



An independent validation of SNPs on CAPN1-CAST with beef tenderness trait in two different muscle (*Longissimus dorsi* and *Semimembranosus*) of Hanwoo cattle

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Abstract

Beef tenderness is one of the major traits to determine high quality beef that Korean consumers are willing to buy because smart consumer are looking for the safe meat such as lower fat but more tender meat. Unlike the past that Korean consumer prefer a highly marbled meat, the smart consumers are emerging to show a strong willingness to buy a more "tender meat" in Korea. These trends promote to establish an alternative beef guaranteed system of eating quality for Hanwoo beef which is called "a palatability prediction system". The palatability prediction model equipped multivariate regression to assess muscle type, cooking method, aging treatment and gene markers as variables and provided Korean consumers with expected eating quality for muscle cut of Hanwoo meat. In order to identify a reliability gene markers for beef tenderness, a validation study of CAPN-CAST gene system has been performed in two different muscle (*Longissimus dorsi* and *Semimembranosus*) of Korean cattle population (n=1,000). A single marker regression model was implemented for this analysis. Interestingly, there was a significant effect ($p \leq 0.05$) of CAPN1:c.580T>C, CAPN1:c.658T>C, and CAPN1:c.1589T>C polymorphisms on Warner-Batz Shear Force (WBSF) in both muscle types (LD and SM), while in the previous study done by Lee et al (2014) it cannot be observed. The CAPN1:c.580T>C was observed as the most significant marker ($p \leq 0.01$) to be associated with WBSF on both LD and SM muscles, while CAPN1:c.658T>C and CAPN1:c.1589T>C were most significant on SM. However, still no one of CAST gene polymorphisms was identified to have significant effect on WBSF in Hanwoo cattle. In conclusion, this study is confirmed that CAPN1:c.948G>C has potential effect to be associated with WBSF as CAPN1:c.580T>C marker in Hanwoo population. Moreover CAPN1:c.948G>C was referred as CAPN316, which has observed to have association with WBSF in many studies used many other cattle breeds.

Key words : CAPN-CAST, beef tenderness, Hanwoo

Introduction

- Tenderness is one of the important meat quality determinant traits in beef industry as the consumers are willingness to pay more for lean but tender meat (Shackelford et al. 2001). Meat tenderness is the single most researched palatability characteristic that is influenced by a combination of factors including marbling, juiciness and flavor (Aberle et al. 2001) Shackelford S. D., Wheeler T. L., Meade M. K., Reagan J
- Genetic tests for meat tenderness utilizing SNPs in the CAST and CAPN1 genes have already been commercialized by Igenity TenderGENE (Merial Ltd., Atlanta, USA) and GeneSTAR Elite Tender (Genetic Solutions Pty. Ltd., Australia). Lee et al. (2014) has also identified seven SNP loci in CAPN1-CAST systems to have effects on meat tenderness in Hanwoo cattle

Material and Methods

- For the validation data set (n=1,000), DNA was derived mostly from samples collected from the abattoir which belongs to Daegwallyeong Hanwoo Company in Gangwon province of Korea.
- All steers were slaughtered at 30 months of age and muscle samples (1.5 kg) were taken from longissimus dorsi (LD muscle) and semimembranosus (SM muscle) to measure Warner Bratzler-Shear Forces (WBSF). Hanwoo steers (n=1,000) were derived from 120 bulls and unrelated dams (2-10 progenies per bull) in pedigree
- Three SNPs in CAST and four SNPs in the bovine CAPN1 genes were genotyped using TaqMan SNP genotyping arrays designed by Applied Biosystems (LSK, Korea) with a BioRad real-time PCR (Lee et al. 2014)
- Single-marker regression analysis was used to test the association between a SNP and shear force. Markers were assumed to be in LD with QTL in close proximity and additive effects were evaluated. Statistical analyses were performed in ASReml (Gilmour et al. 2006). To test an association between each marker and shear force in different muscles, the following linear mixed regression model was used

Results

Table 1. Genotype and allele frequencies for 7 selected SNPs in CAPN1-CAST Gene.

Marker	Genotype	No. of Animals (n=1,000)	Frequency
CAST:c.182G>A (rs109727850)	GG	342	0.342
	AG	495	0.495
	AA	163	0.163
CAST:c.1526A>G (rs109384915)	A	411	0.411
	AA	349	0.349
	AG	477	0.477
CAST:c.1985G>C (rs110914810)	GG	174	0.174
	G	849	0.849
	CG	142	0.142
CAPN1:c.580T>C (rs17872079)	CC	9	0.009
	C	849	0.849
	TT	142	0.142
CAPN1:c.658T>C (rs17872093)	CC	9	0.009
	C	849	0.849
	TT	142	0.142
CAPN1:c.948G>C (rs17872000)	CC	131	0.131
	C	849	0.849
	TT	142	0.142
CAPN1:c.1589T>C (rs17871051)	CT	353	0.353
	CC	83	0.083
	C	564	0.564

Figure 1. Haplotype frequency(A) and among the 4 SNPs in CAPN1 and haplotype effects on shear force in different muscle in Hanwoo(B)

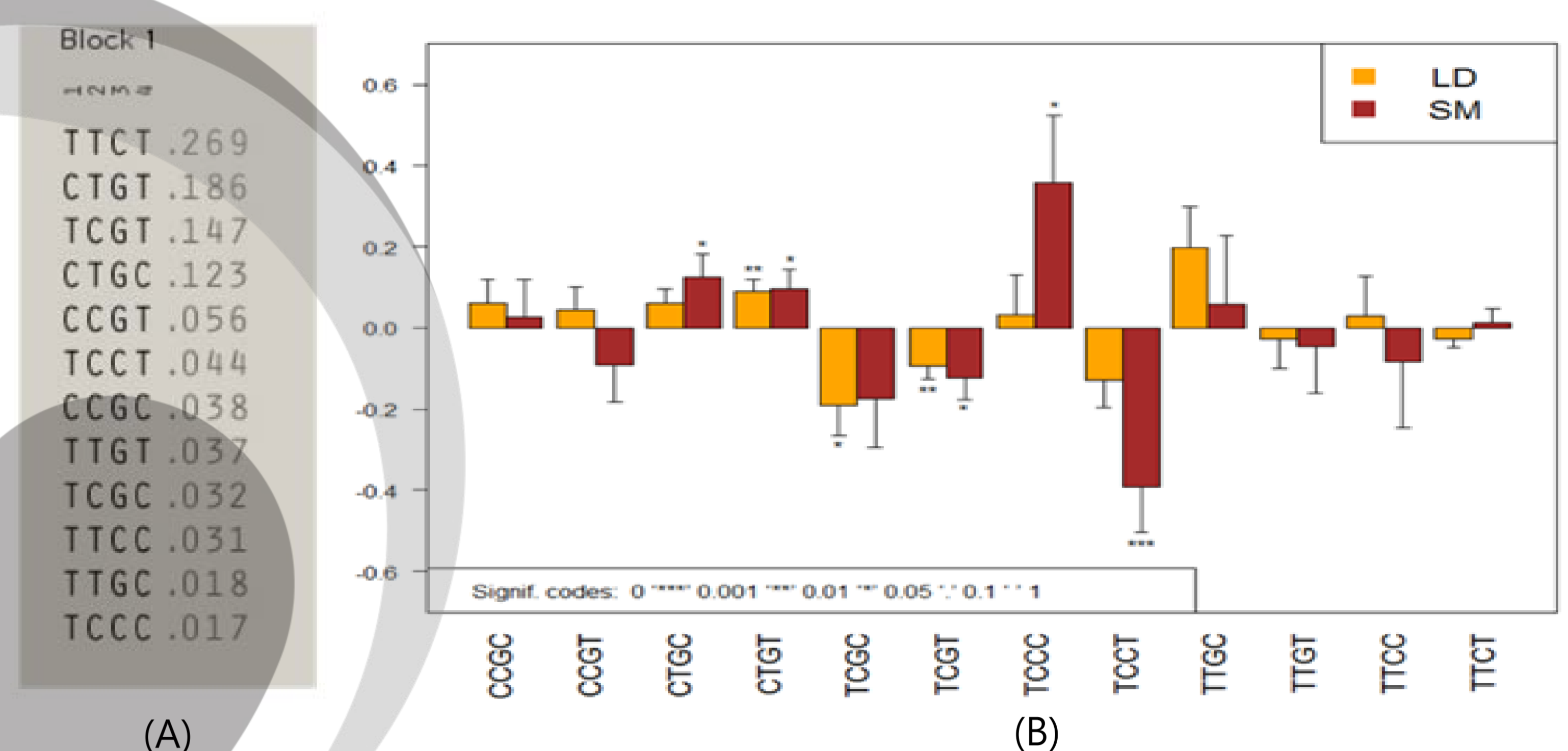


Table 2. Association of CAST/CAPN1 SNP alleles on shear force measurements for two different muscle cuts

Markers	Allele	MAF	WBSF (kg) in Longissimus dorsi at 7 days				WBSF (kg) in Semimembranosus at 7 days			
			effects	F-stat	p-val	%Var	effects	F-stat	p-val	%Var
CAST:c.182G>A (rs109727850)	A	0.41	-0.02 ± 0.04	0	0.96	0.13	-0.05 ± 0.06	0	0.968	0.83
CAST:c.1526A>G (rs109384915)	G	0.41	-0.07 ± 0.05	1.38	0.24	1.64	-0.1 ± 0.07	2.91	0.09	3.34
CAST:c.1985G>C (rs110914810)	C	0.08	0.09 ± 0.07	0.01	0.91	0.82	0.18 ± 0.1	1.56	0.215	3.29
CAPN1:c.580T>C (rs17872079)	C	0.40	0.19 ± 0.06	25.74	<0.001**	12.0	0.12 ± 0.08	9.39	0.002**	4.78
CAPN1:c.658T>C (rs17872093)	C	0.34	-0.06 ± 0.06	4.79	0.03*	1.11	-0.12 ± 0.08	8.32	0.004**	4.43
CAPN1:c.948G>C (rs17872000)	C	0.36	0.002 ± 0.06	0.10	0.74	0.002	0.01 ± 0.08	0.16	0.686	0.03
CAPN1:c.1589T>C (rs17871051)	C	0.26	-0.004 ± 0.05	4.25	0.04*	0.006	0.07 ± 0.06	7.89	0.005**	1.30

Conclusion

- Significant association of CAPN1:c.580T>C, CAPN1:c.658T>C, and CAPN1:c.1589T>C polymorphisms ($P < 0.05$) on WBSF of both LD and SM muscle types while CAST gene polymorphisms showed lack of association.
- Additive effects of C allele of the CAPN1:c.580T>C and CAPN1:c.1589T>C gene markers were associated with an increase of 0.19 and -0.004 kg, and 0.12 and 0.07 kg WBSF on LD and SM, respectively CAPN1:c.658T>C had negative effects on WBSF. Furthermore, out of 12 reconstructed haplotypes, 6 of them had significant association with WBSF ($P < 0.05$)
- In conclusion, the significantly associated SNPs information of CAPN1 gene could be utilized in marker assisted selection programs for improving beef tenderness of Hanwoo

Reference

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