COMPARISON OF HISTOCHEMICAL CHARACTERISTICS AND MEAT QUALITY TRAITS IN DIFFERENT PIG BREEDS

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Introduction

Mechanisms controlling pork quality development are often associated with altered postmortem muscle metabolism. Specifically, changes in the rate of glycolysis can create unfavorable muscle pH. A high rate of pH decline and a low ultimate pH result in muscle protein denaturation and diminish quality parameters (Ryu *et al.*, 2005). One of the main factors determining muscle biochemical pathways is fibre type composition: skeletal muscle is composed of different types of fibres, which are the results of co-ordinated expression of distinct sets of structural proteins and metabolic enzymes (Chang *et al.*, 2003). Because muscle fibres contain different myosin heavy chains, which are responsible for their different ATPase activity (Picard *et al.*, 1999), it is possible that fibre type composition may be associated with postmortem changes in the conversion of muscle to meat, and subsequently meat quality (Ryu and Kim, 2006). Therefore, the variation in fibre type characteristics can explain part of the variation in some meat quality traits.

Some recent studies found correlations between muscle fibre characteristics and meat quality traits in beef (Ozawa *et al.*, 2000) and in pigs (Ryu and Kim, 2005). For the practical application of this knowledge to improve and control meat quality, more information of the effects of the fibre type characteristics on meat quality is necessary. Therefore, this research focuses on comparing muscle histochemical characteristics between Berkshire, Landrace, Yorkshire, and crossbred pigs.

Materials and Methods

This study involved 594 pigs from four different breeds as follows: Berkshire, n=105; Landrace, n=102; Yorkshire, n=221 and crossbred pigs (Landrace×Yorkshire×Duroc, LYD), n=166. Pigs were slaughtered according to standard commercial procedures in a Korean abattoir. Within 45 min postmortem, muscle samples for histochemical analysis were taken from the *longissimus* muscle at the 8th *thoracic vertebrae*. Samples were cut into 0.5 × 0.5 × 1.0 cm pieces, promptly frozen in isopentane cooled by liquid nitrogen, and stored at -80°C until subsequent analyses. Serial transverse muscle sections (10μm) were obtained from each sample with a cryostat at -20°C and mounted on glass slides. The myosin adenosine triphosphatase activities were detected after acid (pH 4.7) preincubation (Brooke and Kaiser, 1970). About 600 fibres per sample were examined by an image analysis system and the muscle fibres were divided into type I, IIa, and IIb according to the nomenclature of Brooke and Kaiser (1970).

Muscle pH was measured directly on carcass at the 7th/8th *thoracic vertebrae* using a spear type electrode at 1 h (pH_1) and 24 h postmortem (pH_u). Following 24 h of chilling, *M. longissimus dorsi* was taken to evaluate the meat quality traits. Drip loss was determined by suspending muscle samples standardised for surface area in an inflated plastic bag for 48 h at 2°C. The colour of the meat was measured at the 8th/9th *thoracic vertebrae* at 24h postmortem with a chromameter after exposing the surface to the air for 30 min at 2°C. The average of triplicate measurements was recorded and the results were expressed as C.I.E. L*, a*, and b*. The data were analysed statistically using the SAS program. The differences between the breeds were studied using analysis of variance and Duncan's test was used to locate the differences.

Results and Discussion

Muscle fibre number and cross-sectional area were not significantly different between pig breeds, which could be explained by the differences in weight and age of the pigs (Table 1). A clear difference in histochemical property was observed in the results of fibre type composition. The area percentage of type I fibres was higher ($P< 0.001$), and that of type IIb fibres was lower ($P < 0.05$) in Berkshire pigs than those of other breeds. The muscle pH_1 and pH_u were significantly higher in Berkshire pigs (Table 2). Water-holding capacity measured as drip loss and colour parameters were significantly different between breeds ($P < 0.001$). Ryu and Kim (2005) reported that the percentage of type IIb fibres was negatively related to the pH at 45 min postmortem and positively related to drip loss and lightness. Solomon *et al.*, (1998) also suggested that high proportion of type IIb fibres may be more prone to PSE pork because of its anaerobic nature, higher glycogen content, and lower ultimate pH. In this study, Berkshire pigs, which showed the highest muscle pH, the lowest drip loss, and L* values, contained a significantly higher percentage of type I fibres and a lower percentage of type IIb fibres than those of other breeds.

Table 1: Cross-sectional area, the number of fibres per mm^2, and fibre type composition (means ± s.d.) of *longissimus dorsi* muscle in different breeds

	Breed				Levels of significance
	Berkshire	Landrace	Yorkshire	LYD	
Cross-sectional area (μm^2)	4262 ± 743.8	4063 ± 732.1	4170 ± 691.5	3993 ± 734.1	NS
Fibre number/mm^2	241 ± 40.6	253 ± 45.8	246 ± 39.6	258 ± 44.4	NS
Area percentage (%)					
Type I	7.51 ± 3.12^a	6.21 ± 2.15^{bc}	6.80 ± 2.57^{ab}	5.43 ± 2.53^d	***
Type IIa	5.80 ± 3.26^a	5.60 ± 2.85^a	6.42 ± 2.81^{ab}	7.13 ± 2.48^b	**
Type IIb	85.03 ± 11.80^a	88.19 ± 3.87^b	86.78 ± 3.71^b	87.45 ± 3.30^b	*
Number percentage (%)					
Type I	10.69 ± 4.39^a	9.14 ± 3.32^b	8.92 ± 3.64^b	8.13 ± 3.79^b	***
Type IIa	9.02 ± 4.36^a	9.40 ± 3.72^{ab}	10.61 ± 4.36^b	11.44 ± 4.24^c	***
Type IIb	80.29 ± 6.49	81.53 ± 4.98	80.47 ± 5.21	80.43 ± 4.89	NS

Levels of significance: NS = not significant; * $P < 0.05$; ** $P < 0.01$; *** $P < 0.001$.
Means within a row with no common superscript differ significantly ($P < 0.05$).

Table 2: Meat quality traits (means ± s.d.) of the porcine *longissimus dorsi* muscle in different breeds

	Breed				Levels of significance
	Berkshire	Landrace	Yorkshire	LYD	
Muscle pH_1	6.19 ± 0.24^a	5.86 ± 0.33^c	6.03 ± 0.36^b	6.02 ± 0.27^b	***
Muscle pH_u	5.66 ± 0.22^a	5.50 ± 0.14^d	5.56 ± 0.11^c	5.61 ± 0.12^b	***
Drip loss (%)	2.97 ± 1.55^c	5.99 ± 2.81^a	4.66 ± 2.69^b	4.24 ± 2.14^b	***
Lightness (L^*)	45.29 ± 2.47^a	49.72 ± 3.63^d	47.66 ± 2.36^c	46.60 ± 3.43^b	***
Redness (a^*)	7.87 ± 1.69^a	6.60 ± 1.42^b	6.85 ± 1.33^b	6.83 ± 1.23^b	***
Yellowness(b^*)	3.10 ± 1.16^a	3.77 ± 1.3^b	3.36 ± 0.91^a	3.69 ± 1.13^b	***

Levels of significance: *** $P < 0.001$.
Means within a row with no common superscript differ significantly ($P < 0.05$).

Conclusions

Comparing the fibre type composition observed from the different breeds, the results imply that the *longissimus dorsi* muscle of Berkshire pigs is more oxidative than that of other breeds. A high pH value in Berkshire pigs is due to a high percentage of type I fibres and a low percentage of type IIb fibres. Based on these results, it is concluded that muscle fibre composition is useful parameter to explain the variation of the meat quality.

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