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Effect of Pig Slaughter Weight on Pork Quality

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돼지의 도살체중이 돈육질에 미치는 효과

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Abstract

A total of 240 crossbred(Landrace × Yorkshire × Duroc) pigs were housed from 70 kg live weight and slaughtered at weights of 95, 105, 115 and 125 kg. The left side loins of carcass were obtained at 24 hr postmortem to measure pork quality. There were significant differences($p<0.01$) in eye muscle area of pork loins between the slaughter weights of 95 and 105 kg. However, no differences were observed in pork than 105 kg of slaughter weight. Ultimate pH values were decreased with increasing slaughter weight and cooking loss was also reduced($p<0.01$) at the heavier weights. Slaughter weights did not affect the shear force and intramuscular fat. However, dry matter(DM) and crude protein(CP) contents of loin were increased, and cooking loss and sarcomere length were decreased with increasing slaughter weight. The lightness(L^*) and redness(a^*) of pork loin were increased with increasing slaughter weight. Results suggested that pork quality may be improved when pig slaughter weight is increased from 95 to 125 kg.

Key words : pigs, slaughter weight, pork quality

Introduction

Pork quality is becoming increasingly important to pork processors and consumers. However, pig breeders and pork producers have concentrated on reducing subcutaneous fat in pigs until recent years. Until now, pig breeder programmers have been contributed to the improvement of growth rate, food conversion efficiency and carcass quality, but not taken into account pork quality except for the halothane susceptibility gene(Bidanel et al., 1994).

In the past, pork quality attributes have generally been considered to be independent of either live pig weight or carcass weight(Sather et al., 1991). However, modern genotypes are much leaner and have higher growth rates than their historical counterparts. While genetic and environmental component and their interaction in the immediate preslaughter period are considered to be the main factors which determine the incidence of low quality pork(Murray et al., 1989). The changes in lean deposition are also likely to be accompanied by changes in tissue distribution of the carcass. Full carcass dissections however are costly and laborious to perform while the composition of a meat cut is less costly to determine and is closely correlated with full carcass composition(Planella and Cook, 1991).

Increasing carcass weight concomitantly increases with age when slaughtered. It is difficult to obtain pigs of different weights at the same age and vice versa without changing genotype or feeding regime. However, these factors have a major influence on the parameters affecting meat quality such as muscle collagen concentration(Touraille et al, 1989) and

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intramuscular fat content(Wood and Warris, 1990). A further effect of increasing age at slaughter may be increased the incidence of boar taint(Claus et al., 1994). In addition to the relationship among pork color, water-holding capacity(WHC) and slaughter weight is not a simple one. Pork color has been shown to be unrelated to carcass weight in several studies (Sutton et al., 1997; Unruh et al., 1996) while other studies have shown significant changes in pork color with increasing carcass weight(Martin et al., 1980; Unruh et al., 1996). Moreover, Lee and Joo(1999) suggested that pork loin became more red with increasing slaughter weight while WHC was not affected.

The present study aimed to determine the effect of increasing slaughter weight, through increased age at slaughter, on the composition of a carcass and pork quality of lean genotype crossbred(Landrace×Yorkshire×Duroc) pigs.

Materials and Methods

Animals

A total of 240 crossbred(Landrace×Yorkshire×Duroc), approximately 70 kg live weight pigs were randomly allocated to a 2×4 factorial design experiment. In order to achieve the target slaughter weights which were 95, 105, 115 and 125 kg, respectively, pigs were housed in single sex groups of 30 and offered a commercial feed at libitum(DE 13.9 MJ · kg^{-1}, lysine 10.5 g · kg^{-1}). Pigs which had reached the target slaughter weight were slaughtered at a commercial slaughter abattoir. After slaughter the carcasses were subjected to the normal commercial practice in that plant. Cold carcass weights were recorded post slaughter. Immediately after fabrication, the left side loins of carcasses were obtained at 24 hrs postmortem, and transported to laboratory using a refrigerated van to measure pork quality parameters.

Meat composition

Samples were weighed and photographed, and eye-muscle areas were determined by tracing round the photograph of the muscle with a pen linked to a graphics tablet(Grafbar Mk II) which digitalized the image and the area computed using Design CAD software. Then samples dissected subcutaneous fat and intermuscular fat. Moisture losses in the freezer were attributed to the lean component of the sample. Nitrogen and fat contents were determined using a modified Bligh and Dyer (1959) procedure followed by Soxhlet extraction with petroleum ether.

Meat quality

Ultimate pH of the M. *Longissimus* was measured on a sample homogenized in distilled water. To determine sarcomere length, the method of Koolmees et al.(1986) was used for sample preparation. Sarcomere lengths were calculated from a minimum of 10 observations per sample according to the formula used by Cross et al.(1981). To determine drip loss a 3~4 cm slice of M. *Longissimus dorsi* was placed in a plastic net bag which was in turn placed inside a pre-weighed polythene bag in a chilling room at 1℃ for 2 days. The net bag was then removed and the polythene bag with exudates was then weighed. Samples of M. *Longissimus dorsi* 40 mm thick were taken 2 days after slaughter were weighed and placed in polythene bags, and heated in a water bath at 70℃ for 50 min. Following cooking, the samples were weighed and cooking loss determined. From each cooked sample 10 cores, diameter 13.5 mm, 35 to 40 mm long were obtained and the shear force determined using a Warner-Bratzler shear cell attached to an Instron Model 6021 Universal test machine. The shear force was determined with the conditions of test speed 100 mm per minute with a 1 kN load cell calibrated to read over the range 0~20 kg. The color of M. *Longissimus dorsi* muscle was measured using a Color difference meter(CR 300b, Minolta Co., Japan).

Statistical analysis

Data were analysed as a 4×2 factorial design using the SPSS 8.0 for windows(SPSS, Chicago, IL, USA) and the analysis of variance calculated with carcass weight and gender as main effects. Individual animals were taken as the experimental unit for pork quality data.

Results and Discussion

Table 1 shows the mean and range of slaughter and carcass weights obtained. There was no significant difference between boars and gilts at each weight groups. The higher slaughter weight of boars than gilts represents the higher target slaughter weight range for boars than gilts. Increasing slaughter weight is one method of increasing output and efficiency for the processor as labor costs per unit carcass

Table 1. The mean and range of slaughter and carcass weights(kg) of pigs

Slaughter weight	Boar		Gilt	
	Slaughter weight range	Cold carcass weight range	Slaughter weight range	Cold carcass weight range
95	91~104	69~ 84	88~ 99	71~ 79
105	100~114	78~ 91	103~110	79~ 93
115	112~128	92~105	110~123	88~102
125	122~142	100~111	123~138	96~109

weight are reduced. Also, increasing carcass weight increases output of lean meat per sow per annum for the producer. Furthermore changes in patterns of consumer demand have facilitated the use of cuts from heavier pigs(Ellis and Horsfield, 1988). The downside to this approach is that consumers demand leaner meat but traditionally increasing slaughter weight was associated with increases in carcass fatness. However due to intense genetic selection for leanness, carcass composition has been changed. For example, the fat/lean ratio of a 70 kg carcass in the 1960s was 0.87(Adam and Smith, 1966), in the 1970s it was 0.75(Kempster and Evans, 1979), in the 1980s 0.37(Wood, 1993). Therefore, at a given weight the modern pig carcass has a much higher lean content and increasing slaughter weight has a lower impact on meat composition than in their historical counterparts.

Table 2 shows that increasing slaughter weight increased eye muscle area significantly($p<0.01$). Slaughter weight significantly($p<0.01$) affected protein and dry matter content, both parameters being higher at 115 and 125 kg slaughter weight than at 95 and 105 kg slaughter weight(Table 3). The dry matter, protein and fat contents were all significantly($p<0.01$) higher in gilts compared to boars. Similar differences between the genders have been reported at lighter weights(McCracken et al., 1997). As slaughter weight increased subcutaneous fat levels also increased in this study(data were not shown). Previous work(Lee and Joo, 1999) also showed that there were numerical increases in the level of intramuscular fat with increases in subcutaneous fat with increasing slaughter weight. Lee and Joo(1999) reported that lower backfat levels were closely correlated with lower intramuscular fat values. Boars had significantly lower intramuscular fat levels and this result was in agreement with Malmfors and Nilsson(1978) who also found that boars had lower intramuscular fat levels than meat from castrates or

Table 2. The effect of slaughter weight and gender on carcass weight and eye muscle area

Slaughter weight (kg)	Mean slaughter weight (kg)	Cold carcass weight (kg)	Eye muscle area (cm^{-2})
95	94.2	72.3	37.1^{b}
105	105.4	81.1	41.8^{a}
115	116.7	90.4	43.4^{a}
125	126.4	99.8	44.3^{a}
SEM	0.54	0.48	0.74
Gender			
Boar	112.2^{a}	85.5	40.3^{b}
Gilt	109.8^{b}	83.8	42.7^{a}
SEM	0.51	0.32	0.49

[a,b] Means in the same column with different superscripts are significantly different($p<0.01$).

Table 3. The effect of slaughter weight and gender on meat composition of pork loin

	Meat composition(g/100g)		
	Dry matter	Crude protein	Fat
Slaughter weight(kg)			
95	24.9^{b}	23.4^{b}	0.71
105	24.9^{b}	23.6^{b}	0.72
115	25.4^{a}	24.0^{a}	0.79
125	25.6^{a}	24.1^{a}	0.84
SEM	0.06	0.07	0.04
Gender			
Boar	24.9^{b}	23.5^{b}	0.72^{b}
Gilt	25.5^{a}	24.1^{a}	0.81^{a}
SEM	0.04	0.05	0.03

[a,b] Means in the same column with different superscripts are significantly different($p<0.01$).

gilts. In this study, gilts tended to be higher daily feed intake and this may have contributed to the higher intramuscular and subcutaneous fat contents. Overall the intramuscular fat values(1.84~1.97%) are similar with others, for example 2%(McGloughlin et al., 1988); 1.4%(Edwards et al., 1992) and 0.7~4.5%(Eikelenbloom et al., 1996).

According to Mottram and Edwards(1983), intramuscular fat contributes to the organoleptic quality of pork via effects on juiciness, flavour and tenderness. Wood(1993) suggested that intramuscular fat levels of less than 10 g kg^{-1} could be adequate. Therefore, intramuscular fat levels in this study could be adequate, and the trend for intramuscular fat levels to increase with increasing slaughter weight was also accompanied by decreases in cooking loss(Table 4). As slaughter weight increased cooking loss % was significantly($p<0.01$) decreased while drip loss % and shear value were not statistically different among slaughter weights. Garcia-Macias et al.(1996) reported that body water tended to be replaced with fat and hence water/protein ratios were affected by increased fat levels. However, Jeremiah and Weiss(1984) did not observe any changes in cooking loss as weight increased up to 110 kg. There was no significant differences in shear values among slaughter weights. Cisneros et al.(1994) reported a significant decreases in panel scores for tenderness with increasing slaughter weight over the range 73 ~137 kg. The relationship between gender and meat qualityis not clear. There was no significantly difference in shear values between gilts and boars. However, Barton-Gade(1987) found that boars had significantly higher shear values than gilts. Malmfors and Nilsson(1978) found no significant differences between boars and gilts in terms of tenderness, but the board tended to have higher cooking and drip losses.

The ultimate pH(pHu) values of the pork loin was significantly higher at 95 and 105 kg than at 125 kg($p<0.01$) while sarcomere length decreased with increasing slaughter weight(Table 4). Also, there were no statistically differences in gender effects for the other parameters of pork quality. Because of the slower rate of cooling in heavier carcasses, Cisneros et al.(1994) suggested the possibility of greater PSE incidence in heavier carcasses. The trend for drip loss to increase with slaughter weight is agreement with that foundby Cisneros et al.(1994) and may be related to slower cooling rates in heavier carcasses. However, in this study, PSE pork was not observed. All pHu values were in the normal acceptable range.

Table 5 shows that the lightness values were changed with slaughter weight. The L^* values for gilts at 125 kg slaughter weight were lower than those of boars, while L^* values of 125 kg boars were significantly lower than the other slaughter weights. The reverse trend was seen for gilts where L^* values at 125 kg slaughter weight were significantly higher than at

Table 4. The effects of slaughter weight and gender on quality of pork loin

	pH_u	Cooking loss(%)	Drip loss (%)	Sarcomere length(㎛)	Shear value ($kg \cdot cm^{-2}$)
Slaughter weight (kg)					
95	5.62^a	28.2^a	4.76	2.02^a	3.67
105	5.64^a	26.4^b	5.34	2.04^a	3.64
115	5.58^{ab}	25.8^{bc}	5.13	1.95^{ab}	3.58
125	5.51^b	24.4^c	5.52	1.91^b	3.55
SEM	0.007	0.42	0.201	0.014	0.063
Gender					
Boar	5.59	26.6	5.23	1.97	3.61
Gilt	5.57	25.9	5.36	1.96	3.59
SEM	0.004	0.223	0.105	0.009	0.042

^{a,b,c} Means in the same column with different superscripts are significantly different($p<0.01$).

Table 5. Effect of slaughter weight on color measurements of pork loin

Slaughter weight(kg)	L*		a*		b*	
	Boar	Gilt	Boar	Gilt	Boar	Gilt
95	49.21[a]	47.67[b]	7.21[b]	7.62[b]	7.62	8.25
105	48.56[a]	47.83[b]	8.11[a]	7.54[b]	8.11	7.93
115	48.34[a]	47.35[b]	8.31[a]	7.36[b]	8.33	7.84
125	46.42[b]	49.31[a]	8.23[a]	8.53[a]	8.75	9.12
SEM	0.714	0.698	0.233	0.254	0.201	0.214

[a,b] Means in the same column with different superscripts are significantly different($p<0.01$).

all other weights. The a* values for gilts at 95 kg slaughter weight were significantly lower($p<0.01$) than those of boars at the same slaughter weight. The a* values of boars at 95 kg slaughter weight were significantly lower than other slaughter weights. The higher a* and b* values at higher slaughter weights are in agreement with the observations of Garcia-Macias et al.(1996) and may be explained by increased pigment content.

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