EFFECT OF BREED ON MEAT QUALITY AND FATTY ACID COMPOSITION OF KOREAN NATIVE BLACK PIGS, LANDRACE AND YORKSHIRE

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Background

The eating quality and fatty acid composition are known to influence nutritional, technological and sensory qualities of both fresh and processed meat products as important factors that affect the consumer's choice.. Although it is generally accepted that an increased level of the intramuscular fat (IMF) has a positive influence on the sensory qualities of pork (Fernandez et al., 1999), the variation in fatty acid composition also affected firmness of fat, shelf life, and flavor. As fatty acid composition was changed for diet, genetics, sex or fatness, the ratio of the certain fatty acids such as C18:0 and C18:2 provided the best prediction of firmness with the highest correlation with firmness measured subjectively or objectively(Wood et al., 1978). Campo et al.(2003) found that C18:3 produces more intense odors in a model system. In this point, manipulating fatty acids in pork will ultimately influence not only the economics of meat processing, but also the acceptance by the consumer. There were clear effect of breed type on the concentrations of total fatty acids in muscle has been reported. Wood et al. (2004) reported that the *longissimus* and *psoas* muscles of Duroc and Berkshire purebred pigs contained higher concentrations of both neutral lipids and phospholipids than those of Large Whites and Tamworth. Meat of Korean Native Black Pigs (KNBP), on the other hand, has been characterized as redder and higher palatability than that from other commercial breeds especially for Korean consumers. This finding, however, for lack of information, was substantiated by conducting this study.

Objectives

The objective of this experiment was to determine the effect of breed on meat quality of loin muscle and fatty acid compositions.

Materials and methods

<u>Animals :</u> A total of thirty male pigs (10 KNBP, 10 Landrace, and 10 Yorkshire) were sampled from the National Livestock Research Institute's (NLRI) breeding program. KNBP weighed an average of 72 kg; Landrace, 118 kg; and Yorkshire, 118 kg; with ages of 192 days, 201days, and 194 days; respectively. All pigs were transported to the National Livestock Research Institute and conventionally slaughtered for two consecutive days with an electronic stunner (230 volts for 2.5 sec). The carcasses were placed in a 1℃ chiller until the following day and submitted to standard processing procedures and divided into retail cuts. Loin muscle and subcutaneous fat layer samples were separated from each carcass and analyzed for meat quality and fatty acid composition.

<u>Analytical methods:</u> Chemical compositions were analyzed by using methods of Association of Official Analytical Chemists (AOAC) (1996). Water-holding capacity(WHC) was measured by using the method of Ryoichi et al.(1993). WB-shear force(WBS) was measured on cooked steaks(25-mm thick) according to the method described by Wheeler et al.(2000). Color values on freshly cut surface of the WBS block were measured by a chroma meter (Minolta Co. CR 301) for lightness (L), redness (a) and yellowness (b) of CIE after a 30-min blooming at 1℃. Cooking loss was calculated as a percent for the weight changes during cooking for WBS measurement. Total lipids were extracted by using chloroform-methanol (2:1, v/v) according to the procedure of Folch et al.(1957). An aliquot of the lipid fraction was methylated as described by Morrison and Smith(1964). Fatty acid methylesters were analyzed by a gas chromatograph (Varian 3400) fitted with a fused silica capillary column, Omegawax (205, 30 m × 0.32 mm I.D., 0.25 film thickness). The injection port was at 250℃ and the detector was maintained at 260℃. Nitrogen was used as the carrier gas. Results were expressed as percentages, based on the total peak area.

Statistical analysis: Data were analyzed by using the SAS program (1996) and means were separated by the Student-Newman-Keuls' test. To determine the breed effect on samples, data were analyzed as one-factor randomized block experiments with treatments. The level of significance was $p<0.05$.

Results and discussion

Objective meat quality KNBP was significantly higher in fat contents and lower in moisture content than those of the other two breeds (Table 1). Protein and ash contents, however, were not significantly different among three breeds. The loin muscle of KNBP had significantly higher *a* values(redness) than those of the other two breeds. The *L* values(lightness) of KNBP were lower than those of Yorkshire, and the *b* values(yellowness) were higher than those of Landrace($p<0.05$). Consumer perference and choice was believed to depend on the interaction of the objective qualities of the product with expectation of consumers and the consumer prefers pork with a high intensity of pink (Brewer et al., 1998). The loin muscle of the Hampshire breed, according to the studies of Lindahl et al.(2001), has been reportd to have redder and yellower color than the loin muscle of the Swedish Landrace and the Swedish Yorkshire breeds. These differences in color were related to the lower pH and higher glycogen level of Hampshire, resulting in higher internal reflectance and higher pigment content. In this study, postmortem pH_{24hr} values were not significantly different for three breeds (data were not shown). Variations in pigment content between pork breeds have been reported (von Lengerken et al., 1985), but no data that compare the pigment content of the pork from KNBP, Landrace, and Yorkshire were found. Among these three breeds, data on WHC and cooking loss were not significantly different($p>0.05$). However, the Warner Bratzler shear force values of KNBP and Landrace were significantly lower than those of Yorkshire ($p<0.05$)

Fatty acid compositions There were significantly higher levels of C18:1n-9, C16:0, C18:0, 18:2n-6, C16:1n-7, and C14:0 in decreasing order for the intramuscular fat and the subcutaneous fat of three breeds. KNBP had significantly higher levels of C18:2n-6, C18:3n-3 in the intramuscular fat, and C18:2n-6, C18:3n-6, C20:4n-6 in the subcutaneous fat than those of the other breeds. The higher concentrations of C18:2n-6 and C18:3n-3 in Duroc were associated with high fat deposition in muscle adipose cells relative to the other breeds such as Berkshire, Large white, and Tamworth(Wood et al., 2004). Significantly higher levels of C16:1n-7, C20:1n-9, C20:4n-6, and C20:5n-3 in the intramuscular fat and C16:1n-7 and C20:5n-3 in the subcutaneous fat were observed in Landrace and Yorkshire than in KNBP($p<0.05$). However, total SFAs and total MUFAs in the intramuscular fat and subcutaneous fat did not significantly differ among the three breeds (Table 2).

On the other hand, total PUFAs were significantly higher in the intramuscular fat as well as in the subcutaneous fat of KNBP than those of the other two breeds (Fig. 1). Higher PUFA level in the backfat of the three breeds possibly led to a softer fat(Warnants et al., 1999). The ratio of C18:0 to C18:2 was found to provide the best firmness(Whittington, 1986). There were no significant differences in the concentrations of C18:0 among the three breeds($p>0.05$). Total contents of PUFA n-3 were not significantly different among three breeds, but the total contents of PUFA n-6 of KNBP were significantly higher than those of the other two breeds. The ratio of PUFA to SFA (P:S) of KNBP was 0.47, and it is significantly higher than that of Landrace(0.32) and Yorkshire(0.33)($p<0.05$) (Fig. 2). The recommended ratio of polyunsaturated fatty acids(PUFA) to saturated fatty acids(P:S) should be increased to above 0.4(Wood et al., 2003). Since health practitioners have correlated meat with an imbalanced fatty acid intake among the consumers of today, there must be ways to improve the P:S ratio during meat production. In addition, researchers have also reported that the ratio of n-6:n-3 PUFA is a risk factor in cancers and coronary heart disease, especially in the formation of blood clots leading to heart attacks (Enser, 2001). The recommendation, therefore, is for a ratio of n-6: n-3 PUFA less than 4, but that in pork is usually higher than this value. In this study, pork from three breeds had significantly higher ratio of n-6 to n-3 due to their relatively low concentration of n-3 PUFA. Therefore, pork can be manipulated towards a more favorable n-6:n-3 ratio as with the.P:S ratio. Saturated and monounsaturated fatty acids are synthesized in vivo and less readily influenced by diet than the polyunsaturated fatty acids, C18:2n-6 and C18:3n-3, which cannot be synthesized, but can be manipulated by dietary change (Enser et al., 2000). Pork of KNBP, which grew slow and deposited more fat in muscle when compared with other breeds, contained significantly higher PUFA n-6 than that of Landrace and Yorkshire under the same feeding program and environmental rearing condition. Therefore, the feeding program needs to be established to increase the levels of the PUFA n-3 such as C18:3n-3 for a more balanced and potentially beneficial composition of fatty acid for different breeds.

Conclusions

Breed influenced growth rate and affected the fatty acid composition of intramuscular fat and subcutaneous fat. High levels of polyunsaturated fatty acids, especially for C18:2n-6 and C18:3n-3, were found in KNBP. High levels of monounsaturated fatty acids, especially for C16:1n-7, C20:1n-9, C20:4n-6, and C20:5n-3, were observed in Landrace and Yorkshire. Meat is a major source of fat in the human diet and there is interest in modifying the composition of meat by dietary means to improve the nutritional value. Fat and fatty acids are important because of their effects on human health; thus, it is important to select production options which maximize both meat quality and healthiness in meat production. To improve the nutritive value of pork, manipulation of the fatty acid composition by using dietary means is necessary in the light of today's consumer's health. Thus, it is essential that researchers try to increase the proportion of unsaturated fatty acids in the meat. This can be done by establishing a feeding program that can increase levels of the PUFA n-3. Grass feeding or high levels of C18:3n-3 supplementation, in particular, can be done to put in place a more balanced and potentially beneficial fatty acid composition of different breeds. Our findings in this study showed a significantly higher level of polyunsaturated fatty acids in KNBP compared with that of Landrace and Yorkshire. Thus, further studies on fatty acid metabolism for different breeds must be investigated.

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Table 1. Quality characteristics of Korean Native Black Pigs(KNBP), Landrace and Yorkshire.

Breed	Proximate Composition (%)				CIE			CL[2] (%)	WBS[3]	WHC[4]
	Protein	Fat	Moisture	ash	L	a	b			
KNBP[1]	22.71 (0.29)	4.38 (0.72)^{a}	73.16 (0.51)^{b}	1.03 (0.02)	46.04 (0.91)^{b}	10.96 (0.65)^{a}	4.73 (0.46)^{a}	26.22 (0.83)	6.56 (0.46)^{b}	55.54 (0.95)
L	23.29 (0.20)	1.56 (0.29)^{b}	74.82 (0.17)^{a}	1.05 (0.01)	47.89 (0.85)^{ab}	6.95 (0.37)^{b}	2.83 (0.34)^{b}	26.01 (1.03)	8.92 (0.41)^{a}	54.76 (0.80)
Y	23.40 (0.22)	1.88 (0.19)^{a}	75.33 (0.22)^{a}	1.05 (0.01)	50.00 (1.51)^{a}	7.26 (0.50)^{b}	3.85 (0.47)^{ab}	25.52 (1.57)	7.15 (0.39)^{b}	53.96 (0.71)

[1]KNBP-Korean Native Black Pigs, L-Landrace, Y-Yorkshire; [2]CL - cooking loss; [3]WBS Warner Bratlzer shear force; [4]WHC - water holding capacity; $^{a-b}$ Means with a same superscript within a row are not significantly different ($p<0.05$)

Table 2. Comparison of fatty acid profiles for Korean Native Black Pigs(KNBP), Landrace and Yorkshire

	Intramuscular fat			Subcutaneous fat		
	KNBP	Landrace	Yorkshire	KNBP	Landrace	Yorkshire
C14:0	1.11(0.04)	1.27(0.01)	1.22(0.07)	1.10(0.05)	1.18(0.04)	1.20(0.09)
C16:0	24.78(0.26)	25.46(0.18)	24.89(1.26)	21.48(2.15)	24.80(0.42)	25.12(0.73)
C18:0	15.43(0.29)	15.95(0.43)	15.76(0.81)	14.97(0.69)	15.94(0.25)	15.64(0.81)
C16:1 *n*-7	2.00(0.09)^{b}	2.39(0.14)^{a}	2.71(0.26)^{a}	1.78(0.06)^{b}	2.04(0.06)^{a}	2.24(0.21)^{a}
C18:1 *n*-7	0.06(0.01)	0.09(0.00)	0.07(0.03)	0.04(0.01)	0.04(0.01)	0.04(0.01)
C18:1 *n*-9	40.11(0.81)	42.03(1.25)	43.15(1.40)	40.41(1.12)	40.52(0.24)	39.58(0.60)
C18:2 *n*-6	14.78(0.60)^{a}	11.19(1.06)^{b}	10.41(0.88)^{b}	17.29(0.64)^{a}	12.95(0.61)^{b}	13.59(0.68)^{b}
C18:3 *n*-3	0.67(0.08)^{a}	0.24(0.02)^{b}	0.24(0.02)^{b}	0.83(0.08)	1.00(0.04)	1.02(0.09)
C18:3 *n*-6	0.51(0.12)	0.23(0.01)	0.20(0.02)	0.94(0.03)^{a}	0.51(0.03)^{b}	0.53(0.02)^{b}
C20:1 *n*-9	0.03(0.00)^{b}	0.34(0.13)^{a}	0.36(0.08)^{a}	0.73(0.05)	0.65(0.03)	0.66(0.04)
C20:4 *n*-6	0.21(0.02)^{b}	0.49(0.05)^{a}	0.67(0.14)^{a}	0.14(0.01)^{a}	0.09(0.00)^{b}	0.10(0.01)^{b}
C20:5 *n*-3	0.06(0.00)^{b}	0.11(0.02)^{a}	0.11(0.01)^{a}	0.03(0.01)^{b}	0.07(0.01)^{a}	0.08(0.01)^{a}
C22:4 *n*-6	0.25(0.01)	0.21(0.03)	0.20(0.02)	0.26(0.02)	0.21(0.03)	0.20(0.03)
n-3	0.72(0.08)^{a}	0.35(0.03)^{b}	0.35(0.02)^{b}	0.87(0.08)^{a}	1.07(0.04)^{b}	1.10(0.10)^{b}
n-6	15.76(0.65)^{a}	12.12(1.11)^{b}	11.48(0.90)^{b}	8.63(0.67)	13.76(0.65)	14.41(0.70)

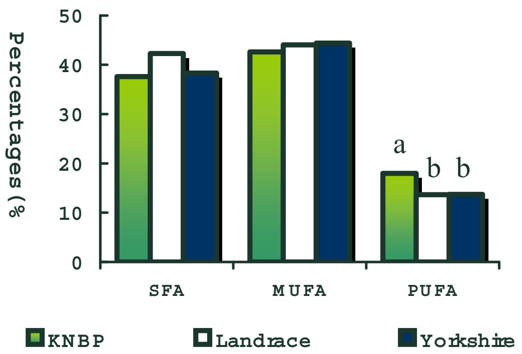

Fig. 1. Comparison of fatty acid contents by breed

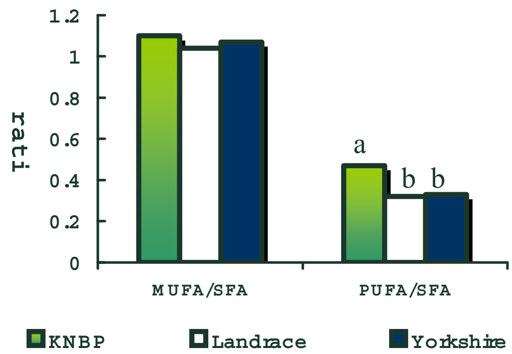

Fig. 2. Comparison of the ratio of M: S and P: S by breed

*SFA=sum of the saturated fatty acids, MUFA=sum of the monounsaturated fatty acids, PUFA=sum of the polyunsaturated fatty acids, n-3=sum of the n-3 fatty acids and n-6=sum of the the n-6 fatty acids
$^{a-b}$ Means with a same superscript within a row are not significantly different ($p<0.05$)