

## Effects of Sex and Market Weight on Performance, Carcass Characteristics and Pork Quality of Market Hogs

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**ABSTRACT :** An experiment was conducted to examine the effects of sex and market weight on performance, carcass characteristics and pork quality. A total of 224 crossbred pigs (initially 26.64 kg BW) were allotted in a 2×4 factorial arrangement in a randomized complete block (RCB) design. The variables were sex (gilts and barrows) and different market weights (100, 110, 120 and 130 kg). Average daily gain (ADG) and average daily feed intake (ADFI) were significantly higher ( $p<0.01$ ) in barrows than gilts, ADFI and feed conversion ratio (FCR) increased as body weight increased ( $p<0.05$ ). Gender differences were observed in carcass characteristics. Backfat thickness and drip loss were greater in barrows ( $p<0.01$ ), while loin eye area ( $p<0.01$ ), flavor score ( $p<0.05$ ) and lean content ( $p<0.001$ ) were higher in gilts. Carcass grade and water holding capacity were the highest in 110 kg market weight pigs. The 100 kg market weight pigs showed lower juiciness, tenderness, shear forces and total palatability than the other market weights ( $p<0.01$ ). Hunter values ( $L^*$ ,  $a^*$  and  $b^*$ ) were increased as market weight increased ( $p<0.05$ ). Hunter  $a^*$  value was greater in gilts ( $p<0.01$ ) but  $L^*$  value and  $b^*$  value were not affected by sex of pigs. Net profit [(carcass weight×price by carcass grade)-(total feed cost+cost of purchased pig)] was higher in gilts than barrows ( $p<0.01$ ), and was higher ( $p<0.05$ ) in the pigs marketed at 110 and 120 kg market weight compared with 100 kg market weight. These results demonstrated that gilts showed higher carcass characteristics, pork quality, feed cost per kg body weight gain and net profit compared with barrows. Moreover, 110 or 120 kg body weight would be the recommended market weight based on pork quality and net profit for swine producers. (*Asian-Aust. J. Anim. Sci.* 2004, Vol 17, No. 10 : 1452-1458)

**Key Words :** Sex, Market Weight, Pork Quality

### INTRODUCTION

Within the limitations of the pig's genetic potential, economic advantages are available to the swine industry through extension of the feeding period (Martin et al., 1980). For example, labor costs per kg of carcass weight can be reduced by increasing market weight and therefore the efficiency for processors can also be increased. However, pork quality has not been considered with extended feeding periods. Meat quality is becoming an increasingly important issue to meat processors and consumers (Beattie et al., 1999). Pork quality was shown to be affected by diet, genotype and sex (Christian et al., 1980; Unruh et al., 1996; Choi et al., 2001; Jiang et al., 2003) while age or market weight can also affect meat quality. Choi et al. (2000) studied the relationship between marketing day and pork quality. However, little information is available on whether market weight, within the usual commercial limits, may influence carcass characteristics and pork quality. Indeed, restricting feed intake in order to increase age at a given slaughter weight could be the main reason for differences in meat quality (Ellis et al., 1990; Warkup et al., 1990; Candek-Potokar et al., 1998). In addition, net profit

evaluation would be an useful measurement for practical application. Therefore, the aim of this study was to evaluate the effect of sex and market weight of finishing pigs on performance, carcass characteristics, pork quality and economic efficiency.

### MATERIALS AND METHODS

#### Animals and experimental design

A total of 224 crossbred pigs ([Landrace×Yorkshire] ×Duroc) with an average body weight of 26.64±0.14 kg were allocated to a 2×4 factorial arrangement in a randomized complete block (RCB) design in seven replicates with four pigs per pen. Pigs were grouped based on sex and body weight and assigned to eight treatments. The variables were sex (gilts and barrows) and 4 different market weights (100, 110, 120 and 130 kg).

#### Feeding trials

Pigs were housed in half-slotted concrete floored pen (1.2×2.6 m<sup>2</sup> for the growing period and 1.6×3.1 m<sup>2</sup> for the finishing period) and were allowed *ad libitum* access to water and diet (mash form) during entire experimental period. Body weight and feed intake were recorded at d 35, d 63 and marketing. Feed conversion ratio was calculated by dividing the amount of feed consumed with the corresponding body weight gain. The diets were formulated to contain approximately 4.383 kcal/kg (GE), 4.315 kcal/kg

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**Table 1.** Chemical composition of diets

	Growing (27-53 kg)*	Early finishing (53-80 kg)	Late finishing (80 kg-slaughter)
Chemical composition <sup>1</sup>			
Gross energy (kcal/kg)	4,383.24	4,315.11	4,266.15
Crude protein (%)	16.75	14.66	11.71
Crude fat (%)	7.96	6.49	4.62
Crude ash (%)	4.50	4.36	5.29
Calcium (%)	0.59	0.56	0.72
Avail. phosphorus (%)	0.22	0.22	0.20

<sup>1</sup> Analyzed value. \* Average body weight of all the pigs in the experiment.

(GE) and 4.266 kcal/kg (GE) of gross energy and 16.75%, 14.66% and 11.71% of crude protein for growing period, early finishing period and late finishing period, respectively. The chemical composition of other nutrients are shown in Table 1.

### Carcass characteristics

When the mean weight of pigs in a pen reached market weight (100, 110, 120 or 130 kg), two pigs of median weight in each pen were selected and slaughtered according to industry-accepted procedures for carcass analysis at the slaughter house. Carcasses were chilled conventionally at 0°C for 24 h. At 24 h postmortem, carcass measurements were collected including backfat thickness (first rib, last rib and last lumbar vertebra), carcass length and carcass grade evaluated by Animal Products Grading Service (Ministry of Agriculture and Forestry, 2001). Then, the left side of each carcass was ribbed between the 10th and 11th thoracic vertebrae. The cross-section of the longissimus muscle was traced onto cellophane film and longissimus muscle area was measured using a compensating Planimeter (PLACOM KP-90 N, Koizumi Co., Japan). The longissimus muscle between the 5th and 13th thoracic vertebrae was ribbed for further analysis. The weight of lean pork was calculated by the following equation (NPPC, 1991): Carcass fat-free lean (lb) =  $0.95 \times [7.231 + (0.437 \times \text{hot carcass weight, lb}) - (18.746 \times 10^{\text{th}} \text{ rib fat depth, in.}) + (3.877 \times 10^{\text{th}} \text{ rib loin eye area, in.}^2)]$ . Percentage lean was derived by dividing the lean weight of the hot carcass weight and multiplying by 100.

### Meat quality

A 10 g sample of longissimus muscle was collected for pH determination. The muscle sample was homogenized in a commercial homogenizer (Model AM-7, Nihonseiki Kaisha, Ltd., Japan) with 100 ml of distilled water for 1 min. at 7,000 rpm and pH was measured at room temperature with a digital pH meter (Mettler Delta 340, Mettler-Toledo, Ltd., UK).

To determine drip loss, a 2 cm slice of longissimus muscle (100 ± 5 g) was placed in a plastic net bag which was

in turn placed inside a pre-weighed polypropylene bag in a cold room at 4°C for 5 days. The net bag was then removed and the polypropylene bag plus exudate was weighed. Drip loss was expressed as a percentage of the initial weight of the slice. Water holding capacity was measured according to the procedure of Miller and Harrison (1965). Samples (1 g) were pressed on Whatman No. 1 filter paper between two Plexiglass plates using a Carver Laboratory Press (Carver, Carver Inc., USA) for 1 minute at 8,000 psi. Water holding capacity was reported as the ratio of total fluid area to meat film area. A sample of longissimus muscle 2 cm thick was weighed, placed in a polypropylene bag and heated in a water bath at 70°C for 40 min. Following cooking, the sample was weighed and cooking loss determined. From each cooked sample, rectangular parallel-piped slices (1 × 2 × 1 cm<sup>3</sup>) were obtained and the shear force was determined using a Sun Rheo Meter (Compac-100, Sun Scientific Co. Ltd., Japan) under 110 mm/min table speed, 20 mm/min chart speed and 10 kg load cell max.

The longissimus muscle from each carcass was subjectively evaluated for marbling (1=devoid to practically devoid; 2=traces to slight; 3=small to modest; 4=moderate to slightly abundant; 5=moderately abundant or greater). The samples were taken from the 5th to the 13th rib of the loin region for the sensory analyses. Pork was prepared by making 1 cm thick loin slices from each pig. The samples were heated in a 70°C water bath for 40 min before they were presented to panelists, who evaluated sensory quality. Flavor, tenderness, juiciness and overall taste were scored on a scale of 1 to 5, where 1 is extremely bland, tough, dry and poor and 5 is extremely intense, tender, juicy and excellent, respectively.

Hunter L\*, a\* and b\* values of the longissimus muscle were measured with a Spectro Colorimeter (Model JX-777, Color Techno. System Co., Japan) calibrated against a standard white tile (L\*, 89.39; a\*, 0.13; b\*, 0.51). Light source was white fluorescent light (D65).

### Proximate analysis

Longissimus samples were collected at 1 d postmortem, frozen and stored at -20°C until analysis. Longissimus samples were freeze dried (Ilsin Eng. Co., Korea) and ground with a 1 mm Wiley mill for proximate analysis. Chemical analyses of longissimus muscle were conducted according to the methods of the AOAC (1995) and gross energy content of sample was measured using an adiabatic bomb calorimeter (Parr Instrument, Moline, IL).

### Economic efficiency

Carcass weight was recorded immediately following slaughter. Carcass price of each pig was obtained from the publicly assessed value by carcass grade. Net profit was calculated by the equation as following: Net profit = (carcass weight × price by carcass grade) - (total feed cost + cost of

**Table 2.** The effect of sex and market weight on growth performance in pigs<sup>1</sup>

Items	Sex		SE	P	Market weight (kg)				SE	P
	Barrow	Gilt			100	110	120	130		
ADG (g)	724	671	9.40	***	696	714	707	674	13.29	NS <sup>2</sup>
ADFI (g)	2,447	2,236	25.27	***	2,188	2,353	2,406	2,425	35.73	***
FCR	3.39	3.35	0.04	NS	3.14	3.30	3.42	3.61	0.06	***

<sup>1</sup> Total of 224 pigs, averaging initial body weight was 26.64±0.14 kg, four pigs/pen, 7 pens/treatment.

<sup>2</sup> NS: not statistically significant. \*\*\* p<0.001.

**Table 3.** The effect of sex and market weight on carcass characteristics

Items	Sex		SE	P	Market weight (kg)				SE	P
	Barrow	Gilt			100	110	120	130		
Carcass weight (kg)	86.43	87.28	0.79	NS <sup>1</sup>	76.34	84.60	91.05	95.53	1.11	***
Backfat thickness (cm)	2.91	2.64	0.06	**	2.67	2.70	2.80	2.94	0.08	NS
Carcass length (cm)	102.41	102.84	0.42	NS	97.68	101.59	104.14	107.09	0.59	***
Loin eye area (cm <sup>2</sup> )	38.53	44.27	0.99	***	37.76	39.94	43.51	44.38	1.40	**
Dressing percentage (%)	75.55	76.67	0.56	NS	76.60	76.75	75.80	75.30	0.79	NS
Pork grade <sup>2</sup>	2.46	2.36	0.12	NS	2.20	1.99	2.49	2.96	0.16	***
Lean weight (kg)	39.38	42.49	0.55	***	35.70	39.35	42.69	46.00	0.77	***
Lean percentage (%)	45.58	48.26	0.44	***	46.65	46.77	47.76	46.50	0.62	NS

<sup>1</sup> NS: not statistically significant. <sup>2</sup> A grade=1, B grade=2, C grade=3, D grade=4. \*\* p<0.01, \*\*\* p<0.001.

purchased pig).

#### Statistical analysis

Data were analyzed as 2×4 factorial, using the General Linear Model (GLM) procedure of SAS (1985). The pen was the experimental unit for the growth performance data; however, individual pig was used as an experimental unit for all carcass characteristics and meat quality measurements.

## RESULTS AND DISCUSSION

### Growth performance

The effects of sex and market weight on average daily gain (ADG), average daily feed intake (ADFI) and feed conversion (FCR) were shown in Table 2. Barrows grew faster (p<0.001) and had higher feed intake (p<0.01) than gilts. There was no significant effect of sex on FCR. Our results for performance agreed with previous studies (Ellis et al., 1996; Larzul et al., 1997).

Kanis et al. (1990) reported that pigs grew substantially more slowly from 60 kg to slaughter weights of 140 kg compared with 100 kg, and Ellis et al. (1996) found a significant effect of slaughter weight on growth rate with pigs killed at 120 kg growing significantly slower than those slaughtered at either 80 or 100 kg. They reported that ADG declined by 6% between 100 and 120 kg. In the current study, ADG was improved by 3% between 100 and 110 kg and declined by less than 1% between 110 and 120 kg. Neely et al. (1979) and Cisneros et al. (1994), however, reported that there were no significant changes in growth rate to slaughter weights above 100 kg live weight, which is similar to our findings. Feed conversion ratio was affected by market weight (p<0.01). The main reason for the reduction of feed efficiency would be explained by the

physiological characteristics of pigs because lean growth occurred in growing period while fat growth did in finishing period. In addition, the feed of late finishing period was designed for 80-110 kg pigs, which could partly relate to the result of FCR. Our results concerning feed efficiency agreed with the results of Neely et al. (1979) and Candek-Potokar et al. (1998). No interaction was present between sex and market weight (p>0.10).

### Carcass characteristics

The effects of sex and market weight on carcass characteristics were presented in Table 3. Carcass weight, carcass length, carcass percentage and grade were not affected by sex (p>0.10). Barrows, however, had thicker backfat than gilts (p<0.01), and gilts had wider loin eye area, heavier lean weight, and higher lean percentage (p<0.01). Unruh et al. (1996) found higher percentage of loin in gilts than in barrows and Choi et al. (2000) reported that barrows showed thicker (p<0.05) backfat thickness and gilts showed larger (p<0.05) loin area in approximately 110 kg live weight pigs subsequently gilts had better grades than barrows (p<0.05). Even though we did not find an effect of sex on grade, gilts showed numerically better grade than barrows in 110 kg market weight pigs (gilt 1.79, barrow 2.19). Since lean weight was calculated by the equation (NPPC, 1991) in which loin eye area and fat depth would affect the estimated lean weight, gilts with thinner backfat and wider loin area showed heavier lean weight and higher lean percentage (p<0.01). Larzul et al. (1997) and DeSmet et al. (1996) also demonstrated that gilts had more lean than barrows because of thinner backfat and wider loin area.

Backfat tended to be thicker as market weight increase (p=0.11) and loin eye area and lean weight were affected by market weight (p<0.01). However, lean percentage was

**Table 4.** The effect of sex and market weight on meat quality

Items	Sex		SE	P	Market weight (kg)				SE	P	Interaction
	Barrow	Gilt			100	110	120	130			
pH	5.64	5.66	0.03	NS <sup>1</sup>	5.60	5.74	5.58	5.72	0.04	**	***
Drip loss (%)	12.35	9.56	0.66	**	20.71	9.82	7.71	5.57	0.93	***	NS
Water holding capacity	1.43	1.42	0.05	NS	1.71	1.56	1.29	1.13	0.08	***	NS
Cooking loss (%)	35.35	32.53	0.56	***	38.23	31.11	34.67	31.76	0.79	***	NS
Shear force (kg)	2.49	2.62	0.09	NS	2.20	2.66	2.60	2.76	0.12	**	NS
Marbling score <sup>2</sup>	2.72	2.43	0.12	NS	2.42	2.61	2.66	2.60	0.17	NS	*
Sensory quality											
Flavor <sup>3</sup>	3.31	3.41	0.03	*	3.06	3.39	3.56	3.43	0.05	***	NS
Tenderness <sup>4</sup>	3.24	3.32	0.04	NS	3.03	3.47	3.31	3.31	0.06	***	NS
Juiciness <sup>5</sup>	3.14	3.10	0.03	NS	2.88	3.19	3.25	3.16	0.04	***	NS
Overall taste <sup>6</sup>	3.20	3.17	0.03	NS	2.95	3.23	3.29	3.27	0.04	***	NS
Hunter value											
L*	46.36	45.91	0.62	NS	44.22	46.06	46.30	47.97	0.88	*	NS
a*	2.62	4.06	0.31	**	1.64	3.17	2.86	5.67	0.44	***	NS
b*	5.04	5.29	0.24	NS	4.89	4.57	5.06	6.13	0.34	*	NS

<sup>1</sup> NS: not statistically significant.

<sup>2</sup> 1=devoid to practically devoid; 2=traces to slight; 3=small to modest; 4=moderate to slightly abundant; and 5=moderately abundant or greater.

<sup>3</sup> Scored on a scale of 1 to 5, where 1=extremely bland and 5=extremely intense.

<sup>4</sup> Scored on a scale of 1 to 5, where 1=extremely tough and 5=extremely tender.

<sup>5</sup> Scored on a scale of 1 to 5, where 1=extremely dry and 5=extremely juicy.

<sup>6</sup> Scored on a scale of 1 to 5, where 1=extremely poor and 5=extremely excellent. \* p<0.05. \*\* p<0.01. \*\*\* p<0.001.

constant as market weight increased ( $p>0.10$ ). Carcass grade was numerically the best when the market weight was 110 kg. Candek-Potokar et al. (1998) found increased fatness when the market weight was increased from 100 to 130 kg ( $p<0.05$ ), which agrees with our results. A number of studies also have reported an increase in longissimus muscle area as slaughter weight increased beyond 100 kg (Brude et al., 1963; Skitsko and Bowland, 1970; Neely et al., 1979; Rhim et al., 1995). The constant lean percentage as market weight increased was similar to previous findings (Neely et al., 1979; Martin et al., 1980). No interaction was present between sex and market weight ( $p>0.10$ ).

### Meat quality

The effects of sex and market weight on meat quality was shown in Table 4. The influence of sex and market weight on meat quality was varied and sometimes not completely clear. No significant difference between gilts and barrows was found for the pH of longissimus muscle ( $p>0.10$ ), which was in agreement with Gueblez et al. (1993). However, Larzul et al. (1997) found significantly lower longissimus muscle ultimate pH in gilts than in barrows (5.59 vs. 5.65,  $p<0.001$ ). The pH value of longissimus muscle was significantly higher at 110 and 130 kg than at 100 and 120 kg ( $p<0.01$ ). There was a significant interaction between sex and market weight ( $p<0.01$ ) on pH of longissimus muscle. The longissimus muscle pH of barrows on 100, 110, 120 and 130 kg market weight treatments were 5.67, 5.67, 5.65 and 5.59, respectively, while the corresponding values for gilts were 5.53, 5.81, 5.51 and 5.84, respectively. The pH of longissimus muscle

was not affected by market weight in barrows. In contrast, the pH of longissimus muscle was higher on 110 and 130 market weight than other treatments in gilts ( $p<0.01$ ). Unruh et al. (1996) reported the longissimus muscle from pigs fed to 104 and 127 kg had similar ( $p>0.05$ ) 24 h pH. The pH values ( $5.66\pm 0.02$ ) in the current studies were in the acceptable range and would not be significantly noticed by consumers practically.

Drip loss ( $p<0.01$ ) and cooking loss ( $p<0.001$ ) for longissimus muscle of barrows were significantly higher ( $p<0.01$ ) than longissimus muscle of gilts. This is different from the work of Choi et al. (2000) who found no effect of sex on drip loss when they raised pigs for different periods (160, 170 and 180 days) without changing slaughter weight (110 kg) and restricted feed to pigs to meet the age and the slaughter weight. In the present experiment, however, pigs were allowed *ad libitum* access to water and feed throughout the whole experiment. Drip loss, cooking loss, water holding capacity and shear force were significantly affected by market weight ( $p<0.01$ ). Drip loss was higher at 100 kg market weight than the other market weights ( $p<0.05$ ) and shear force was also lowest at 100 kg market weight ( $p<0.05$ ). Martin et al. (1980) reported increasing carcass weight was associated with less percentage drip loss and Beattie et al. (1999) demonstrated a decrease in cooking loss with increasing carcass weight from 70 kg up to 100 kg ( $p<0.001$ ). Numerous experiments demonstrated that there were effects of market weight on drip loss (Beattie et al., 1999), cooking loss (Jeremiah and Weiss, 1984; Unruh et al., 1996) or shear force (Martin et al., 1980; Unruh et al., 1996; Beattie et al., 1999). Different analytical methods or the

different content of moisture, crude fat and/or crude protein could explain the differences observed among experiments.

Marbling score was affected by sex and tended to be higher in barrows than in gilts, although it was not statistically significant ( $p=0.11$ ). Average daily feed intake was significantly higher ( $p<0.01$ ) for barrows in the present study and this might have contributed to 12% higher marbling score in the longissimus muscle from barrows and subsequently intramuscular fat in longissimus muscle was also higher ( $p<0.05$ ) in barrows (Table 5). Unruh et al. (1996) reported that barrow longissimus muscle had more marbling ( $p<0.05$ ) and a higher percentage of lipid ( $p<0.01$ ) than longissimus muscle from gilts. No significant effect of market weight on marbling score was observed ( $p>0.10$ ). Compared with marbling scores of longissimus muscle from the pigs of 100 kg market weight, relative marbling scores of 110, 120 and 130 kg market weight were numerically 8%, 10% and 7% higher, respectively. This trend could be supported by the higher tendency of intramuscular fat contents (19%, 14% and 21%, respectively, Table 5). Beattie et al. (1999) also found a numerical increase in the level of intramuscular fat with increasing carcass weight.

The flavor of longissimus muscle was more intense in gilts ( $p<0.05$ ), while tenderness, juiciness and overall taste were not affected by sex ( $p>0.10$ ). Flavor, tenderness, juiciness and overall taste were evaluated and showed the lowest values in 100 kg market weight pigs compared with the other market weights ( $p<0.05$ ). Christensen (1975) demonstrated that sensory quality had a close relation with intramuscular fat. In the present experiment, the changes in sensory quality as market weight increased could be explained by the trend of marbling score and intramuscular fat content in longissimus muscle. Rhim et al. (1995) reported that the tenderness of longissimus muscle was higher in the pigs slaughtered at 132 kg than at 103 kg ( $p<0.05$ ). However, Martin et al. (1980) showed no effects of slaughter weight on tenderness.

There was no significant effects of sex on  $L^*$  values or  $b^*$  values. Hunter  $a^*$  values for gilts were significantly higher ( $p<0.01$ ) than for barrows. Larzul et al. (1997) reported that sex did not affect the  $L^*$  values of pork and Choi et al. (2000) found Hunter  $L^*$ ,  $a^*$  and  $b^*$  value had no

relation with sex of pigs. The  $L^*$  values of longissimus muscle were higher at 130 kg market weight than 100 kg market weight ( $p<0.05$ ). However, there was no significant difference in longissimus muscle lightness among other market weight treatments ( $p>0.05$ ). In a number of studies, meat lightness has been shown to be unrelated to carcass weight (Shuler et al., 1970; Garcia-Macias et al., 1996; Candek-Potokar et al., 1998; Beattie et al., 1999). Although, Unruh et al. (1996) found darker longissimus muscle from high-lean genotype pigs slaughtered at 127 kg compared with 104 kg, they reported slaughter weight had no effect on the lightness of longissimus muscle from medium-lean genotype pigs. Hunter  $a^*$  and  $b^*$  values were higher at 130 kg market weight than the other market weight pigs ( $p<0.05$ ). The higher  $a^*$  and  $b^*$  values at higher market weights in the current study could be explained by increased pigment content and agreed with the results of numerous experiments (Martin et al., 1980; Garcia-Macias et al., 1996; Beattie et al., 1999). In some studies, no significant effect of weight on meat color was found (Shuler et al., 1970; Sutton et al., 1997). Moreover, in contrast with our result, a decrease with weight in color score has also been reported (Candek-Potokar et al., 1998).

The effects of sex and market weight on meat quality including pH, drip loss, shear force, marbling score and Hunter values in the previous studies were varied and sometimes controversial. The conflicting reports in the literature might partly be explained by the differences in genotype, pre- and post-slaughter handling and measuring methods.

### Proximate analysis

The effects of sex and market weight on chemical composition of longissimus muscle were presented in Table 5. Crude protein was significantly lower ( $p<0.01$ ) in the longissimus muscle of barrows compared with gilts, while fat content and gross energy were significantly higher ( $p<0.05$ ) in the longissimus muscle of barrows compared with gilts. Higher intramuscular fat contents in barrows than gilts could be explained by significantly higher ( $p<0.001$ ) ADFI for barrows (Table 3) and marbling scores were also 12% higher ( $p=0.11$ ) in barrows (Table 4). The results of longissimus muscle fat content by sex in the present study

**Table 5.** The effect of sex and market weight on proximate nutrient content of longissimus muscle

Items <sup>1</sup>	Sex		SE	P	Market weight (kg)				SE	P
	Barrow	Gilt			100	110	120	130		
Moisture (%)	73.94	74.04	0.21	NS <sup>2</sup>	73.89	73.96	74.37	73.75	0.31	NS
Crude ash (%)	4.52	4.78	0.10	NS	4.95	4.58	4.62	4.45	0.15	NS
Crude protein (%)	77.09	79.58	0.58	**	77.57	76.48	78.91	80.39	0.82	**
Crude fat (%)	11.40	9.84	0.55	*	9.35	11.16	10.67	11.32	0.78	NS
Phosphorus (%)	0.15	0.16	0.00	NS	0.15	0.16	0.16	0.15	0.01	NS
Gross energy (cal/g)	5,604	5,515	31.30	*	5,538	5,597	5,545	5,556	44.27	NS

<sup>1</sup> Crude ash, crude protein, crude fat, phosphorus and gross energy was measured on an air dry condition after the determination of moisture content.

<sup>2</sup> NS: not statistically significant. \*  $p<0.05$ , \*\*  $p<0.01$ .

**Table 6.** The effect of sex and market weight on economic efficiency

Items	Sex		SE	P	Market weight (kg)				SE	P
	Barrow	Gilt			100	110	120	130		
Carcass weight (kg)	86.43	87.28	0.79	NS <sup>1</sup>	76.34	84.60	91.05	95.53	1.11	***
Carcass price (\$ <sup>2</sup> /kg)	1.79	1.96	0.02	***	1.90	1.93	1.87	1.80	0.02	**
Total feed cost (\$)	54.08	52.29	0.76	NS	41.85	50.35	56.85	63.70	1.07	***
Net profit <sup>3</sup> (\$)	42.50	60.57	1.53	***	45.61	54.82	55.18	50.54	2.16	**

<sup>1</sup> NS: not statistically significant.

<sup>2</sup> The Korean currency (won) was converted at the exchange rate of 1,300 won to the U.S. dollar.

<sup>3</sup> Net profit was calculated by the equation as following: Net profit=(carcass weight×price by carcass grade)-(total feed cost+cost of purchased pig), the cost of purchased pig (body weight=26.64 kg) was regarded as approximately \$57.69. \*\* p<0.01. \*\*\* p<0.001.

were in agreement with a number of previous studies (Uttaro et al., 1993; Unruh et al., 1996; Larzul et al., 1997). Uttaro et al. (1993) also found less longissimus muscle protein and ash content in barrows compared with gilts and reported shear values were lower in barrows. In addition, DeVol et al. (1988) demonstrated intramuscular fat to be highly related to Warner-Bratzler shear value ( $r=-0.29$ ). In the present study, although shear force values were not statistically different by sex factor, the shear values of longissimus muscle in barrows were numerically 5% lowered compared to gilts (Table 4).

Market weight significantly affected the crude protein content of LM ( $p<0.01$ ). Crude protein content of longissimus muscle was higher in the pigs of 130 kg market weight than of 100 kg or 110 kg market weight ( $p<0.05$ ). The effects of market weight on crude fat content of longissimus muscle were not significant ( $p>0.05$ ). Compared with the fat contents of longissimus muscle from pigs slaughtered at 100 kg, however, those from pigs of 110, 120 and 130 kg market weight were 19%, 14% and 21% higher, respectively. This result was reflected on the higher marbling score of longissimus muscle (8%, 10% and 7%, Table 4). In agreement with part of our results, Candek-Potokar et al. (1998) reported the muscle of 130 kg pigs had higher protein and more intramuscular fat compared with 100 kg pigs. Beattie et al. (1999) also reported carcass weight ( $p<0.001$ ) affected protein and dry matter content, both parameters being higher at 90 and 100 kg carcass weight than at 70 and 80 kg carcass weight, which is similar to the present findings. However, Rhim et al. (1995) reported that percent fat of LM was not different in the pigs slaughtered at 103 kg and at 132 kg ( $p>0.05$ ).

#### Economic efficiency

The effect of sex and market weight on economic efficiency was shown in Table 6. Carcass weight and total feed cost were not different between sexes ( $p>0.10$ ). However, net profit [(carcass weight×price by carcass grade)-(total feed cost+cost of purchased pig)] was higher in gilts ( $p<0.01$ ) than in barrows. Carcass price according to carcass grade was also higher in gilts ( $p<0.01$ ) than barrows, which mainly contributed to higher net profit in gilts. Feed cost per weight gain was significantly higher ( $p<0.01$ ) in

the pigs raised up to 120 or 130 kg than in 100 kg market weight pigs. Net profit was higher ( $p<0.05$ ) in the pigs of 110 or 120 kg market weight compared with 100 kg market weight. Carcass weight and total feed cost increased as market weight increased, while carcass price was declined when pigs were slaughtered later than 110 kg of body weight ( $p<0.05$ ). There was no significant sex×market weight interaction on economic efficiency.

These results demonstrated that gilts showed higher carcass characteristics, pork quality and net profit compared with barrows. In addition, 110 or 120 kg body weight would be the recommended market weight based on pork quality and profit for producers.

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