efficiency (feed conversion

ratio, growth, carcass quality). Since the early 1990s, reproduction traits have been added to the selection index. TN Select is a 100% stress-free purebred Pietrain sire line established in 1998 in Germany. Selection focus has been on a combination of production and carcass quality traits, with a strong emphasis on carcass lean yield.

The experiment was carried out in one building with natural ventilation. The temperature during the fattening period decreased gradually from 19.5°C in week 1 to 16.5°C by week 12. Each pig had 0.65 m² of floor space, and the sex ratio within groups was kept close to 1:1. Pigs from each group were housed in four sectors, each comprising two pens of 16.67 m² accommodating around 25 pigs. The fattening phase lasted 76-78 days. At the end of this period, the YLL group contained 195 pigs, the YLP group 198 pigs, and the YLD group 173 pigs.

When the pigs reached approximately 105±9 kg body weight (around 160 days of age), 60 individuals from each group (8 pens × 8 pigs), balanced by sex (barrows and gilts) and of similar body weight, were chosen for slaughter evaluation (in total 180 carcasses). The pigs were transported 110 km (duration 2 h 5 min) in the same vehicle under conditions of 19-22°C. At the slaughterhouse, pigs were rested for 15 h at 15-17°C, with a total fasting period of 24 h. Importantly, pigs were not mixed with unfamiliar individuals either during transport or lairage.

Production traits

Body weight at the beginning (BW1) and at the end of the fattening period (BW2) was recorded. For all pigs within a given group, average daily gain (ADG), average daily feed intake (ADFI), feed conversion ratio (FCR), and mortality were monitored weekly. These values were determined based on weekly analyses of feed consumption, body weight, and losses recorded for each pen. Then, the fattening performance parameters were averaged over the eleven-week fattening period.

Carcass and fresh meat quality

At slaughter, pigs were stunned with a Butina CO₂ system (Marel, Iceland). The proportion of lean meat in the carcass and in specific cuts (ham, loin, shoulder, belly) was estimated non-invasively using an ultrasonic AutoFom device (SFK Technology, Herlev, Denmark). Hot carcass weight was determined before chilling with 100 g accuracy. Carcasses were cooled in three stages: initially at 1°C for 7-8 h, subsequently at -3 to -4°C for 6-7 h, and finally at 4-6°C for about 10 h. After chilling, 30 carcasses per group (85±5 kg hot carcass weight, balanced 1:1 for sex) were selected for further analysis.

During carcass cutting, samples of *LL* were collected from the section between the 1st and 4th lumbar vertebrae on the right side of the carcass. Muscle samples were packed in labelled foil bags, transported in insulated containers, and stored at 4°C until analysis. From each *LL*, three slices (3 cm thick) were cut from the anterior part for measurement of drip loss, pH value, and colour. The remaining portion was placed in plastic bags, labelled, and frozen at -19°C for about one month for subsequent determination of water-holding capacity, shear force, and sensory traits.

The following analyses were performed on fresh *LL* samples:

- pH was measured at 35 min, 3 h, and 24 h *post mortem* (*p.m.*) on right carcass halves stored in the cold room of the meat processing plant, and at 48 h and 96 h *p.m.* on *LL* muscles in the laboratory, using a portable pH meter equipped with a temperature probe (CP-411, Elmetron, Poland). The pH meter featured automatic temperature compensation (ATC); both the electrode and temperature sensor were immersed simultaneously during calibration with standardized buffer solutions (pH 4 and 7) and during muscle pH measurements.
- Electrical conductivity (EC) was recorded at 2 h and 24 h *p.m.* (EC_2 and EC_{24}) on right halves with the LF-Star device (Ingenieurbüro Matthäus, Germany).
- Drip loss was determined according to Prange *et al.* [1977]. At 24 h *p.m.*, 50 g muscle pieces were cut from the central part of the 3 cm slice, sealed in plastic bags, and stored at 4°C. Weight loss was expressed as percentage after 48 h and 72 h *p.m.*
- Colour characteristics: lightness (L^*), redness (a^*), yellowness (b^*), chroma (C^*), and hue angle (h°) were evaluated at 24 h and 48 h *p.m.* on freshly cut slices after 20 min blooming at 4°C using a HunterLab MiniScan XE Plus 45/0 with a measuring port diameter of 31.8 mm (HunterLab Inc., Virginia, USA) with standard illuminant D65 and 10° observer.

In addition, pH was determined at 24 h *p.m.* in the *semimembranosus muscle* (*SM*) of right carcasses halves with a CP-411 pH meter (Elmetron, Poland).

Frozen meat quality

Samples of the *LL* (approx. 300 g) were removed from frozen storage, weighed (pre-thaw weight), thawed at 4°C for 24 h. Subsequently, they were weighed again after thawing (pre-cook weight). Thawing loss was calculated as the percentage reduction between pre-thaw and pre-cook weights. The samples were then cooked in water at 80-81°C until the internal temperature reached 72°C in each sample, cooled to 20°C, and weighed once more (post-cook weight). Cooking loss was expressed as the percentage difference between pre-cook and post-cook weights, while total fluid loss was defined as the percentage difference between pre-thaw and post-cook weights. The muscle samples obtained in this way were used for shear force measurement and sensory evaluation.

Shear force was assessed with a Warner-Bratzler device manufactured by the Baking Industry Research Centre (Bydgoszcz, Poland). Cylindrical cores (1.0 cm diameter), cut parallel to the muscle fibres using a cork borer, were positioned in a triangular slot under the instrument's five blades. A V-shaped blade (60° angle) cut through the samples at a crosshead speed of 200 mm/min, and the maximum force (N) required to shear the meat was recorded. Each value represented the mean of three consecutive measurements.

The acceptability analysis of sensory attributes followed PN-EN ISO 8589:2010 guidelines. Subsamples of approximately 25 g were prepared to assess colour, aroma, tenderness, juiciness, and flavour. The meat portions were placed in lidded glass jars

(≈ 30 mL) coded with random three-digit numbers and held in a water bath at 54°C until serving. Evaluations were performed under daylight conditions at 20°C . To cleanse the palate, panellists consumed unsweetened hot tea between samples. A five-member trained panel conducted the evaluations across nine sessions using a 5-point hedonic scale (1 = unacceptable, 5 = very acceptable), in accordance with PN-EN ISO 8586:2014-03. Each session was held on a different day, with representative samples from each group of crossbred pigs selected for evaluation. During each of the nine sessions (10 samples per session), all participants assessed the same samples twice.

Proximate analysis

The basic chemical composition of *LL* muscle was determined according to AOAC [2016] official methods:

- Dry matter was determined by drying 2 g samples at 102°C for 12 h until constant weight was achieved using a SUP-4M dryer (Wawa-Med, Poland).
- Total protein content was determined by the Kjeldahl method (conversion factor 6.25), with a Kjeltec 2300 Foss Tecator distillation unit (Häganäs, Sweden).
- Crude fat was determined by extraction with light petroleum using a Büchi B-811 extraction system (Büchi, Switzerland).
- Crude ash (total mineral content) was determined after combustion at 550°C for 10 h in an FCE 7SHM Czylok muffle furnace (Jastrzębie-Zdrój, Poland).

Statistical analysis

For growth performance traits, comparisons between groups were conducted using the GLM procedure with the following model:

$$y_{ij} = \mu + a_i + \beta (x_{ij} - \bar{x}) + e_{ij}$$

where:

y_{ij} – measured trait;

μ – overall mean;

a_i – fixed effect of breed ($i = 1, 2, 3$);

β – partial linear regression coefficient for initial body weight;

x_{ij} – initial body weight of the ij -th individual;

\bar{x} – mean for initial body weight;

e_{ij} – random error.

For carcass and meat quality characteristics:

β – partial linear regression coefficient for hot carcass weight;

x_{ij} – hot carcass weight of ij -th individual;

\bar{x} – mean for hot carcass weight.

For sensory data, the above model was extended by including the panellist and session effect.

Prior to the main analysis, empirical distributions of recorded traits were checked using the Shapiro-Wilk test. Least squares means (LSM) were compared by Tukey's test, while traits with non-normal distribution were analysed with the non-parametric Kruskal-Wallis test. Statistical analyses were performed with Statistica software (TIBCO Statistica, v. 13.3; TIBCO Software Inc., Palo Alto, CA, USA).

Results and discussion

In the present study, the analysed pig groups did not show significant differences in fattening efficiency, with the exception of average daily gain (ADG), which was higher in pigs sired by Duroc boars compared to those sired by Pietrain boars (Tab. 2). Pigs sired by Landrace boars displayed fattening performance comparable to both Duroc- and Pietrain-sired animals. Comparable results have been reported in previous studies, where fatteners derived from Large White × Landrace (LWL) sows and Duroc boars showed higher ADG than those sired by Pietrain boars, although the latter exhibited higher carcass lean content [Morales *et al.* 2013]. Additional studies have confirmed that crossing YL or LWL sows with Duroc boars improves fattening efficiency, as evidenced by lower ADFI and improved FCR compared to pigs sired by Pietrain or Landrace boars [Lattore *et al.* 2003, Hoque and Suzuki 2008, Morales *et al.* 2013, Vidović *et al.* 2015]. Ganchev and Ilczev [2013] also reported that DanBred pigs had higher feed and water intake during the Starter and Grower phases than Topigs hybrids. Conversely, data from Norsvin's boar testing station showed that Norwegian Landrace boars had a higher growth rate of muscle and non-carcass tissues, and lower gains in bone and carcass fat, compared to Duroc boars. In fact, Landrace was identified as the most efficient breed relative to Duroc, based on the highest muscle mass, greatest ADG, and lowest FCR [Gjerlaug-Enger *et al.* 2012].

Table 2. Characteristics of the growth performance of fattening pigs sired by boars from Topigs Norsvin

Parameter	Crossbred pig groups			SEM	<i>p</i> -value
	YLL	YLP	YLD		
BW1 (kg)	29.64 ^b	32.02 ^a	29.72 ^b	0.39	0.013
BW2 (kg)	105.86	104.75	104.80	0.82	0.837
ADG (kg/day)	0.98 ^{ab}	0.93 ^b	0.99 ^a	0.01	0.038
ADFI (kg/day)	2.21	2.15	2.18	0.02	0.375
FCR (kg/kg)	2.26	2.32	2.21	0.02	0.148
Mortality (%)	3.41	4.81	1.56	0.64	0.116

^{ab}Means within rows bearing different superscripts differ significantly at $p \leq 0.05$. SEM – standard error of the mean. BW1 – body weight at the beginning of the fattening period; BW2 – body weight at the end; ADG – average daily gain; ADFI – average daily feed intake; FCR – feed conversion ratio. Number of pens (25 pigs per pen) per group: 8.

In the present study, carcasses of pigs sired by Duroc boars were the least lean overall and across individual primal cuts. Based on the lean meat content of specific carcass parts, Landrace-sired pigs had lower lean meat content than those sired by Pietrain boars (Tab. 3). These observations are supported by earlier research showing that hybrids derived from YL or L × Large White sows and Duroc boars had the lowest carcass and lean cut yields among groups that also included Landrace- and Pietrain-sired pigs, despite having the highest lean meat percentage [Lattore *et al.* 2003; Vidović *et al.* 2015]. Comparable lean meat contents were reported by Koćwin-Podsiadła *et al.* [2004b] for YL fatteners and their hybrids with Danish Duroc and purebred Landrace pigs (ranging from 56.14 to 56.91%). The same study also showed that, relative to the maternal YL line, YL × Duroc crossbreds had a longer fattening period (by six days), thinner backfat (by approx. 0.2 cm), greater loin weight without fat and skin (by approx. 1 kg), greater shoulder weight (by approx. 0.2 kg), and lower weights of belly (by approx. 0.5 kg) and ham without fat and skin (by approx. 0.4 kg). Similarly, Ruusunen *et al.* [2012] demonstrated that Finnish YL sows mated with Finnish or Norwegian Landrace boars produced pigs with longer loins and higher carcass lean content than pigs sired by Norwegian Duroc × Norwegian Landrace boars.

Table 3. Characteristics of the slaughter value of carcass of fattening pigs sired by boars from Topigs Norsvin

Trait	Crossbred pig groups			SEM	<i>p</i> -value
	YLL	YLP	YLD		
HCW (kg)	83.29 ^B	85.99 ^A	85.00 ^A	0.21	0.001
Lean meat in carcass (%)	58.54 ^A	58.81 ^A	56.80 ^B	0.14	0.001
Lean meat in ham (%)	61.47 ^B	63.01 ^A	59.73 ^C	0.17	0.001
Lean meat in loin (%)	56.31 ^B	57.69 ^A	53.50 ^C	0.23	0.001
Lean meat in shoulder (%)	58.67 ^B	59.84 ^A	57.27 ^C	0.13	0.001
Lean meat in belly (%)	54.70 ^B	56.03 ^A	52.67 ^C	0.19	0.001

^{ab}Means within rows bearing different superscripts differ significantly at $p \leq 0.05$.

SEM – standard error of the mean; HCW – hot carcass weight.

Sample size per group – 60.

In contrast to their lower lean meat content, Duroc-sired pigs in the present study were characterised by superior meat quality, as reflected in the highest pH values, best water-holding capacity, and highest IMF content (Tab. 4 and 5). These traits were associated and, likely contributed to, improved sensory characteristics and the lowest shear force values. Other studies have also confirmed the positive impact of crossbreeding YL sows with purebred Duroc boars – compared to YL or purebred Landrace fatteners – on the physicochemical and technological quality of pork [Koćwin-Podsiadła *et al.* 2004a, Grześ *et al.* 2005, Rybarczyk *et al.* 2018]. In the Norsvin breeding programme, the Norwegian Landrace and Duroc breeds differ markedly in meat quality: Landrace had lower pH and significantly higher drip loss than Duroc. Duroc meat was darker (lower L^*), redder (higher a^*), more yellow (higher b^*), and richer in IMF than Landrace meat [Gjerlaug-Enger *et al.* 2010]. Similar findings were reported by Ruusunen *et al.* [2012], who found that loins from

Finnish Landrace boars were lighter in colour (higher L^*) than loins from Norwegian Duroc \times Norwegian Landrace and Norwegian Landrace boars. Zhang *et al.* [2018] also observed that the pure breeds – Landrace, Yorkshire, and Duroc – outperformed their crossbred counterparts in meat quality under identical rearing conditions in the tested groups. However, YL and YLD crossbreds were found to produce meat with a more favourable fatty acid profile compared to the purebreds.

Table 4. Characteristics of the pH and electrical conductivity (EC) of muscles of fattening pigs sired by boars from Topigs Norsvin

Trait	Crossbred pig groups			SEM	<i>p</i> -value
	YLL	YLP	YLD		
pH _{35min}	6.48	6.50	6.44	0.02	0.317
pH ₃	5.99	6.09	5.98	0.03	0.199
pH ₂₄	5.52 ^B	5.49 ^B	5.63 ^A	0.01	0.001
pH ₂₄ SM	5.51	5.52	5.49	0.01	0.483
pH ₄₈	5.54 ^A	5.45 ^B	5.57 ^A	0.01	0.001
pH ₉₆	5.41 ^B	5.49 ^A	5.52 ^A	0.01	0.001
EC ₂ (mS/cm)	4.09	3.76	4.06	0.14	0.293
EC ₂₄ (mS/cm)	4.37	4.49	5.03	0.18	0.120

^{ab}Means within rows bearing different superscripts differ significantly at $p \leq 0.01$. SEM – standard error of the mean; HCW – hot carcass weight. Sample size per group – 30.

Table 5. Characteristics of the water loss measurements and basic chemical composition of muscles of fattening pigs sired by boars from Topigs Norsvin

Trait	Crossbred pig groups			SEM	<i>p</i> -value
	YLL	YLP	YLD		
Fresh meat					
drip loss ₂₄ (%)	3.70 ^A	3.45 ^a	2.80 ^{Bb}	0.10	0.001
drip loss ₇₂ (%)	6.91 ^A	6.70 ^A	5.29 ^B	0.16	0.001
Frozen meat					
thawed loss (%)	12.63 ^A	9.39 ^B	8.55 ^B	0.32	0.001
cooking loss (%)	31.54 ^A	28.47 ^B	25.97 ^C	0.34	0.001
total fluid loss (%)	40.17 ^A	35.19 ^B	32.31 ^C	0.45	0.001
Basic chemical composition					
total protein (%)	22.32 ^a	22.48 ^a	21.88 ^b	0.07	0.034
intramuscular fat (%)	1.90 ^B	1.82 ^B	2.60 ^A	0.09	0.001
dry matter (%)	25.31 ^B	25.37 ^B	26.57 ^A	0.10	0.001
ash (%)	1.19	1.17	1.19	0.01	0.073

^{aA...}Means within rows bearing different superscripts differ significantly at: small letters – $p \leq 0.05$; capital – $p \leq 0.01$. SEM – standard error of the mean; EC – electrical conductivity. Sample size per group – 30.

The results obtained in the present study indicate that pigs sired by Pietrain boar crossbreds had lower meat quality compared to Duroc-sired ones. Similar findings have been reported by other authors, who observed a consistent decline in meat quality among Pietrain-sired crossbreds in comparison to those from Duroc sires [Edwards *et al.* 2003, Kuhn *et al.* 2005]. However, as noted by Šimek *et al.* [2004], using Pietrain

× Duroc boars in crosses with Large White sows can enhance lean meat content in the offspring without compromising meat quality in specific breeding schemes.

In the present study, the *LL* muscles of Duroc-sired pigs showed the lowest yellowness (b^*) and chroma (C^*) values (Tab. 6). This is likely related to consistently higher pH values at 24 to 96 hours *p.m.*, superior water-holding capacity, and the lowest shear force among the YLD pigs. As demonstrated by Ryu and Kim [2005], in YL× Duroc crossbreds, b^* values are significantly negatively correlated with pH at both 45 minutes and 24 hours *p.m.*, and significantly positively correlated with drip loss and shear force.

Table 6. Characteristics of the colour traits of muscles of fattening pigs sired by boars from Topigs Norsvin

Trait	Crossbred pig groups			SEM	<i>p</i> -value
	YLL	YLP	YLD		
<i>24 h post mortem</i>					
L*	57.12 ^B	59.13 ^A	56.54 ^B	0.28	0.001
a*	6.11	5.42	5.54	0.12	0.304
b*	15.55 ^A	14.42 ^{Ba}	13.94 ^{Bb}	0.10	0.001
C*	16.79 ^A	15.42 ^B	15.02 ^B	0.12	0.001
h°	68.70	69.47	68.40	0.36	0.557
<i>48 h post mortem</i>					
L*	58.76	58.42	58.06	0.26	0.286
a*	6.48 ^A	5.92 ^{AB}	5.53 ^B	0.12	0.007
b*	14.38	14.61	14.25	0.07	0.136
C*	15.80 ^a	15.80 ^a	15.31 ^b	0.09	0.042
h°	65.93 ^B	68.02 ^{AB}	68.82 ^A	0.40	0.009

^{aA}...Means within rows bearing different superscripts differ significantly at: small letters – $p \leq 0.05$; capital – $p \leq 0.01$.

SEM – standard error of the mean; L* – lightness; a* – redness; b* – yellowness; C* – chroma; h° – hue angle.

Sample size per group – 30.

The most favourable sensory attributes – tenderness, juiciness, and flavour – as well as the lowest shear force of the *LL* muscle, were observed in pigs sired by purebred Duroc boars (Tab. 7). These findings are consistent with previous research reporting higher tenderness and juiciness, along with lower shear force, in meat from Duroc-sired pigs compared to those sired by Landrace or YL boars [Koćwin-Podsiadła *et al.* 2004a, Grześ *et al.* 2005]. These differences are likely explained by the higher pH at 24 h *p.m.*, improved water-holding capacity, reduced cooking losses, and increased intramuscular fat (IMF) content recorded in the YL × Duroc pigs in the present study. Studies on Duroc, Large White, and Landrace pigs – as well as YL × Duroc crossbreds – have shown that pH at 24 h *p.m.* is significantly negatively correlated with drip and cooking losses and positively correlated with tenderness and juiciness. In contrast, both drip and cooking losses are significantly negatively correlated with tenderness and positively correlated with shear force [Hermesch *et al.* 2000; Miar *et al.*, 2014; Cabling *et al.* 2015]. It is generally accepted that a minimum IMF content of 1.5% is required to ensure a satisfying eating experience [Fortin *et al.* 2005]. However,

IMF levels above 3.5% may lead to consumer rejection due to visible fat, and the positive effects of higher IMF are likely maintained only if they are not accompanied by increased intermuscular fat [Fernandez *et al.* 1999]. Based on the mean values obtained in the present study, all three groups of pigs sired by Duroc, Pietrain, and Landrace boars from Topigs Norsvin met the optimal IMF range in the *LL* muscle (1.82-2.60%).

Table 7. Characteristics of the sensory assessment and shear force of muscles of fattening pigs sired by boars from Topigs Norsvin

Trait	Crossbred pig groups			SEM	p-value
	YLL	YLP	YLD		
Colour (pts)	4.61	4.74	4.75	0.02	0.159
Aroma (pts)	4.38 ^B	4.72 ^A	4.79 ^A	0.02	0.001
Tenderness (pts)	3.04 ^B	3.59 ^{Ab}	3.96 ^{Aa}	0.04	0.001
Juiciness (pts)	3.05 ^B	3.20 ^B	3.69 ^A	0.03	0.001
Flavour (pts)	3.37 ^B	3.54 ^B	3.93 ^A	0.03	0.001
Shear force (N)	53.95 ^A	53.69 ^A	46.85 ^B	0.97	0.002

^{aA...}Means within rows bearing different superscripts differ significantly at: small letters – $p \leq 0.05$; capital – $p \leq 0.01$.

SEM – standard error of the mean. Sample size per group – 30.

In this study conducted on fattening pigs derived from DanBred sows and Pietrain, Landrace, and Duroc boars from Topigs Norsvin, fattening efficiency was found to be similar across all groups. In terms of carcass characteristics, the highest lean meat content was observed in pigs sired by Pietrain boars, followed by those sired by Landrace, while the lowest lean meat content was recorded in pigs sired by Duroc boars. However, meat from Duroc-sired pigs demonstrated the most favourable technological and sensory qualities, which were associated with higher dry matter content, including IMF. The results also suggest that pigs sired by Pietrain boars had slightly better meat quality than those sired by Landrace boars, despite similar basic chemical composition. Overall, the findings confirm that under the conditions of this study the Pietrain breed contributes most effectively to carcass lean meat content in commercial pig production, while the Duroc breed has the most positive influence on meat quality.

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