ASSOCIATION BETWEEN DNA MARKERS OF CANDIDATE GENES AND CARCASS COMPOSITION AND MEAT QUALITY IN KOREAN CATTLE

Chung, K.Y.[1], Kim, W.T.[2], Shin, S.C.[2], and Chung, E.R.[2]

Department of Animal Science, University of Missouri, Columbia 65201
Nutreco Swine Research Centre, P.O Box 220, 5830 AE Boxmeer, The Netherlands

Background

The challenge to the beef industry is the production of cattle that exhibit favorable or superior carcass composition and meat quality due to the increasing demand of the consumer for high quality meat. Advances in molecular techniques have made it possible to select animals based upon desirable genotypes to meat production, regardless of age or sex of individual. It has been proposed that candidate gene analysis can be used to identify individual genes affecting the carcass traits and meat quality in beef cattle (Beever et al., 1990; Sellier, 1994; Haegeman et al., 2003). Candidate genes are selected on the basis of known relationship between physiological or biochemical processes and quantitative traits of interest. Leptin is a hormone in the fat metabolism pathway that has been shown to affect the amount of marbling in beef (Willis et al., 1998). The myogenic factor 5 (MYF5) gene plays a role in myogenic lineage determination and/or myocyte differentiation (Li et al., 2004). Heart fatty acid-binding proteins (H-FABP) are involved in fatty acid transport from the cell membrane to the intracellular sites of fatty acid utilization (Gerbens et al., 1999). Therefore, the leptin, MYF5 and H-FABP genes are important candidate genes for the identification of genetic markers for carcass composition and meat quality in Korean cattle.

Objectives

The objectives of this study were to analyze DNA markers of three candidate genes and to investigate their possible association with carcass composition and meat quality in Korean cattle.

Materials and methods

A total of 215 Korean cattle registered in the official performance-testing program from the National Livestock Research Institute, R.D.A. were used in this study. Carcass traits studied were carcass weight (CW), dressing percentage (DP), eye muscle area(EMA), backfat thickness(BMT) and marbling score(MS). The meat quality was classified according to Korean beef carcass grading from 1(high quality grade) to 3(low quality grade). Genomic DNA was extracted from blood samples and dissolved in TE buffer and kept at -20℃. Genotyping of the leptin, MYF5, and H-FABP genes were carried out using the PCR-RFLP technique. Primer sequences and restriction enzymes used in PCR-RFLP analysis are presented in Table 1.
Allele frequencies in the two groups selected for high and low quality grades were tested using chi-square test. The GLM procedure of SAS was used to test the association between the genotypes of the candidate genes and the carcass traits.

Table 1. Primer sequences and restriction enzymes of candidate genes used in PCR-RFLP analysis

Candidate gene	Primer sequence (5′ to 3′)	Enzyme	Fragment size (bp)
Leptin	GTCACCAGGATCAATGACAT AGCCCAGAATGAAGTCCAA	BgI Ⅱ	1,820
MYF5	ACAGCGTCTACTGTCCTGATG CGTGGCATATACTAAGGACAC	Taq Ⅰ	890
H-FABP	TACCTGGAAGTTAGTGGACAGC CTTGGCTCTGCTTTATTGACCT	Msp Ⅰ	612

Results and discussion

The three candidate genes of leptin, MYF5 and H-FABP were genotyped using PCR-RFLP method to determine their association with carcass composition and meat quality in Korean cattle. Representative results of PCR-RFLP analysis detected on polyacrylamide gel electrophoresis are shown in Figure 1, 2 and 3.

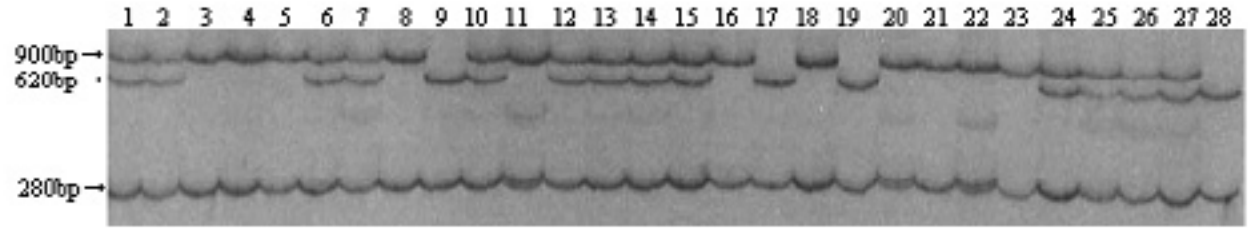

Fig. 1. RFLP genotype markers of leptin gene in 12% polyacrylamide gel following digestion with *BgI II* restriction enzyme of PCR products. In the gel, lanes 3~5, 8, 11, 16, 18, 20~22 and 23 represent AA genotype, lanes 1, 2, 6, 7, 10, 12~15, 24~26 and 27 represent AB genotype and lanes 9, 17, 19 and 28 represent BB genotype.

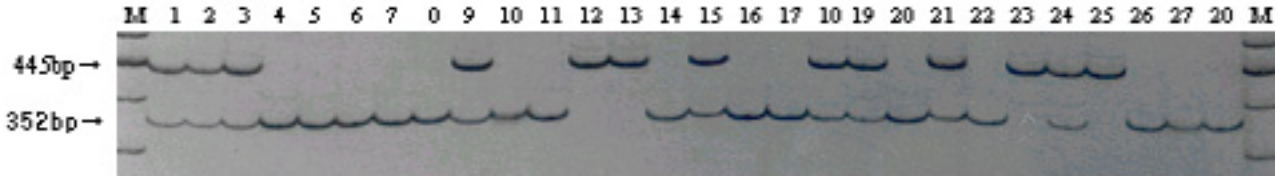

Fig. 2. RFLP genotype markers of MYF5 in 13% polyacrylamide gel following digestion with *Taq I* restriction enzyme of PCR products. In the gel, lanes 12, 13, 23 and 25 represent AA genotype, lanes 1~3, 9, 15, 18, 19, 21 and 24 represent AB genotype and lanes 4~8, 10, 11, 14, 16, 17, 20, 22, 26, 27 and 28 represent BB genotype. M : molecular size marker(100bp DNA ladder)

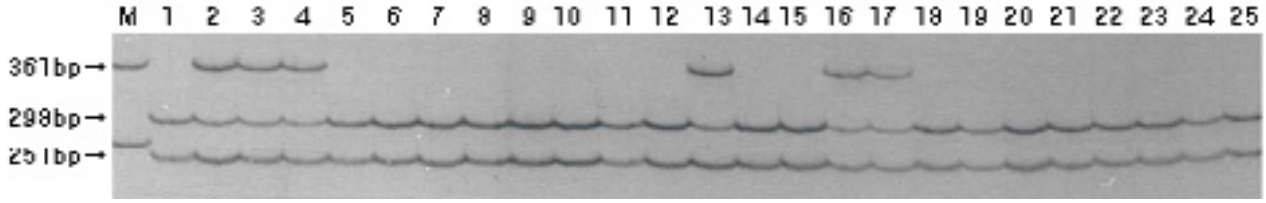

Fig. 3. RFLP genotype markers of H-FABP in 12% polyacrylamide gel following digestion with *Rsa I* restriction enzyme of PCR products. In the gel, lanes 1, 5~12, 14, 15, 18~24 and 25 represent AA genotype, lanes 2, 3, 4, 13, 16 and 17 represent AB genotype. M : molecular size marker(100bp DNA ladder)

The gene frequencies for A and B alleles in all animals were 0.57 and 0.43 for leptin, 0.61 and 0.39 for MYF5 and 0.90 and 0.10 for H-FABP, respectively. The difference in allele frequencies between the two groups selected for high and low quality grades was significant (P<.05) at leptin and MYF5 genes (Table 2).
Least squares means and standard errors of carcass traits for different genotypes of three candidate genes are given in Table 3. The gene frequencies for A and B alleles in all animals were 0.57 and 0.43 for leptin, 0.61 and 0.39 for MYF5, and 0.90 and 0.10 for H-FABP, respectively. The difference in allele frequencies between the two groups selected for high and low quality grades was significant (P<.05) at leptin and MYF5 genes(Table 2).
The effect of leptin gene was significant for backfat thickness (P<.01). The backfat thickness of animals with the BB genotype (1.43±0.64cm) was significantly higher than that of animals with the AA genotype (0.66±0.52cm). The MYF5 gene was found to be significantly associated with eye muscle area (P<.05). Animals with the AA genotype (98.82±7.92cm^2) produced a higher eye muscle area than animals with the BB genotype (81.94±8.37cm^2).

Table 2. Comparisons of allele frequency between the two groups selected for high (n=52) and low(n=43) quality grades using chi-square test

Candidate gene	χ^2	df	P
Leptin	5.6461	1	P<.010
MYF5	4.4731	1	P<.025
H-FABP	1.7412	1	P<.100

Table 3. Least square means and standard errors of carcass composition for leptin, MYF5 and H-FABP genotypes in Korean cattle

Candidate gene	Genotype	Carcass traits				
		CW(kg)	DP(%)	BFT(cm)	EMA(cm^2)	MS
		LSM±SE	LSM±SE	LSM±SE	LSM±SE	LSM±SE
Leptin	AA	481.43±78.47	60.80±2.35	0.66±0.52^{b}	91.63±7.92	3.92±1.01
	AB	479.43±78.02	60.54±1.56	0.94±0.38^{ab}	89.23±8.53	3.83±0.94
	BB	486.82±77.25	60.51±2.84	1.43±0.64^{a}	88.26±8.23	3.82±0.48
MYF5	AA	482.35±81.71	61.29±2.13	0.94±0.38	98.82±7.92^{a}	3.94±0.98
	AB	487.58±94.47	60.27±2.22	1.04±0.45	86.52±8.22^{ab}	3.77±0.96
	BB	479.75±90.46	61.26±2.52	1.03±0.54	81.94±8.37^{b}	3.59±0.72
H-FABP	AA	485.39±94.25	59.27±2.46	0.98±0.42	93.00±7.60	3.71±0.83
	AB	488.76±98.94	61.66±2.04	1.09±0.53	96.13±7.60	3.64±0.88

Superscripts with different letters in the same column significantly differ (P<.05).
CW=Carcass weight; DP=Dressing percentage; BFT=Backfat thickness; EMA=Eye muscle area; MS=Marbling score (ranges 1-5)

However, there were no significant effects of H-FABP gene on carcass traits. The significant association between the specific gene and quantitative traits suggests that the gene may be one of the causative genes or that the gene is very close to the causative gene(s)(Li et al., 2004). These results suggest that the leptin and MYF5 may be candidate genes that influences some carcass traits and meat quality in Korean cattle. The gene-specific RFLP markers of leptin and MYF5 genes could be used as genetic markers to select for increased backfat thickness and eye muscle area in breeding programs. Further investigations are needed in other populations of Korean cattle to verify the associated effects of the candidate gene-specific DNA marker.

Conclusions

In other to find DNA markers to improve the carcass and meat quality of Korean cattle we studied the association between genotypes in the three candidate genes (leptin, MYF5 and H-FABP) and carcass composition and meat quality. Genotypes of three candidate genes were determined for 215 animals using PCR-RFLP method. Allele and genotype frequencies were calculated for each genes. The allele frequencies were different between the two groups selected for high and low quality grades at leptin and MYF5 genes (P<.05). The leptin genotype was found to have significant association (P<.05) with backfat thickness. A significant association (P<.05) was also found between the MYF5 genotype and eye muscle area. No significant association, however, was defected for the H-FABP genotype. The results indicate that the leptin and MYF5 gene-specific RFLP markers could be used as DNA markers to select animals with desirable meat quality.

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