EFFECTS OF κ-CASEIN GENOTYPES AND MILK RENNETING PROPERTIES ON YIELD AND COMPOSITION OF FRESH CHEESE

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SUMMARY

Two cheese making trials were arranged to investigate the effect of κ-casein genotypes and milk renneting properties on fresh cheese yield and composition. Test groups of cows with κ-casein B-allele had lower milk protein and casein content and inferior fresh and dry matter cheese yield compared to groups of cows with κ-casein A- or E-alleles. Groups of cows with κ-casein B-allele produced, however, cheese with lower fat content but higher protein content. Good milk renneting properties had a positive effect on cheese yield but did not affect on cheese composition.

Keywords: Dairy cow, renneting properties, protein genotypes, cheese.

INTRODUCTION

The amount of milk used for cheese production is increasing steadily in Finland. During the last 25 years the proportion of produced milk used for cheese production has increased from 13 % to 40 % (Agrifacts 1996). Cheese yield is the sum of quantities of fat, protein, other dry matter and water transferred from milk into cheese (van Boekel 1993). Milk composition varies for example between dairy breeds, and by feeding and health of cows. In several studies, significant differences have been reported in effect of milk protein genotypes on milk composition and renneting properties (e.g., Schaar 1984, Davoli *et al.* 1990 and Ikonen 1997). The κ-casein B-allele has in most cases had a favourable effect on casein content and renneting properties of milk. Some studies have dealt with effects of milk protein genotypes and milk renneting properties on cheese production, but the results have been contradictory (e.g., Schaar *et al.* 1985, Marziali and Ng-Kwai-Hang 1986 and Walsh *et al.* 1995). Ahlfors (1996) reported that about 8 % of Finnish Ayrshire (Fay) cows had very poor milk renneting properties. According to Ikonen *et al.* (1996) the frequency of κ-casein B-allele was much lower in Fay cows than in some other dairy breeds. Research is needed to investigate reasons to this situation and to improve efficiency of cheese manufacture.

The objective of this study was to estimate effects of κ-casein genotypes and milk renneting properties on yield and composition of fresh cheese.

MATERIALS AND METHODS

The cheese-making trials were performed in a small-scale cheese-making dairy on a private farm with 60 Fay cows. Genotypes for α_{s1}-, α_{s2}-, β- and κ-casein and β-lactoglobulin were determined for all cows in the herd. Milk composition and renneting properties of all the cows were measured once before the cheese-making trials. There were two groups of cows in trial during a three-week-long test period. Fresh cheese was made once a week from the milk of the test groups, 50 l vat of each group. Cheese yield ((kg cheese/kg milk) x 100 %) was measured, and cheese composition (dry matter, fat-%, and protein-%) was analysed. Milk composition (protein-%, fat-%, lactose-%, casein-%, pH and somatic cell count) and renneting properties (renneting time (R, min), curd firming time (K_{20}, min) and curd firmness (E_{30}, mm)) of each test group were determined on the second week of every three-week-long test period.

κ-casein genotypes. Two groups of five cows were composed to study effects of κ-casein genotypes on cheese yield and cheese composition: Group A consisted of cows with κ-casein genotypes AA, AE or EE and group B of cows with κ-casein genotypes AB or BE. Comparison of κ-casein genotypes was carried out for seven test periods. Cows in the groups were changed after first, third and fifth test period. The pairs of groups consisted of cows in equal parity, stage of lactation and, as far as possible, same genotypes of other milk proteins than κ-casein.

Good and poor renneting properties. Another trial was made to investigate the effect of milk renneting properties on cheese manufacture. Group G consisted of five cows with good milk renneting properties and group P of cows with poor renneting properties. Comparison of good and poor renneting properties lasted for three test periods, and the individuals in groups remained the same during that time. All the cows had κ-casein genotype AE. The pair of groups consisted of cows in equal parity and stage of lactation.

The analysis of the data was carried out both with WSYS program (Vilva 1992) assuming test periods being independent, and with General Linear Models -procedure of the Statistical Analysis System (SAS GLM, SAS Institute Inc. 1993) assuming test periods with identical composition of test groups being correlated. The latter was employed in comparison of κ-casein genotypes, where cows in the test groups (A and B) were changed every second test period. Test group and test period were included in statistical model in both cases. The test group was the only factor in statistical model when the effects of renneting properties were analysed. Statistical significance of the differencies between groups was tested with F-test.

RESULTS AND DISCUSSION

κ-casein genotypes. Total protein and casein contents in milk, and fresh cheese yield and dry matter yield were higher in group A than in group B (Table 1). Cheese fat content and fat in dry matter were higher in group A but cheese protein content was higher in group B. Thus, the fraction of protein retained in the cheese was larger in group B than in group A, which implies the favourable effect of the κ-casein B-allele. Both statistical methods (assuming

independent observations or correlated observations) gave parallel results even though the correlated observations -model gave less significant effects than the independent observations -model. The superiority of group B in cheese protein content was statistically significant only when correlation between observations accounted for in the analyses. The results are in disagreement with most of the other studies, where κ-casein B-allele has been found superior to the other κ-casein variants in milk protein content, renneting properties and cheese yield (e.g., Marziali and Ng-Kwai-Hang 1986 and Walsh *et al.* 1995). On the other hand, Schaar *et al.* (1985) did not find any significant differences between κ-casein genotypes in cheese yield.

Table 1. Means and standard deviations (s.d.) of milk and cheese traits, and differences between groups in cheese-making trials (A: κ-casein genotypes AA/AE/EE, B: κ-casein genotypes AB/BE; and G: good renneting properties, P: poor renneting properties)

	κ-casein genotype[1]			Renneting properties[2]		
Trait	Mean	s.d.	Difference A - B	Mean	s.d.	Difference G - P
Milk						
protein (%)	3.19	0.16	+0.16**	3.26	0.11	+0.20**
fat (%)	3.64	0.34	+0.14	3.59	0.26	+0.38(*)
lactose (%)	4.87	0.13	-0.18*	4.88	0.06	-0.10*
casein (%)	2.26	0.11	+0.12**	2.29	0.07	+0.12*
R (min)	9.00	1.02	±0.00	10.33	2.62	-4.66**
K_{20} (min)	6.00	1.24	+1.20(*)	8.25	2.88	-5.16***
E_{30} (mm)	37.36	3.41	-2.20	32.50	6.09	+11.00***
Cheese						
yield (%)	13.15	1.06	+0.68**	13.59	1.64	+1.56*
dry matter (%)	48.98	1.28	-0.12	48.18	1.37	+0.68
d.m. yield (%)	6.31	0.50	+0.32*	6.55	0.85	+0.84*
fat (%)	24.15	1.59	+0.96*	23.35	1.02	-0.02
fat in d.m. (%)	50.31	2.60	+2.08**	48.46	1.65	-0.76
protein (%)	19.15	0.83	-0.40	19.49	0.97	+0.10

[1] 7 test periods: 7 observations for milk composition and renneting properties per group, 18 observations for cheese yield and composition per group.

[2] 3 test periods: 3 observations for milk composition and renneting properties per group, 9 observations for cheese yield and composition per group.

F-test: (*) $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$ (ignoring correlation between observations).
d.m.=dry matter

Good and poor renneting properties. There was highly significant difference in milk renneting properties between the two groups, which reflects that the groups were chosen with right criteria. The group G, with good renneting properties, had significantly higher total protein content and casein content in milk than the group P, with poor renneting properties

(Table 1). Fresh cheese yield was 1.56 %-units higher and dry matter yield 0.84 %-units higher in group G than in group P. Cheese composition did not differ between the groups. The test groups remained almost unchanged during the three months test period, but in statistical analyses it was not possible to account for the correlation between observations. Thus, the differencies between groups may be overestimated. The results of this study agree with those of Ng-Kwai-Hang *et al.* (1989) and Walsh *et al.* (1995).

The effect of κ-casein B-allele on cheese yield in this study was opposite to the results in most of the other studies. This may be due to a chance, because only a few cows with κ-casein B-allele were available, and possibility to change cows in test groups was limited.

Milk renneting properties had a clear effect on cheese yield. It might therefore be of economical interest to breed cows for better milk renneting properties. One of the current breeding objectives of dairy cows in Finland is high protein content of milk, which may have a positive effect on cheese manufacture. There is no equipment available for rapid measurement of milk renneting properties at the moment. Milk protein genotypes could be a possible choice of selection, even though the results in this study do not fully support the predominant conception of their effects on milk renneting properties and cheese yield.

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