

Comparison of Meat Quality and Fatty Acid Composition of *Longissimus* Muscles from Purebred Pigs and Three-way Crossbred LYD Pigs

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Abstract

This study was conducted to find pork quality to meet the needs of consumers. Thus, the meat quality and fatty acid composition of *longissimus* muscles from purebred pigs (Landrace, Yorkshire, and Duroc) and three-way crossbred LYD pigs were compared and evaluated. Chemical compositions of *longissimus* muscles were significant ($p < 0.05$) different among pigs. Duroc contained significant ($p < 0.05$) higher fat contents than other pigs, whereas significant ($p < 0.05$) higher moisture contents were observed in Landrace, Yorkshire, and LYD pigs compared to those of Duroc pigs. The values of pH_{24h} and pH_{14d} were the highest in Landrace pigs. Myoglobin contents of LYD pigs were higher ($p < 0.05$) than those of purebred pigs. Regarding meat color, Duroc and Yorkshire pigs had higher redness values than Landrace and LYD pigs, while Landrace pigs had the lowest ($p < 0.05$) color values among all pigs. There was no significant difference in shear force or water holding capacity (WHC). Duroc pigs maintained the lowest drip loss during 14 d of cold storage. In sensory evaluation, the marbling scores of Duroc pigs were higher ($p < 0.05$) than other pigs. Regarding fatty acid compositions, total USFA, poly-, n-3, and n-6 contents were the highest ($p < 0.05$) in LYD pigs, while total SFA contents were the highest ($p < 0.05$) in Duroc pigs. Based on these results, purebred pigs had superior overall meat quality to crossbred pigs.

Keywords: purebred pigs, crossbred pigs, meat quality, fatty acid composition

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Introduction

Worldwide meat consumption has been steadily increasing over the last fifty years. Meat consumption in 1961 per head was 23.1 kg, it was increased to 42.20 kg per head in 2011 (Sans and Combris, 2015). This phenomenon is due to economic and population growth of emerging countries in the world over the past few decades (Gandhi and Zhou, 2014).

For commercial pork production, three-way crossbred pigs (Landrace × Yorkshire dam × Duroc sire or LYD) have been reared to improve piglet productivity, meat

yield, and meat quality in earnest by pig producers in Korea since 1970 (Jin *et al.*, 2006; Korea Pork Producers Association, 2007) because Landrace pigs have long carcass length, thin subcutaneous fat layer, large hams, and high muscularity in the carcass while Yorkshire pigs have similar meat quality to that of Landrace pigs (Ruusunen *et al.*, 2012). According to Lee *et al.* (2012), Yorkshire and Landrace pigs are similar to each other in terms of pork quality traits such as softness, juiciness, flavor, mouth coating, etc. In addition, Landrace and Yorkshire are highly prolific with good mothering ability. Duroc breed is used as a terminal sire to enhance intramuscular fat and growth rate of the three-way crossbreds (Serrano *et al.*, 2008; Suzuki *et al.*, 2003). Ultimately, this pig breeding system has brought high litter size, fast growth performance, and much volume of meat. Therefore, up to now, pork distributed to the Korea pork market are mainly from three-way

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crossbred pigs.

However, this pig breeding system might lead to pale soft exudative (PSE) meat. Pork quality traits of crossbred pigs such as pH_{24h}, water holding capacity, meat color, marbling, and muscle fiber type are known to be decreased compared with pork from pure Berkshire and Duroc breeds (Cameron *et al.*, 1990; Kang *et al.*, 2011; Ryu *et al.*, 2008). Until now, this pig breeding system is still being for pig production in Korea. Recently, with import of pork due to free trade agreement (FTA) and consumer's demand of high quality pork, producing high quality pork is becoming more and more important than quantitative production. According to the report of Wu *et al.* (2015), preference and willingness to pay of consumers for pork consumption was significantly influenced by quality certification followed by appearance and traceability information. This tendency was also reported in the study of Papanagioutou *et al.* (2013).

Therefore, the objectives of this study preferentially were to compare meat quality and fatty acid compositions of *longissimus* muscles among purebred pigs used for the three-way crossbred system and crossbred pig, and to provide scientific information on pig breeding system for producing high quality pork to meet the consumer's needs and to determine factors that might be able to enhance quality of pork in Korea.

Materials and Methods

Animals and sampling

A total of 79 pigs were used in this study, including 15 purebred Duroc gilt, 15 purebred Landrace gilt, 20 purebred Yorkshire gilt, and 29 Crossbred LYD gilt pigs at a breeding pig farm in Yeonggwang-Gun, Jeollanam-do, Korea. Purebred pigs were reared from September 2014 to February 2015. Crossbred pigs (Landrace × Yorkshire × Duroc) were provided by a commercial pig farm in Yeonggwang-Gun, Jeollanam-do, Korea. Pigs were raised according to Korean Feeding Standard for Swine (National livestock research institute, 2012) in each farm. Basal diet was formulated to meet nutrient requirements of pigs. It consisted of corn (51.43%), wheat and wheat bran (18.72%), soybean meal (19.08%), and other feedstuffs and additives (10.77%, Table 1). Each breed of pigs were slaughtered in an unified final weight (110-114 kg), and samples were collected through a total of two times slaughter. When the mean weight of pure and crossbred pigs in respective pens reached market weight, pigs were conventionally slaughtered and chilled overnight. At 24 h

Table 1. Formula of basal diets

| Ingredients | Finisher |
|---------------------------|----------|
| Corn | 51.43 |
| Wheat | 15.00 |
| Wheat bran | 3.72 |
| Soybean meal | 19.08 |
| Molasses | 4.00 |
| Animal fat | 4.00 |
| C. Phosphate | 1.16 |
| Limestone | 0.48 |
| Salt | 0.32 |
| CuSO ₄ | 0.08 |
| Methionine | 0.03 |
| Lysine | 0.15 |
| Antibiotic | 0.20 |
| Mix-Vitamin ¹⁾ | 0.11 |
| Mix-Meneral ²⁾ | 0.10 |
| Etc | 0.14 |
| Total | 100.00 |
| Calculated analysis (%) | |
| Crude protein | 15.34 |
| Crude fat | 6.41 |
| Crude ash | 4.78 |
| Crude fiber | 2.98 |
| ME (kcal/kg) | 3,277 |

¹⁾Supplied per kg diets: Vitamin A, 8,000,000 IU; Vitamin D, 1,500,000 IU; Vitamin E, 40,000 ppm; Vitamin K 1,500 ppm; Thiamin, 1,000 ppm; Riboflavin, 4,000 ppm; Vitamin B₁₂, 20 ppb; Pyridoxine, 2,000 ppm; Niacin 20,000 ppm; Biotin, 30 ppm; Folic acid, 600 ppm.

²⁾Supplied per kg diet: Se, 250 mg; I, 200 mg; Fe, 60,000 mg; Mn, 25,000 mg; Zn, 60,000 mg; Cu, 15,000 mg.

postmortem, the *longissimus* muscle from the left side between the 5th and 13th rib was removed. Meat qualities were evaluated at Meat Science Laboratory of Chungbuk National University.

pH

Using a homogenizer (Nihonseiki, Japan), 10 g of samples was homogenized in 100 mL of distilled water for 30 s at 7,000 rpm. The pH levels of the homogenate was determined using a pH meter (Mteeler Delta 340, Mettler-tolede, Ltd, UK) at 24 h and 14 d after slaughter.

Meat color

The L*, a* and b* values were determined on the surface of freshly cut meat after 20 min bloom time using a Spectro Colormeter (Model JX-777, Color Techno. System Co., Japan) calibrated to the white plate (L*, 89.39; a*, 0.13; b*, -0.51). L*, a*, b* values described Hunter lab color system (L*=lightness, a*=redness, b*=yellowness) using a white fluorescent light (D65) as light source. Each

measurement was performed in 6 replicates, taking the mean value as the assay result.

WHC (Water holding capacity)

The centrifugation method described by Laakkonen *et al.* (1970) was used to measure WHC. *Longissimus* muscle sample (0.5 ± 0.05 g) from each line were placed in centrifugation tube with filter units, heated for 20 min at 80°C, and then cooled for 10 min. Samples were centrifuged at $2,000 \times g$ for 10 min 4°C and WHC calculated as the change of sample weight.

Drip loss

A 2 cm thick slice (weight 100 ± 5 g) cut from *logissimus* muscle was placed into polypropylene bag and then vacuum packaged and stored for 24 h, 48 h, and 14 d at 4°C. Drip loss was calculated by weight difference of samples.

Shear force test

A 3 cm thick slice (weight 100 ± 5 g) cut from *logissimus* muscle was placed into polypropylene bag and then cooked for 40 min at 70°C in the water-bath and then cooled for 30 min. samples were cut into $1 \times 2 \times 1$ cm (width \times length \times height) pieces and max weight were measured by a shearing, and cutting test using a Rheo meter (Model Compac-100, SUN SCIENTIFIC Co., Japan) under the following operational conditions: Table speed of 110 mm/min, graph interval of 20 m/sec and load cell (max.) of 10 kg using the Rheology Data System Ver. 2.01.

Sensory evaluation

Well-trained in-house tasting panelists (n=5) evaluated sensory attributes of fresh and cooked meat. The subjective color, marbling, hardness, juiciness, tenderness, flavor and overall acceptability were scored using on a 5-point hedonic scale: 1- very pale, very low in intramuscular fat, very flabby, very dry, very tough, very mild, very unacceptable, 5- very dark, very high in intramuscular fat, very firm, very juicy, very soft, very intense, very acceptable. The sample was evaluated independently by the panelists 3 different times.

Myoglobin

Myoglobin content was measured by method of Krzywicki (1982) with modification. Two grams of sample was homogenized by polytron (PT 3100, Kinematica AG, USA) with 18 mL of (4°C) 40 mM phosphate buffer (pH

6.8) for 30 s. After centrifuging the slurry at 5,200 rpm for 10 min, the fluid was filtered with Whatman No. 2 ϕ 150 mm. Filtered fluid was measured by spectrophotometer (Optizen-3220UV, Mecasys, Korea) at 700 nm and 525 nm, respectively. The content of myoglobin was calculated using the equation:

$$\text{Myoglobin} = (A_{525} - A_{700}) \times 2.303 \times (18 / \text{sample weight})$$

where A_{λ} = absorbance at λ nm.

Proximal analysis and collagen

Moisture, protein, lipid and ash were assayed according to the AOAC (2000) methods.

Sample (4 g) was put into triangular flask and then 30 mL of sulfuric acid solution was added. After covered the triangular flask, was heated in dry oven at 105°C for 16 h. Pretreat samples were placed in 500 mL of volume flask and then diluted with deionized water. After homogenization, the fluid was filtered with Whatman No. 2 ϕ 150 mm. 5 mL of filtrate was diluted to 100 mL. Then 2 mL of diluted solution was placed into test tube. 1 mL of oxidant solution was added into test tube. After shaking, samples were placed at room temperature for 20 min. After 1 mL of color reagent was added, were heated in water-bath at 60°C for 15 min, and then cooled at flowing water for more than 15 min. The absorbance was measured by spectrophotometer (Optizen-3220UV, Mecasys, Korea) at 558 nm. Collagen content (g/100 g) was calculated using the regression equation which standard curve was obtained from absorbance with color-development and measurement of 2 mL of working standard solution.

Fatty acid composition

Total lipid was extracted by the Folch *et al.* (1957) method. According to the method of LepageRoy (1986), samples were methylated in water-bath at 100°C for 1 h. After cooling, samples were added hexane and then the top of layer was taken. Separation and quantification of the fatty acid methyl esters was carried out using a gas chromatograph (HP 5890 II, Hewlett Packard Co., USA) equipped with a capillary column (100 m \times 0.25 mm i.d. \times 0.20 μ m film thickness). Nitrogen was used as carrier gas, the oven temperature was initially held at 180°C, then final temperature was 240°C (2°C/min). The injector and detector temperatures were maintained at 250°C.

Statistical analysis

Statistical analyses were carried out using the GLM

(Generalized Linear Model) procedure of the SAS package (Statistical analysis system: The SAS (2003) system Release 9.01), Means were compared using the Duncan's multiple range test at a level of significance of $p < 0.05$. And the following model:

Comparison of purebred and crossbred pigs

$$y_i = \mu + \tau_i + \varepsilon$$

where, y = observed value of the trait

μ = mean

T = breeds effect (Purebreds and crossbred)

ε = random error

Results and Discussion

Chemical properties of *longissimus* muscles

The chemical compositions of *longissimus* muscles from purebred and crossbred pigs are summarized in Table 2. The moisture contents of Duroc were the lowest ($p < 0.05$) compared to those of Landrace, Yorkshire, or crossbred pigs. Fat contents in *longissimus* muscle from Duroc pigs were the highest ($p < 0.05$). Regarding protein and ash contents of *longissimus* muscles of pigs, significant difference was not found among pigs. The pH values of *longissimus* muscles measured at 24 h after slaughter of Landrace pigs were higher ($p < 0.05$) than those of crossbred pigs. The pH values of Duroc and Yorkshire pigs were similar ($p > 0.05$) to each other. These results were also observed at 14 d after slaughter. Both purebred and crossbred pigs maintained a normal range of pH values (5.4 to 5.6) during cold storage for 14 d. Collagen contents were not significantly ($p > 0.05$) different among these pigs. However, myoglobin contents of crossbred pigs were significantly ($p < 0.05$) higher than those of purebred pigs.

Of all commercial breeds, Duroc breed is famous for abundant intramuscular fat. According to the report of Cameron *et al.* (1990) and Suzuki *et al.* (2003), Duroc pigs

have more intramuscular fat content but less moisture content in *longissimus* muscle than Landrace and Berkshire pigs. Similar results have been reported by other researchers (Alonso *et al.*, 2009; Edwards *et al.*, 1992). The variations in pH values of pork could be due to post-mortem glycolysis (Fernandez *et al.*, 1994). Lower pH values indicate lower meat quality compared to meat with normal pH (Zhu *et al.*, 2011). The final pH of meat could also be affected by breeds, feeding environment, slaughtering, and post management of carcass. Of these factors, the most important one might be breeds. According to the study of Meinert *et al.* (2008), the pH_{24} values of crossbred pigs (DLY) are lower ($p < 0.05$) than those of purebred pigs, including Hampshire, Duroc, and Black spotted pigs. Lee *et al.* (2012) have reported that the pH_{24} values of *longissimus* muscles from Duroc pigs are not significantly different from those of Landrace and Yorkshire pigs, while the pH_{24} values of Berkshire pigs are higher compared to those of Duroc, Landrace, or Yorkshire pigs. Such result is due to genetic effect of breeds. Although we did not measure muscle fiber types, glycolytic rate might depend on the muscle fiber type of meat. Pork containing higher type IIB fiber and lower type I fiber has faster glycolytic rate and faster post-mortem glycolysis produces more lactate in meat compared to reverse cases (Choe *et al.*, 2008). According to the report of Ryu *et al.* (2008), number of type IIB from *longissimus dorsi* muscle of Landrace pig was higher than that of LYD pig, and Landrace pig also showed higher tendency in type IIB muscle fiber density, area and total number than those of Duroc and Yorkshire (Lee *et al.*, 2012). In this study, the differences in chemical compositions and pH variation might be due to genetic lineage of pigs.

Meat quality of *longissimus* muscles

Comparison results of meat quality of *longissimus* muscle from purebred and crossbred pigs are shown in Table 3. The meat color of *longissimus* muscle was described

Table 2. Comparison of chemical composition of *longissimus* muscles of pigs in Korea

| Traits | Duroc | Landrace | Yorkshire | Crossbred |
|---------------------|-------------------------|-------------------------|-------------------------|-------------------------|
| Moisture (%) | 72.85±1.73 ^b | 75.18±0.97 ^a | 74.50±0.97 ^a | 74.24±1.58 ^a |
| Fat (%) | 2.83±0.97 ^a | 1.46±0.40 ^b | 1.86±0.66 ^b | 1.85±1.03 ^b |
| Protein (%) | 22.56±1.18 | 22.28±0.92 | 22.51±0.90 | 22.80±2.10 |
| Ash (%) | 1.14±0.11 | 1.06±0.12 | 1.11±0.12 | 1.09±0.16 |
| pH (24hr) | 5.63±0.22 ^{ab} | 5.76±0.31 ^a | 5.65±0.30 ^{ab} | 5.56±0.10 ^b |
| pH (14day) | 5.67±0.21 ^{ab} | 5.72±0.24 ^a | 5.64±0.23 ^{ab} | 5.57±0.10 ^b |
| Collagen (g/100g) | 0.55±0.42 | 0.68±0.39 | 0.79±0.73 | 0.64±0.40 |
| Myoglobin (mg/100g) | 2.00±0.51 ^b | 2.22±0.77 ^b | 2.06±0.74 ^b | 2.83±0.57 ^a |

^{a,b}Means±SE with different superscription within the same row differ ($p < 0.05$).

Table 3. Comparison of meat color, shear force, WHC and drip loss of *longissimus* muscles of pigs in Korea

| Traits | Duroc | Landrace | Yorkshire | Crossbred |
|-----------------|-------------------------|-------------------------|--------------------------|-------------------------|
| CIE L* | 57.18±5.29 ^a | 53.18±5.05 ^b | 56.20±4.67 ^{ab} | 57.93±4.79 ^a |
| CIE a* | 7.32±1.92 ^a | 5.63±1.00 ^b | 6.91±2.05 ^a | 5.17±1.35 ^b |
| CIE b* | 10.17±1.28 ^a | 8.60±1.40 ^b | 9.67±1.66 ^a | 9.83±1.62 ^a |
| Shear force (g) | 2004.57±461.38 | 2096.41±534.83 | 1814.98±429.59 | 1833.8±458.77 |
| WHC (%) | 56.91±9.06 | 61.99±6.93 | 62.46±10.34 | 56.74±8.37 |
| Drip loss (%) | 24 h | 3.14±1.55 ^b | 3.65±1.59 ^b | 3.83±1.18 ^b |
| | 48 h | 3.57±1.22 ^b | 2.89±1.65 ^b | 3.56±1.82 ^b |
| | 14 d | 6.73±2.89 ^b | 8.46±3.20 ^{ab} | 8.72±2.81 ^a |

L*, lightness; a*, redness; b*, yellowness.

^{a,b}Means±SE with different superscription within the same row differ ($p<0.05$).

by CIE* color values, including lightness (L*), redness (a*), and yellowness (b*). The lightness values of Duroc and crossbred pigs were significantly ($p<0.05$) higher than those of Landrace pigs. The redness values of Duroc and Yorkshire pigs were higher ($p<0.05$) than those of Landrace and crossbred pigs. The yellowness values of *longissimus* muscles were the lowest ($p<0.05$) in Landrace pigs. On the other hand, there was no significant ($p>0.05$) difference in shear force or water holding capacity (WHC) values among these *longissimus* muscles. Regarding the drip loss values of *longissimus* muscles during cold storage, purebred pigs had significantly ($p<0.05$) lower values than crossbred pigs until 48 h from post-slaughter. However, at day 14 after cold storage, the drip loss values of purebred pigs were similar ($p>0.05$) to those of crossbred pigs. It has been reported that meat color closely follows the pH, intramuscular fat, and myoglobin contents in meat (Lee and Joo, 1999; Mancini and Hunt, 2005). Therefore, the highest fat contents of Duroc pigs might have increased the lightness values of *longissimus* muscles, while the lowest pH values of LYD pigs might have decreased the lightness values of *longissimus* muscles. However, myoglobin contents did not appear to influence the meat colors of pigs. According to Newcom *et al.* (2004), the loins of Duroc pigs has higher ($p<0.05$) redness values but lower ($p<0.05$) lightness values than those of Landrace and Yorkshire pigs, while the yellowness values are not significantly different among pigs, similar to the results of this study. Lee *et al.* (2012) have reported that the shear force values of pork loins from Landrace and Yorkshire pigs are higher than those of Duroc pigs. They have concluded that abundant intramuscular fat contents in loins of Duroc pigs make meat juicier and tender compared to Landrace and Yorkshire pigs. Meinert *et al.* (2008) have also reported that LYD pigs have higher shear force values than Duroc pigs. Several factors can influence the shear force value of meat, including connective

tissue, IMF, and sarcomere length (Aaslyng *et al.*, 2002). In this study, although there was no significant difference in the measurement of WHC of *longissimus* muscles, the values of drip loss during 14 d storage at 4°C cold chamber were significantly different among pigs. Meinert *et al.* (2008) have reported that drip loss values could be affected by IMF content of *longissimus* muscles. According to the report of Mörlein *et al.* (2007), IMF could also act as a physical barrier against drip loss. In the current study, the pig that containing a lot of fat was Duroc pigs. However, there were no significant differences in fat contents of the other pigs.

Sensory evaluation of *longissimus* muscles

Results of comparison of sensory evaluation of *longissimus* muscles from purebred and crossbred pigs are shown in Table 4. The sensory evaluation was proceeded for both fresh and cooked meats. For fresh meat, the meat color and hardness traits were not significantly ($p>0.05$) different among pigs. However, the *longissimus* muscles of Duroc pigs had higher ($p<0.05$) marbling scores compared to those of other pigs. There was no significant ($p>0.05$) difference among the marbling scores of other pigs. Although there were no significant ($p>0.05$) differences in juiciness, tenderness, flavor, and overall acceptability of cooked meat, the *longissimus* muscles of Duroc pigs tended to have higher tenderness, flavor, and overall acceptability compared to those of Landrace and Yorkshire pigs ($p>0.05$). In addition, the *longissimus* muscles of crossbred pigs had higher ($p>0.05$) flavor and overall acceptability than purebred pigs. Sensory evaluation could be affected by a variety of factors such as IMF, gender, muscle fibers, environmental and genetic factors (Lee *et al.*, 2012; Meinert *et al.*, 2008; Straadt *et al.*, 2013; Verbeke *et al.*, 1999). Therefore, it is difficult to define briefly and clearly. As stated above, a lot of research studies have shown that Duroc breed contains abundant intramuscular

Table 4. Comparison of sensory evaluation* of *longissimus* muscles of pigs in Korea

| Traits | | Duroc | Landrace | Yorkshire | Crossbred |
|--------|-----------------------|------------------------|------------------------|------------------------|------------------------|
| Fresh | Color | 2.65±0.58 | 3.00±0.61 | 2.87±0.53 | 2.75±0.69 |
| | Marbling | 2.68±0.65 ^a | 2.01±0.40 ^b | 2.15±0.47 ^b | 1.76±0.63 ^b |
| | Hardness | 2.83±0.71 | 2.76±0.57 | 2.68±0.73 | 2.88±0.76 |
| Cooked | Juiciness | 2.25±0.62 | 2.45±0.63 | 2.68±0.55 | 2.58±0.72 |
| | Tenderness | 3.06±0.21 | 2.37±0.59 | 2.38±0.65 | 2.30±0.48 |
| | Flavor | 2.53±0.66 | 2.14±0.49 | 2.33±0.51 | 2.58±0.48 |
| | Overall acceptability | 2.62±0.65 | 2.00±0.41 | 2.48±0.40 | 2.63±0.50 |

*1- very pale, very low in intramuscular fat, very flabby, very dry, very tough, very mild, very unacceptable

5- very dark, very high in intramuscular fat, very firm, very juicy, very soft, very intense, very acceptable

^{a,b}Means±SE with different superscription within the same row differ ($p<0.05$).

fat compared to other commercial breeds. Therefore, the marbling score of pigs in this study was consistent with results of pre-conducted research studies.

Fatty acid compositions of *longissimus* muscles

The fatty acid compositions of *longissimus* muscles from purebred and crossbred pigs are summarized in Table 5. The major fatty acids of *longissimus* muscles were oleic acid, palmitic acid, stearic acid, and linoleic acid. Oleic acid (45.10-46.76%) had the greatest percentage in the fatty acid compositions. Its concentrations were higher in Landrace and Yorkshire *longissimus* muscles than those in Duroc and cross bred pigs. Concentrations of linoleic acid, an essential fatty acid, was the highest ($p>0.05$) in the *longissimus* muscles of crossbred pigs. The contents of linoleic acid in other purebred pigs were not significantly ($p>0.05$) different. Palmitic acid contents (20.99-23.34%) were the highest among saturated fatty acids. Its

contents were higher ($p<0.05$) in the *longissimus* muscles of purebred pigs than those of crossbred pigs. However, palmitoleic acid contents were higher ($p<0.05$) in the *longissimus* muscles of crossbred pigs than those of purebred pigs. The contents of stearic acid were the lowest in the *longissimus* muscles of crossbred pigs compared to other pigs. Contents of γ -Linoleic acid, linolenic acid, and eicosenoic acid among unsaturated fatty acids were also significantly ($p<0.05$) higher in the *longissimus* muscles of crossbred pigs than those of purebred pigs. The contents of arachidonic acid in the *longissimus* muscles of Yorkshire pigs were higher ($p<0.05$) than those of Duroc and crossbred pigs.

In terms of overall fatty acids, the *longissimus* muscles of Duroc pigs contained the highest ($p<0.05$) contents of total saturated fatty acid compared to those of other pigs. The highest ($p<0.05$) contents of unsaturated fatty acid were observed in the *longissimus* muscles of crossbred

Table 5. Comparison of fatty acid composition of *longissimus* muscles of pigs in Korea

| Fatty acids | Duroc | Landrace | Yorkshire | Crossbred |
|-----------------------------------|-------------------------|--------------------------|-------------------------|-------------------------|
| Myristic acid (C14:0) | 1.65±0.23 ^a | 1.49±0.14 ^b | 1.59±0.13 ^a | 1.32±0.10 ^c |
| Palmitic acid (C16:0) | 23.34±0.92 ^a | 22.91±0.81 ^a | 23.02±0.94 ^a | 20.99±0.94 ^b |
| Palmitoleic acid (C16:1n7) | 0.88±0.21 ^b | 0.92±0.19 ^b | 0.97±0.20 ^b | 2.32±0.19 ^a |
| Stearic acid (C18:0) | 13.78±0.97 ^a | 13.24±1.05 ^{ab} | 12.74±1.04 ^b | 11.92±1.43 ^c |
| Oleic acid (C18:1n9) | 45.33±1.69 ^b | 46.76±1.60 ^a | 46.29±1.30 ^a | 45.10±1.53 ^b |
| Linoleic acid (C18:2n6) | 13.28±1.43 ^b | 12.93±1.55 ^b | 13.63±1.57 ^b | 16.08±1.48 ^a |
| γ -Linoleic acid (C18:3n6) | 0.03±0.01 ^b | 0.03±0.01 ^b | 0.03±0.01 ^b | 0.07±0.01 ^a |
| Linolenic acid (C18:3n3) | 0.65±0.08 ^b | 0.64±0.10 ^b | 0.67±0.08 ^b | 0.88±0.10 ^a |
| Eicosenoic acid (C20:1n9) | 0.82±0.12 ^b | 0.80±0.15 ^b | 0.79±0.10 ^b | 1.07±0.10 ^a |
| Arachidonic acid (C20:4n6) | 0.19±0.03 ^{bc} | 0.21±0.03 ^{ab} | 0.22±0.04 ^a | 0.18±0.03 ^c |
| Total | 100.00±0.00 | 100.00±0.00 | 100.00±0.00 | 100.00±0.00 |
| Saturated fatty acid (SFA) | 38.78±1.58 ^a | 37.66±1.29 ^b | 37.36±1.56 ^b | 34.26±2.10 ^c |
| Unsaturated fatty acid (USFA) | 61.21±1.58 ^c | 62.33±1.29 ^b | 62.63±1.56 ^b | 65.73±2.10 ^a |
| Mono-USFA | 47.04±1.83 ^b | 48.50±1.62 ^a | 48.06±1.32 ^a | 48.49±1.64 ^a |
| Poly-USFA | 14.17±1.52 ^b | 13.83±1.67 ^b | 14.57±1.67 ^b | 17.23±1.60 ^a |
| n3-Fatty acids | 0.65±0.08 ^b | 0.64±0.10 ^b | 0.67±0.08 ^b | 0.88±0.10 ^a |
| n6-Fatty acids | 13.51±1.44 ^b | 13.18±1.57 ^b | 13.89±1.59 ^b | 16.34±1.50 ^a |

^{a,b}Means±SE with different superscription within the same row differ ($p<0.05$).

pigs. On the other hand, among unsaturated fatty acids, the contents of mono-unsaturated fatty acid were lower ($p < 0.05$) in the *longissimus* muscles of Duroc pigs compared to other pigs. The *longissimus* muscles of crossbred pigs contained significantly higher ($p < 0.05$) poly-, n3- and n6- unsaturated fatty acids compared to those of purebred pigs, including Duroc, Landrace, and Yorkshire pigs.

According to CameronEnser (1991), *longissimus* muscles of Duroc pigs contain more SFA (C14:0 and C16:0) but less PUFA (C18:2 and C20:4) than British Landrace pigs. Similar results were obtained in our study. Straadt *et al.* (2013) have reported that higher levels of SFA (C14:0 and C16:0) in loins have significantly negative correlations with sensory attributes, including acidic flavor, chewing resistance, crunchy fibers, fibrousness, and acidic aftertaste. Likewise, fatty acid compositions could affect the tenderness of pork loin. Negative correlations between several PUFA and tenderness have also been reported by Lonergan *et al.* (2007). Although the results of sensory evaluation in this study did not showed dramatic differences in sensory attributes, purebred pigs (Duroc, Landrace, and Yorkshire) did have higher saturated fatty acids than crossbred pigs (LYD). Thus, purebred pigs are much beneficial than crossbred pigs in pork quality. On the other hand, in terms of human health associated with fatty acid ratios, nutritional recommendations for a healthy diet suggest that the ratio of PUFA:SFA should be above 0.4 and the ratio of n-6:n-3 PUFA should be less than 4 (Department of Health, 1994). In the current study, the ratio of PUFA:SFA was the highest in crossbred pigs (0.50), followed by that in Duroc (0.36), Landrace (0.36), and Yorkshire (0.38) pigs, while the ratios of PUFA:SFA were more than 18 in all pigs (Data not shown). According to Wood *et al.* (2004), usually pork contains a high content of C18:2n6 due to cereal-based diet, leading to desirable PUFA:SFA. However, high n-6 PUFA brings undesirable ratio of n-6:n-3 in human health perspective. These tendencies have also been observed in the study of Alonso *et al.* (2015).

Conclusion

The four breeds of commercial pigs in Korea were studied for their pork quality to meet consumer's needs. Duroc pigs had the highest fat content, while Landrace, Yorkshire, and LYD pigs had higher ($p < 0.05$) moisture contents than Duroc pigs. The values of pH_{24hr} ranged from 5.56 to 5.76 in pigs. There was no significant ($p > 0.05$) difference in shear force or WHC among these pigs. How-

ever, the drip loss values of purebred pigs were lower ($p < 0.05$) than crossbred pigs at 24 and 48 h after slaughter while drip loss values of crossbred pigs were not significantly different from those of purebred pigs at 14 d after slaughter. In sensory evaluation, Duroc pigs had the highest marbling scores compared to other pigs. In the fatty acid compositions of pigs, Duroc pigs had the highest SFA contents compared to others, whereas LYD pigs had the lowest SFA contents. LYD pigs contained higher ($p < 0.05$) poly-, n-3, n-6, and total USFA contents than purebred pigs. In conclusion, considering the high pH, reddish color, abundant marbling, and low drip loss of meat, the meat qualities of purebred pigs were satisfactory to the consumer compared to the crossbred pigs.

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