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# The Influence of Kappa Casein Protein Polymorphism on Milk Production Traits and Other Productive Performance Traits of Brown-Swiss Cattle

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**Abstract.-** Polymorphism of kappa casein protein (κ-casein) in total 113 Brown-Swiss cattle was investigated using horizontal starch-urea gel electrophoresis method to verify its effect on milk production traits (actual milk yield, 305 d milk yield, actual fat yield, 305 d fat yield, fat percentage and lactation length) and influence of other factors such as parity and season of calving; aiming at utilizing it as a genetic aid in selection to improve the milk production traits of this breed. The allelice frequencies of A, B, and C were found to be 0.345, 0.633, and 0.022 respectively. Genotype frequencies were in accordance with the Hardy-Weinberg equilibrium. General linear model (GLM) was used to analyze differences between genotypes. The results indicated that κ-casein genotypes significantly ($P<0.05$) affected 305 d milk yield, actual fat yield, 305 d fat yield, fat percentage, and lactation length. But it had no effect on actual milk yield. Parity and season of calving had effect ($P<0.05$) on milk production traits. This study indicated that the κ-casein genetic variants may be used as a genetic aid through increasing the frequency of desired genotypes to improve the milk production traits of this breed.

**Key words:** Kappa casein protein polymorphism, milk production traits, parity, season of calving.

## INTRODUCTION

Improvement of milk yield and its composition are the primary goals for animal selection in dairy industry. Milk components in cattle are quantitative traits, being influenced by environmental and genetic factors. The bovine milk, six major specific proteins include $\alpha_{s1}$-casein (CSN1S1), $\alpha_{s2}$-casein (CSN2), β-casein (CSN1S2), κ-casein (CSN3), α-lactalbumin, and β-lactoglobulin, which are controlled by codominant autosomal genes according to Mendelian inheritance, exist in different allelic forms (Aschaffenburg and Thymann, 1965; Galila and Darwish, 2008). The genetic polymorphism of bovine milk proteins was highly investigated recently as being of great importance in breeding strategies as well as studies on the population structure and preservation of the natural genetic varieties among indigenous breeds. Moreover, a number of studies suggest that milk protein polymorphism has a strong influence on milk qualitative and quantitative traits (Di Stasio and Mariani, 2000; Martin *et al.*, 2002). The using polymorphic markers allows the determination of individual genotypes at many loci and provides information on population parameters like allelic and genotypic frequencies which can be used as a tool for improving the animal selection through Marker Assisted Selection (Wu *et al.*, 2005; Kumar *et al.*, 2006). Till now, several methods have been used for genotyping polymorphisms in milk proteins (Seibert *et al.*, 1985; Guy and Fenaille, 2006; Le *et al.*, 2010). In dairy cows κ-casein main variants A and B have been reported as the most important milk protein types (Mercier *et al.*, 1972; Groscluade *et al.*, 1987; Mayer *et al.*, 1997a), and rare variants of κ-casein C (Di-Stasio and Merlin, 1979; Mariani, 1990) and κ-casein E (Erhardt, 1989). Previous works showed that κ-casein alleles could be used as a useful marker in improving milk yield and composition selection programs (Tarasavich, 1984; Lin *et al.*, 1986; Ng-Kwai-Hang *et al.*, 1990; Bech and Kristiansen, 1990; Khathar *et al.*, 2004; Triaras *et al.*, 2005; Rachagani and Gupta, 2008; Riaz *et al.*, 2008; Ju *et al.*, 2009). However, some studies described that this relationship was not important for milk production traits (Ng-Kwai-Hang *et al.*, 1984, 1991; Mclaen *et al.*, 1984; Eenennaam and Medrano, 1991; Mayer *et al.*, 1997b; Cervantes *et*

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*al.,* 2007; Cortes-Lopez *et al.,* 2012; *Tahira et al.,* 2014). Therefore, the aim of the present study was to investigate the effect of κ-casein protein polymorphism on milk production traits in Brown-Swiss cattle.

## MATERIALS AND METHODS

Milk samples obtained from 113 multiparous Brown-Swiss cows reared in Research and Application Farm of College of Agriculture, Ataturk University were used to determine κ-casein protein. All animals were maintained at the Research and Application Farm of College of Agriculture, Ataturk University, Erzurum, Turkey under similar welfare and nutritional conditions. Totally 541 production records were obtained from Brown-Swiss cows. Four calving seasons were included in such a way that every three months of the year starting from the last month of the previous year were considered as one group of seasons as winter, spring, summer and autumn. Five groups for parity number were included in the model. Lactation milk yields records were adjusted according to Anonymous (1976).

About 10 ml of milk was collected from each animal and 20 mg potassium dichromate was added to each sample as a preservative. Fat-free milk samples were stored in a refrigerator at 4°C until analyzed. Two or three drops of 2-mercapto ethanol were added to samples before electrophoresis. Milk protein genotyping was carried out by using horizontal starch-urea gel electrophoresis (Aschaffenburg and Michalak 1968; Dogru, 1994). Direct counting was used to estimate gene and genotypic frequencies of the κ-casein proteins. The chi-squared test was used to check whether the population was in Hardy–Weinberg equilibrium (Soysal, 1998). The data on the milk production traits of the different κ-casein genotypes were subjected to Analysis of variance (ANOVA) using the General Linear Model (GLM) from the Statistical Analysis Software (SPSS Statistics 17.0). The following statistical model used was:

$$Y_{ijkl} = \mu + G_i + A_j + S_k + e_{ijkl}$$

Where $Y_{ijkl}$, is the observation on each trait of the *ijkl*th animal; μ, is the general mean of each trait; $G_i$, is the fixed effect of *i*th κ-casein genotype; (i=1,2..,4); $A_j$, is the fixed effect of *j*th parity number (j=1, 2,…,5; parity number >5 were pooled with parity of 5); $S_k$, is the fixed effect of the *k*th season of calving (k=1, 2..,4); eijkl, is the random error effect associated to the *ijkl*th observation.

## RESULTS AND DISCUSSION

The aim of this study was to identify κ-casein A κ-casein B and κ-casein C alleles and κ-casein AA, κ-casein AB, κ-casein BB, and κ-casein BC genotypes of κ-casein in a population of Brown-Swiss cows. Out of 113 studied cows, genotypic frequencies of κ-casein genotypes were: 20 cows of the κ-casein AA genotype, 38 of genotype AB, 50 of genotype BB, and 5 of BC genotype. Chi-squared test for deviations from the Hardy-Weinberg equilibrium were carried out to determine statistical significance. Deviations from the Hardy-Weinberg equilibrium was not significant ($\chi^2$=6.29). Such findings have been well documented by a number of investigators (McLean *et al.,* 1984; Eenennaam and Medrano, 1991; Mayer *et al.,* 1997a).

Table I shows the effect of κ-casein genotypes, parity and season of calving on milk production traits in Brown-Swiss cattle. The results indicated that κ-casein genotypes had significant (P<0.05) effect on 305 d milk yield, actual fat yield, 305 d fat yield, fat percentage, and lactation length, but it did not affect actual milk yield. It was observed that cows with genotype BC had significantly higher 305 d milk yield (3447.6 kg) than those of genotypes BB, AB, and AA (3152.7, 3166.8 and 2961.9 kg respectively); and also had insignificantly higher actual milk yield (3533.9 kg) than those of other three genotypes (3365.8, 3365.8, and 3239.6 kg respectively). These results coincide with those reported by various researchers (Lin *et al.,* 1986; Graml *et al.,* 1986; Ng-Kwai-Hang *et al.,* 1990; Bech and Kristiansen, 1990; Khathar *et al.,* 2004; Triaras *et al.,* 2005; Rachagani and Gupta, 2008). All these studies showed an individual effect of κ-casein gene on milk yield and milk fat yield. On the other hand, our results disagree with Ng-Kwai-Hang *et al.* (1984), Mclaen *et al.* (1984), Ng-Kwai-Hang *et al.* (1991), Eenennaam and Medrano (1991), Mayer *et al.* (1997a) and Ju *et al.* (2009) who claimed that κ-casein gene had no significant influence on milk production traits. The results in Table I show that parity number and season of

**Table I.- Least square means and standard errors of milk production traits of κ-casein genotype, parity and season of calving.**

| Parameter | N | Actual milk yield (kg) | 305 d milk yield (kg) | Actual fat yield (kg) | 305 d fat yield (kg) | Fat in Milk (%) | Lactation length (d) |
|---|---|---|---|---|---|---|---|
| **κ-casein genotype** | | | | | | | |
| AA | 70 | 3239.6±112.5[NS] | 2961.7±86.9[b] | 122.9±5.1[b] | 114.7±4.2[c] | 3.84±6.9[b] | 312.9±8.8[ab] |
| AB | 189 | 3461.4±69.4 | 3166.8±53.7[b] | 138.1±3.2[ab] | 127.5±2.6[b] | 3.91±4.3[b] | 329.9±5.4[a] |
| BB | 259 | 3365.8±60.1 | 3152.7±46.6[b] | 130.8±2.8[ab] | 122.6±2.3[bc] | 3.93±3.7[b] | 315.8±4.7[ab] |
| BC | 23 | 3533.9±194.4 | 3447.6±150.3[a] | 142.8±8.9[a] | 140.3±7.3[a] | 4.10±11.9[a] | 298.6±15.1[b] |
| **Parity** | | | | | | | |
| 1 | 110 | 3092.6±99.7[b] | 2800.7±77.1[c] | 121.4±4.6[b] | 111.3±3.8[c] | 4.04±6.1[a] | 334.7±7.7[a] |
| 2 | 105 | 3301.5±101.3[b] | 3117.4±78.4[b] | 129.0±4.6[b] | 123.6±3.8[b] | 3.99±6.2[ab] | 316.3±7.9[ab] |
| 3 | 78 | 3643.9±114.6[a] | 3411.7±88.6[a] | 143.2±5.2[a] | 135.6±4.3[ab] | 3.90±7.1[ab] | 312.5±8.9[b] |
| 4 | 69 | 3740.6±122.2[a] | 3527.8±94.5[a] | 146.8±5.9[a] | 139.2±4.6[a] | 3.96±7.5[ab] | 319.2±9.5[ab] |
| 5 | 179 | 3222.3±85.9[b] | 3053.7±66.1[b] | 127.5±3.9[b] | 121.5±3.2[c] | 3.82±5.3[b] | 288.7±6.7[c] |
| **Season of calving** | | | | | | | |
| Spring | 163 | 3213.9±87.6[b] | 3046.7±67.8[b] | 125.4±4.0[b] | 118.8±3.3[b] | 3.95±5.4[ab] | 307.9±6.9[b] |
| Summer | 117 | 3388.6±97.9[ab] | 3126.1±75.7[b] | 133.9±4.5[ab] | 124.9±3.7[ab] | 3.86±6.1[b] | 312.3±7.6[ab] |
| Autumn | 96 | 3566.1±108.1[a] | 3283.1±83.6[ab] | 140.5±4.9[a] | 132.6±4.1[a] | 3.94±6.7[ab] | 320.5±8.4[a] |
| Winter | 165 | 3431.9±85.4[a] | 3273.1±66.1[a] | 134.5±3.9[a] | 128.8±3.2[a] | 4.03±5.3[a] | 316.4±6.7[ab] |
| Overall | 541 | 3400.2±62.0 | 3182.2±47.9 | 133.6±2.8 | 126.3±2.3 | 3.94±3.8 | 314.3±4.8 |

NS: Non-Significant
a, b, c:Means with same superscripts are not significantly different ($P<0.05$) from one another

calving had significant effect on milk production traits. Milk production traits in cattle are quantitative traits, being influenced by genetic and environmental factors.

This study demonstrated that κ-casein genotypes had significant effect on 305 d milk yield, actual fat yield, 305 d fat yield, fat percentage and lactation length, but it did not affect actual milk yield. Further researches with large numbers of animals and different breeds are required to investigate these associations between κ-casein genotypes and milk production traits. This study also indicated that the κ-casein protein genetic variants may be used as a genetic aid through increasing the frequency of desired genotypes to improve the yield and quality of production in Brown-Swiss.

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