

posebno onih ljudi koji rade sa životinjama kako bi se zakonodavstvo doista i provodilo. Isto tako, kvaliteta proizvoda, u ovom slučaju mesa, treba biti od velike važnosti za naše potrošače, što istraživanja provedena na terenu svakako potvrđuju (Cerjak et al. 2011; Mijatović 2011).

Iz oba rada vidljivo je da većina ispitanika smatra da je dobrobit životinja važna, te da su potrošači premalo informirani o uvjetima kako se drže životinja. Posljednjih godina u svijetu raste interes potrošača za dobrobit životinja i kvalitetu proizvoda animalnog podrijetla. Stoga su zemlje Europske unije prihvatile novi pristup u proizvodnji hrane koji uvažava potrebe potrošača, takozvani "fork to farm" (od stajale do stola) pristup (Mikuš i Petak, 2010). U Hrvatskoj je također povećan interes proizvođača mesa za dobrobit životinja, jer oni koji žele izvoziti na tržište Europske unije moraju zadovoljiti propise koji vrijede na teritoriju unije. Najvažniji čimbenik koji određuje da li će u klaoničkom objektu biti osigurana ili ne dobrobit životinja, je stav osoblja. Stoga se predlaže obavezna edukacija osoblja u klaonicama kako bi se poboljšala razina dobroti i kvaliteta mesa (Grandin i Smith, 2004.).

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Slika 1. Nepravilna upotreba opreme za omamljivanje



Slika 2. Industrijski uzgoj životinja

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## Meat quality traits and chemical composition of hybrid pigs originating from two different terminal sire lines

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short communication

#### Summary

The trial was conducted on 90 carcasses to study effect of terminal sire line (P-337 and P-410) on carcass and meat quality of PIC hybrid pigs slaughtered at 110 kg of live weight. At the slaughter line and in laboratory the following measurements of carcass and meat quality traits were taken: warm carcass weight, carcass lengths "a" and "b", ham length, ham circumference, muscle thickness, fat thickness, lean meat percentage by "TP" method, pH (45min and 24h pm); drip loss; CIE-L\*a\*b\*; cooking loss; instrumental tenderness (WBSF) and chemical composition of the ham. Statistical analyses showed that both groups of animals had satisfactory overall meat quality. However, P-337 sired pigs had higher incidence of PSE meat, while P-410 sired pigs had higher incidence of DFD meat in both ham and LD muscle. Regarding drip loss and lightness of the meat, more samples from P-337 sired fatteners had drip loss higher than 5%, whereas more samples from P-410 fatteners had L\* values higher than 50. Chemical analysis of the ham showed that both groups of animals had desirable IMF content.

**Keywords:** pig, meat quality traits, chemical composition, sire line

#### Introduction

Today hybrid pig lines developed by commercial companies are widely used because they grow faster, convert food more efficiently and have superior carcasses compared to the pure breeds. However, selection on growth and leanness is often accompanied with deteriorated meat quality traits. For this reason choosing a sire line with strong impact on performance without compromising meat quality traits represents a very important decision in pig production. The aim of this paper was to investigate the influence of two different PIC sire lines on meat quality traits and chemical composition of their

progeny's meat.

#### Material and methods

A total of 90 pigs of 110 kg live weight (LW) were used to study the influence of terminal sire line on carcass and meat quality of PIC (Pig Improvement Company) hybrid pigs. The animals were divided into two groups according to terminal sire line (P-337xC23 and P-410xC23). Widely used P-337 terminal sire line was created using Duroc, Large White and Pietrain, mainly to gain robustness without compromising meat quality traits, with emphasis on intramuscular fat content. The P-410 boar is the combination of

the pure lines P-408 and P-337. The P-408 originates from a pure line Pietrain which has been specifically selected to be Hal-1843 stress gene free. During the fattening period animals were fed the same diet and housed in the same conditions. At approximately 110 kg LW pigs were slaughtered at "PIK" Meat Industry in Vrbovec. At the slaughter line following carcass traits were determined: warm carcass weight, carcass lengths from *os pubis* to the 1<sup>st</sup> rib ("a") and from *os pubis* to *atlas* ("b"), ham length and circumference, lumbar muscle thickness – M (measured as the shortest connection between the cranial end of the lumbar muscle

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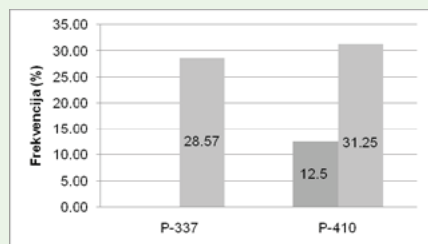


Figure 1 Relative proportion of DFD meat in investigated pig groups

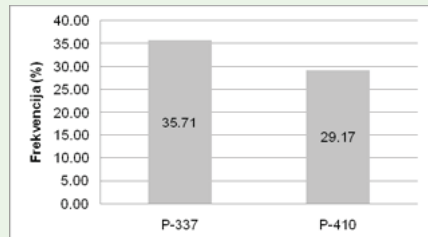


Figure 2 Relative proportion of meat samples with undesirably high drip loss

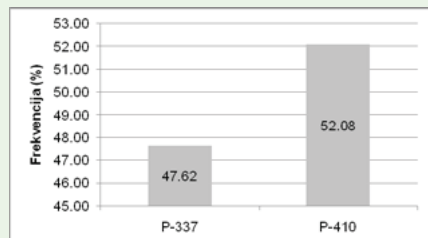


Figure 3 Relative proportion of meat samples with CIE L\* &gt; 50

and dorsal edge of the vertebral canal) and fat thickness – S (measured as the minimum thickness of subcutaneous fat (with skin) at the split of the carcass, above *m. gluteus*

*medius*). Lean meat percentage was calculated according to "Two points" method approved by Croatian Regulation No 144/2010.

Initial pH values ( $pH_{24}$ ) were taken 45 minutes after sticking at *m. longissimus dorsi* (LD) and *m. semimembranosus* (MS) of primarily processed swine carcasses. After 24h of cooling, the ultimate pH values ( $pH_{24}$ ) were taken at the same place as for  $pH_{45}$ . At the same time samples of LD muscle for drip loss and colour measurements were taken. Drip loss was measured by bag method according to Kauffman et al. (1992) after 48h of cooling at 4°C, while light reflectance scores for L\*, a\*, and b\* were obtained using a Minolta CR-300 colorimeter (Minolta Camera Co. Ltd., Osaka Japan) with a 8 mm aperture, D65 light source and a ten-degree standard observer. Instrumental tenderness (WBSF; Warner-Bratzler Shear Force) was measured on at least four subsamples of 2.54 cm thick LD chops. Prior to measurements, chops were defrosted for 24h, sealed in plastic bags and cooked in water bath until an internal temperature of 73°C. The samples were cooled at 4°C overnight. Shear force was measured using a TAXtplus Texture Analyser fitted with a 1 mm thick Warner-Bratzler shear attachment. The mean value of maximal strength necessary for cutting the samples was calculated with a Texture Exponent 4.0 Software (Stable Micro Systems Ltd., UK) and presented as Warner-Bratzler Shear Force (WBSF, N). Cooking loss was established from LD chops used for shear force determination. It was calculated from weights taken before and after cooking and expressed as a percent.

The nitrogen content of the ham was determined by the Kjeldahl procedure, fat content was determined by extraction Soxhlet method, while moisture content was determined by ISO 1442:1997 reference procedure.

The data obtained were submitted to analysis of variance (ANOVA) and

Table 1 Carcass traits of hybrid pigs progenies of P-337 and P-410 terminal sire lines

Trait	P-337 (n=42)	P-410 (n=48)
Warm carcass weight (kg)	42.83 <sup>a</sup> (1.52)	45.14 <sup>a</sup> (6.00)
Muscle thickness, M (mm)	73.57 (5.95)	74.44 (4.92)
Fat thickness, S (mm)	15.33 (3.92)	15.13 (4.87)
Lean meat percentage (%)	57.76 (3.28)	58.31 (3.66)
Length <sub>a</sub> <sup>a</sup> (cm)	91.64 (2.67)	90.71 (2.29)
Length <sub>b</sub> <sup>b</sup> (cm)	106.50 <sup>a</sup> (2.77)	103.65 <sup>b</sup> (2.94)
Ham length (cm)	34.21 <sup>a</sup> (1.00)	35.02 <sup>a</sup> (1.14)
Ham circumference (cm)	73.19 <sup>b</sup> (2.31)	74.92 <sup>a</sup> (1.83)

<sup>a</sup> Means in the same row with different superscript statistically differ at  $p < 0.05$ .

Table 2 Means and standard deviations (in brackets) of meat quality traits from investigated pig groups

Trait	P-337 (n=42)	P-410 (n=48)
$pH_{24}$ in MS	6.30 (0.21)	6.33 (0.18)
$pH_{24}$ in LD	6.32 (0.21)	6.34 (0.18)
$pH_{45}$ in MS	5.85 (0.28)	5.90 (0.21)
$pH_{45}$ in LD	5.70 <sup>a</sup> (0.14)	5.79 <sup>a</sup> (0.15)
Drip loss <sub>48h</sub> %	4.52 (2.49)	3.88 (1.97)
CIE L*	50.08 (3.43)	50.47 (3.38)
CIE a*	7.40 <sup>a</sup> (1.38)	6.62 <sup>b</sup> (1.22)
CIE b*	2.78 (1.17)	2.72 (1.06)
Cooking loss (%)	32.10 <sup>a</sup> (3.57)	33.52 <sup>a</sup> (3.11)
Tenderness - WBSF, (N)	46.47 (7.57)	48.62 (7.34)

<sup>a</sup> Means in the same row with different superscript statistically differ at  $p < 0.05$ .

the differences between the groups under study were analyzed using the Fisher LSD test for comparison of means ( $p < 0.05$ ) by using the Statistica software package (StatSoft, Inc. 1984-2007).

### Results and discussion

Table 1. shows carcass traits of investigated pigs. It can be observed that P-337 progenies were significantly longer, but their hams were shorter with smaller circumference than P-410 sired fatteners.

Results presented in Table 2. show comparison of meat quality traits between P-337 and P-410 sired pigs. pH values measured at 24h *post mortem* in LD muscle differed statistically between the investigated pig groups. Although these values indicate a normal or RFD (reddish-pink, firm, non-exudative) meat, from the Table 2 it can be noticed that these values

were slightly higher in P-410 sired pigs. Lattore et al. (2003), Edwards et al. (2003) and Kušec et al. (2004) investigated the influence of Duroc and Pietrain sires on meat and carcass quality traits of their crossbred progeny. Although proportions of Duroc and Pietrain were different in their study, later authors found  $pH_{24}$  values to be higher in Duroc sired fatteners.

The investigated pig groups did not differ in drip loss values. In contrast, Fischer et al. (2000) and Edwards et al. (2003) reported a lower drip loss for Duroc influenced progeny.

From the Table 2 it can be noticed that significant differences between the groups were found for CIE a\*, i.e. the redness of meat. Edwards et al. (2003) reported these values to be higher in Duroc sired crossbreds (17.33 vs. 17.04,  $p < 0.05$ ). P-410 si-

red fatteners also had significantly higher cooking loss than P-337 sired pigs.

Incidence of DFD and PSE meat in investigated pig groups are presented in Figures 1 and 2.

When  $pH_{24} > 6.00$  criterion was used for identification of DFD meat, there was no incidence of such quality condition in LD muscle of P-337 sired pigs. However, 12 ham samples (28.57%) were classified into DFD meat when the same criterion was used. In case of P-410 sired pigs 6 samples (12.5%) of LD muscle and 15 samples (31.25%) of ham were classified into DFD meat. Muscles with lower oxidative potential, like *m. semimembranosus*, have relatively low glycogen level which degrades fast in *post mortem* muscle. As a consequence, relatively high  $pH_{24}$  values are developed. However, this does not necessarily mean that this meat should be classified as DFD, because its drip loss, colour and tenderness are not necessarily detrimental. Some authors therefore propose considerably higher  $pH_{24}$  values as indicators of DFD meat in those muscles (Adzitey and Nurul, 2011; Hambrecht et al., 2005).

Drip loss is one of the most important indicators of technological meat quality. Pig meat with a drip loss higher than 5% is considered to be undesirable for further processing. In this study 15 LD samples (35.71%) of P-337 sired pigs and 14 LD (29.17%) samples of P-410 sired pigs were found to have drip loss greater than 5%.

One of the most important traits of meat quality from consumer perspective is its colour. Fresh pork colour ranges from white to dark red; however the consumers prefer their fresh pork to be reddish-pink. When objectively measured, the level of paleness (CIE L\*) should be between 40 and 50. Values larger than 50 indi-

cate a PSE condition of meat. Graph 3. illustrates relative proportions of meat samples with CIE L\* values higher than 50. In the case of P-337 sired pigs 20 (47.62%) LD samples were too pale, while in P-410 sired pigs this was proven for 25 samples, i.e. 52.08%.

Statistical comparison of chemical composition of ham between the investigated pig groups are presented in Table 3.

Statistically significant differences between the investigated genotypes were found for moisture and intramuscular fat content. It is well known that intramuscular fat content influences the sensory meat quality traits: taste, colour and tenderness. In pork, intramuscular fat level between 2.5 and 3.5% is considered to have optimal influence on its sensory traits (Fernandez et al., 1999; Daszkiewicz et al., 2005). In both P-337 and P-410 sired pigs intramuscular fat content was higher than 2.5%. This indicates that desirable sensory meat characteristics can be expected from both terminal sire lines. From the Table 3 it can be noticed that P-337 progeny had significantly higher IMF content, probably due to their Duroc origin. This is in accordance with previous findings by Ellis et al. (1996), Brewer et al. (2006) and Šimek et al. (2004). P-337 sired fatteners also had significantly lower moisture content than offspring of P-410 terminal sire line. It is well known that lean pig breeds are characterised by slower growth. For that reasons these animals have higher moisture content at 110 kg LW than faster growing breeds. Since P-410 sire line has a higher proportion of Pietrain than P-337 sire line, its offspring had higher moisture content in ham than P-337 progenies, as could be expected.

#### Conclusions

Based on the investigation on carcass and meat quality traits of fat-

Table 3 Means and standard deviations (in brackets) of chemical parameters of ham from investigated pig groups

Parameter	P-337 (n=42)	P-410 (n=48)
Moisture (%)	73.99 <sup>a</sup> (0.57)	74.59 <sup>a</sup> (0.37)
Protein (%)	21.33 (0.34)	19.22 (6.03)
Fat (%)	3.21 <sup>a</sup> (0.58)	2.69 <sup>b</sup> (0.52)

<sup>a</sup> Means in the same row with different superscript statistically differ at p<0.05.

ners originating from two PIC sire lines, following can be concluded:

P-337 sired pigs had longer carcasses but with shorter hams and lower ham circumference than P-410 sired fatteners.

When pH<sub>24</sub>>6.00 criterion was used for identification of DFD meat, there was no incidence of such quality state in LD muscle of P-337 sired pigs. However, 28.57% of ham samples were classified as DFD meat when same criterion was used. In case of P-410 sired pigs 12.5% of LD muscle and 31.25% of ham were classified into DFD meat.

35.71% LD samples of P-337 sired pigs and 29.17% LD samples of P-410 sired pigs were found to have drip loss greater than 5%.

47.62% LD samples of P-337 sired pigs had CIE L\* > 50, while in P-410 sired pigs this was proven for 52.08% of LD samples.

P-337 had significantly higher IMF level than P-410 sired pigs, although in both groups IMF was higher than 2.5% indicating desirable sensory quality traits.

To strengthen the conclusions drawn from this study, it is recommended to repeat the investigations on larger number of animals.

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### Fleischqualität und chemische Zusammensetzung der hybriden Schweine, Nachfolger zweier Linien des Terminalebers

#### Zusammenfassung

Die Untersuchung wurde auf 90 PIC hybriden Schweinen, Nachfolgern der Terminallinien des Ebers P-337 und P-410 geopfert bei 110 kg lebendigen Gewichts, durchgeführt. Auf der Schlachtlinie und im Labor wurden folgende Eigenschaften der Hälfen und der Fleischqualität festgestellt: warme Schlachtmasse, die Länge der Hälfen "a" und "b", die Länge und der Umfang der Keule, die Dicke des Muskels und des dazugehörigen Rückenspecks, die Fleischigkeit der Hälfte durch die Methode "zwei Punkte", der pH Wert gemessen nach 45 Minuten und 24 h nach dem Schlachten, die Abscheidung des Fleischsaftes, Farbparameter (CIE "a" "b"), instrumentale Zärtlichkeit (WBSF) und die chemische Zusammensetzung der Keule (des Schenkels). Durch die statistische Analyse wurde festgestellt, dass beide Tiergruppen eine zufriedenstellende Fleischqualität hatten. Bei den Nachfolgern der Linie P-337 wurde eine höhere Häufigkeit des BMW Fleisches festgestellt, während bei den Nachfolgern der Linie P-410 eine höhere Häufigkeit des TST Fleisches (getrocknetes hartes und dunkles Fleisch) in der Keule und im Rückenmuskel festgestellt wurde. Was die Abscheidung des Fleischsaftes und die Farbe anbetrifft, so hatten mehrere Fleischmuster der Nachfolger P-337 den Wert des abgeschiedenen Fleischsaftes höher als 5%, während Fleischmuster der Nachfolger P-410 einen Wert L\* höher als 50 hatten. Die chemische Analyse der Keule zeigte, dass beide Tiergruppen einen gewünschten Gehalt des intramuskulären Fettes (IMF) hatten.

**Schlüsselwörter:** Schweine, Eigenschaften der Fleischqualität, chemische Zusammensetzung, Terminallinien des Ebers

### Qualità di carne e composizione chimica di maiali ibridi provenienti da due linee del lattonzolo

#### Somario

Questa ricerca comprende 90 PIC maiali ibridi provenienti da due linee del lattonzolo P-337 e P-410 sacrificati a 110 kg di peso vivo. Sulla linea di macellazione e nel laboratorio sono state determinate le seguenti caratteristiche delle metà ottenute e di qualità di carne: calda massa macellata, lunghezza delle metà "a" e "b", lunghezza e circonferenza di coscia, grossezza del muscolo e dell'apparente pancetta dorsale, carnosità delle metà determinate con il metodo "due punti", valore pH misurato 45 minuti e 24 ore dopo la macellazione, perdita di succo di carne, parametri di colore (CIE "a" "b"), tenerezza di strumenti (WBSF) e composizione chimica della coscia. Fatta l'analisi chimica, è stato determinato che tutti e due i gruppi di animali avevano una qualità soddisfacente di carne. Dagli animali provenienti dalla linea P-337 è stata trovata una frequenza maggiore della carne BMW, mentre quelli provenienti dalla linea P-410 hanno rivelato una maggiore frequenza di carne dura, essicata e scura nella coscia e nel muscolo dorsale. Per quanto riguarda la perdita di succo di carne ed il colore, ci sono parecchi campioni di maiali allevati dalla linea P-337 che hanno dimostrato i valori di perdita di succo di carne più grandi del 5%, e parecchi campioni dalla linea P-410 avevano i valori di L\* più grandi del 50. L'analisi chimica di coscia ha scoperto che tutti e due i gruppi di animali contenevano una percentuale soddisfacente del grasso intramuscolare (IMF).

**Parole chiave:** maiali, caratteristiche di qualità di carne, composizione chimica, linea terminale di lattonzolo

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