CASEIN HAPLOTYPES IN FINNISH AYRSHIRE AND THEIR ASSOCIATION WITH MILK PRODUCTION TRAITS

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SUMMARY

Associations between casein haplotypes and milk production traits were studied in Finnish Ayrshire dairy cattle. Genotyping of casein loci for over 300 AI bulls revealed eight haplotypes, three of which were tested within six heterozygous sires against estimated breeding values of sons. The results indicate that in one of the six half-sib families milkability, fat content, milk yield and protein content were associated with the haplotypes.

INTRODUCTION

Association between casein variants and milk production traits in dairy cattle have been indicated in several studies (Bovenhuis et al. 1992, Cowan et al. 1992, Geldermann et al. 1985, Ng-Kwai-Hang et al. 1984). In spite of the conflicting results obtained in those studies the casein loci are among evident candidates in the search for milk production loci. The casein loci reside on chromosome six in the order alpha$_{s1}$- (CASAS1), beta- (CASB), alpha$_{s2}$- (CASAS2) and kappa-casein (CASK) (Ferretti et al. 1990). The tight linkage of the casein genes permits the use of their combined polymorphisms as haplotypes (Lien et al. 1993), giving higher polymorphism information content.

The objectives of this investigation were to analyze the frequencies of the polymorpishm at the casein loci in Finnish dairy cattle and to use this information to study possible associations between the casein haplotypes and milk production traits.

MATERIAL AND METHODS

The material consisted of over 300 Ayrshire AI bulls born during 1973-1988. DNA extracted from semen samples was typed for CASAS1, CASB, and CASK polymorphism. Casein haplotypes were deduced by comparing sons and sires. Six heterozygous sires and their sons (184) were used for association analysis by the granddaughter design of Weller and Soller (1990) using the predicted breeding values obtained from cow evaluation by animal model (Strandén and Mäntysaari 1992).

The analysis of CASAS1 was carried out according to David and Deutch (1992). CASK was analyzed as described in Velmala et al. (1993) for the A, B and E variants and in Moore et al. (1992) for the BOVCASK microsatellite. CASB was screened for A1 and A2 variants using amplification created restriction sites (Lien et al. 1992).

RESULTS AND DISCUSSION

The typing of the bulls for polymorphisms at the casein genes revealed eight haplotypes (Table 1). Haplotype frequencies were estimated from the sons of homozygous sires by counting the haplotypes inherited from the dam. Heterozygous sires were excluded because sons with their sires genotype lead to underestimation of the frequency of paternal haplotypes. Comparison of our results to a recent study on Norwegian dairy cattle (Lien and Rogne 1993) shows firstly, the absence of haplotypes with allele C of CASAS1 and secondly, the considerably higher frequency of the haplotype with allele E of CASK in Finnish population.

Table 1. Number and frequencies of maternal casein haplotypes in the offspring of homozygous sires.

Haplotype	no.	Freq.	Freq. in Norwegian cattle[a]
1 B A1 244 A	14	0.15	0.10
2 B A1 240 A	6	0.07	0.17
3 B A2 244 A	25	0.27	0.36
4 B A2 240 A	8	0.09	0.11
5 B A1 240 B	6	0.07	0.08
6 B A2 244 B	1	0.01	-
7 B A2 240 B	1	0.01	0.02
8 B A1 244 E	30	0.33	0.05
Total	91		

The loci in the haplotype are in the order: CASAS1 (B), CASB (A1,A2), BOVCASK microsatellite (240, 244 bp) and CASK (A,B,E).
[a]Lien and Rogne (1993)

There were eleven sires with more than ten progeny tested sons (in general, with more than 120 daughters). Six of these grandsires were found to be heterozygous, having either haplotype 3 or 5 against haplotype 8. Of the typed 184 sons, 132 were informative (not heterozygous for the haplotypes in question). Analysis of associations between casein haplotypes and estimated breeding values within individual sires indicate an association of haplotype with milk yield, protein and fat content as well as milkability in one family (Table 2). There is a similar tendency in the same traits in another family but only the difference in fat content is significant, probably due to the small number of sons included in the analysis. In both cases, the haplotype 8 seems to be associated with lower milk yield and higher protein and fat content, all possibly explained by a difference in the water component. In terms of 305 day milk yield, the difference would be about 430 kg.

Predicted breeding values were used in the analysis instead of daughter means adjusted for fixed effects such as herd-year, lactation number, etc. This could be justified because the number of daughters was with little variation, in general, more than 120.

Table 2. Associations between milk production traits and casein haplotypes within individual grandsires. In the differences for various traits, 10 units correspond to one standard deviation of predicted breeding values.

		Haplotype[b]			Difference expressed as deviation from haplotype 8[c]				
Sire	No. sons[a]	3	5	8	Milk yield	Protein yield	Protein %	Fat %	Milkability
33787	14 (23)	12		2	-8.1	-10.6	-0.6	4.5	3.5
33878	11 (15)		5	6	10.7	8.4	-5.8	*-14.8	-11.5
34078	14 (18)	4		10	5.0	3.7	-1.7	-6.6	-4.4
34740	32 (51)	17		15	4.8	5.2	-1.5	2.6	1.5
34798	22 (32)	12		10	*11.2	7.8	*-8.4	**-11.9	***-15.5
34872	39 (44)		21	18	-1.9	2.0	5.9	6.4	3.9

[a]: number of informative sons, number of typed sons in parentheses
[b]: number of sons having inherited each paternal haplotype
[c]: standard errors of estimates were from 3.0 to 7.4
*: $P<0.05$, **: $P<0.01$, ***: $P<0.001$

Reports on the association between e.g. CASK variants and milk yield have been conflicting. The studies have been mainly accomplished by pooling cows according to casein variant. If the association is due to a linked locus, it is not surprising that the effect is seen only in some studies. In our study the effect was seen only in one of the four families where the haplotypes 3 and 8 were segregating, and in one of the two families with the haplotypes 5 and 8 segregating. If the sons had been grouped only according to haplotype, no effect would have been found. Typing of additional markers on chromosome 6 in these families may enable the localization of a milk production locus. It is interesting, although still preliminary to notice that most likely the haplotype 8 and the allele E of CASK can be traced back to a popular bull of the 1970's. More markers are needed to confirm this and to figure out the transmission routes of haplotypes and their putative associated effects.

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