EFFECT OF SIRE ON THE FATTY ACID COMPOSITION OF INTRAMUSCULAR FAT IN HANWOO BULLS

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INTRODUCTION

One of the most important economic characters in Hanwoo is marbling. Improving the performance of such economic character without increasing backfat in Hanwoo through breeding depends on effective use of genetic variation.

For the future demands of meat consumers in Korea, the beef industry should be to produce low fat beef but with adequate concentration of desirable fatty acids affecting on palatability and health. These two goals seem to be contradictory each other.

Because the dietary oleic acid relates positively to the flavor (Melton *et al*., 1982) and sensory panel score (Westerling and Hedrick, 1979) and do not increase serum cholesterol (Grundy *et al*., 1988), most attempts to modify the fatty acid composition of beef have focused on increasing oleic acid through selective breeding. Fatty acid compositions of intramuscular and subcutaneous fats have been found to decrease in saturation with age and body fat content and composition of unsaturated fatty acids increases (Leat, 1975). Fatty acid composition differs among breed types and sexes (Zembayashi *et al*., 1995) and can be altered by diet (Eichhorn *et al*., 1986).

However, little is known concerning genetic effects on fat characteristics of Hanwoo. Thus, the specific objectives of this study were to determine the differences in fatty acids concentrations in intramuscular fat among sires and to estimate the heritability of fatty acids including saturated, monounsaturated and polyunsaturated fatty acids in Hanwoo at slaughter.

MATERIAL AND METHODS

Animals and management. Male calves were produced between Spring and Fall in 1997 sired by 14 and 18 waiting bulls, respectively. One proven bull was used as a control in each season. They were raised at similar conditions from birth at Cattle Genetics Improvement Center, weaned at approximately three months of age, fed for 630 days on a rice straw and corn-based diet.

Statistical Analysis. Data were analyzed by general linear model (GLM) procedures (SAS, 1982) considering appropriate fixed effects (sire and season) and covariates (age and body weight at slaughter, backfat thickness, marbling score and eye muscle area). Covariates were deleted from model if they were found to be unimportant sources of variation ($P>0.20$). Mean fatty acids were first adjusted for the covariates using the GLM procedures(SAS, 1982). The adjusted data (residuals) were then analyzed using REML procedures available in SAS. The variance component for sire represented one-fourth of the additive genetic variance and the residual variance component contained three-fourths of the additive genetic variance in addition to the environmental variance (Falconer, 1989). Therefore, heritability was computed as four times the between-sire variance component divided by the phenotypic variance, which was computed as the sum of sire and residual components of variance.

Fatty Acid Analysis. The esterification technique was based on the direct transesterification method described by Lepage and Roy (1986).

RESULTS AND DISCUSSION

Genetic manipulation of fatty acid composition of Hanwoo intramuscular fat is possible because variation existed among the sires (table 1). Fatty acid compositional differences among sire were stronger and much less influenced by season. Sire effect influenced in major fatty acid composition ($P<0.01$) and season effect influenced in total saturated fatty acid, $C_{16:0}$, and $C_{18:2}$ ($P<0.05$). Except $C_{18:2}$, all fatty acids were higher in Fall-born calves than Spring-born calves.

Total saturated fatty acid was not affected by covariates of weight at slaughter, backfat thickness and marbling fat. Most of major fatty acids, however, were influenced by covariates ($P<0.05$).

Major fatty acids present in order of predominance were oleic ($C_{18:1}$, 45.62 $\pm$ 0.10), palmitic ($C_{16:0}$, 23.86 $\pm$ 0.09), stearic ($C_{18:0}$, 12.31 $\pm$ 0.10), linoleic ($C_{18:2}$, 5.17 $\pm$ 0.10) and palmitoleic ($C_{16:1}$, 3.63 $\pm$ 0.09) acid. The total monounsaturated fatty acid / total saturated fatty acid ratio was 1.26.

A first attempt at estimating the heritabilities of fatty acids from the intramuscular fat is presented in table 2. To our knowledge, there is no published work on heritability estimates of fatty acids in intramuscular fat of Hanwoo. Theoretical range of heritability is from 0 to 1. Heritability estimates of greater than 1 of palmitic and palmitoleic acid indicate that the 304 animals used in this study are not sufficient to obtain reliable heritability estimates.

Table 1. Least squares means and standard errors for fatty acids of intramuscular fat by sire and season

	SFA[A]	UFA[B]	$C_{16:0}$	$C_{16:1}$	$C_{18:0}$	$C_{18:1}$	$C_{18:2}$
Sire	P<0.01[C]	P<0.01	P< 0.01	P< 0.01	P< 0.01	P< 0.01	P< 0.01
	39.99±0.14	49.90±0.20	23.86±0.09	3.63±0.04	12.31±0.10	45.62±0.10	5.17±0.10
Season	P<0.05	NS[D]	P<0.01	NS	NS	NS	P<0.01
Spring	39.07±0.44	49.52±0.66	23.16±0.30	3.45±0.14	12.13±0.31	45.43±0.58	5.92±0.33
Fall	40.91±0.35	50.30±0.53	24.56±0.24	3.82±0.11	12.49±0.25	45.80±0.47	4.43±0.26
Covariate							
WT[E]	NS	P<0.01	P<0.05	P<0.05	P<0.05	P<0.01	P<0.01
BF[F]	NS	P<0.01	P<0.10	NS	P<0.01	P<0.01	P<0.01
MA[G]	NS	P<0.01	P<0.05	P<0.05	NS	P<0.01	P<0.01

[A] Total saturated fatty acids, [B] Total unsaturated fatty acids, [C] Level of significant
[D] Non significant, [E] Weight at slaughter, [F] Backfat thickness, [G] Marbling fat

Except SFA (h^2=0.05), the heritabilities of major fatty acids in intramusculat fat of Hanwoo bulls slaughtered in 24 months of age were moderately high. Heritability of MUFA, stearic acid, Oleic acid, and Linoleic acid were 0.35, 0.80, 0.85 and 0.58, respectively. Few estimates for heritability of fatty acid are available in the literature. In beef cattle, Malau-Aduli *et al.* (1998)

estimated heritabilities of 0.16 and 0.57 for MUFA at weaning and slaughter, respectively, in subcutaneous fat of 324 weaner steers and heifers across 7 genotypes and 26 sires.

This comparatively high heritability of oleic acid suggests that attempt to modify the fatty acid composition of Hanwoo in increasing oleic acid through selective breeding may be feasible.

Table 2. Estimated heritability of fatty acids in intramuscular fat of Hanwoo bulls

Fatty acids	h^2
Saturated Fatty acids (SFA)	0.05
Mono unsaturated fatty acids (MUFA)	0.35
Palmitic acid ($C_{16:0}$)	1.15
Palmitoleic acid ($C_{16:1}$)	2.07
Stearic acid ($C_{18:0}$)	0.80
Oleic acid ($C_{18:1}$)	0.85
Linoleic acid ($C_{18:2}$)	0.58

CONCLUSION

Sire effect influenced in major fatty acid composition ($P<0.01$) and season effect influenced in total saturated fatty acid, $C_{16:0}$, and $C_{18:2}$ ($P<0.05$). Except $C_{18:2}$, all fatty acids were higher in Fall-born calves than Spring-born calves. Heritability of MUFA, stearic acid, Oleic acid, and Linoleic acid were 0.35, 0.80, 0.85 and 0.58, respectively. These results clearly show that high heritability of oleic acid suggests that attempt to modify the fatty acid composition of Hanwoo in increasing oleic acid through selective breeding may be feasible.

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