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Effects of α_{s1}-casein (*CSN1S1*) and κ-casein(*CNS3*) genotypes on technological properties and rheological parameters of milk goat in Murciano-Granadina breed.

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INTRODUCTION

The effects of the *CSN1S1* polymorphisms on milk composition and cheese yield have been widely studied in various goat breeds. However, much less is known about the effect of *CSN3* variants on technological and rheological properties of goat milk. An association analysis between polymorphisms at the *CSN1S1* and *CSN3* loci and milk technological properties and milk rheological parameters measured with a Optigraph® coagulometer, has been carried out in Murciano-Granadina goats in Spain.

MATERIAL AND METHODS

Experimental Design Seventy four goats with BB, EE and EF genotypes at *CSN1S1* locus (associated with high, medium and low levels of CSN1S1 synthesis) and AA, AB, and BB genotypes at *CSN3* locus (the most frequent ones in this breed ACCORDING TO Caravaca et al. 2009) were chosen among a larger number of goats genotypes for both loci. Milk at one milking was collected bimonthly from each goat through an entire lactation period. A single cheese was elaborated with the milk collected from each goat in an experimental cheese manufacturer laboratory. Time to coagulation onset (R), curd firmness at R (AR) and 2R (A2R) times, 20 minutes (A20) and 30 minutes (A30) after coagulation onset and rates of curdling (i.e., time in minutes elapsed to get different degrees of curd firmness, measured through the voltage change which takes place along the curdling process, S2=1000 V, S4=2000 V, S6=3000 V and S8=4000 V) were measured using an Optigraph® (YSEBAERT, France) coagulometer . Dornic acidity (DA), coagulation time (CT) and cheese yield (CY) measurements were taken while cheese was being elaborated.

Statistical Analysis The MIXED procedure from SAS (SAS V8e, 2007) was used for the association analysis as suggested by Little et al. 1998. A model including genotypes for *CSN1S1* and *CSN3* loci and their interaction, herd-year-season of kidding, ordinal of kidding, number of kids born and number of months elapsed from parturition to recording date as fixed factors, considering records taken from each goat (random factor) as repeated measures of the same trait. Linear combinations of parameters values L′β (L being a vector of coefficients) and their corresponding variance V (L′β), estimated with this model, allowed for testing differences between genotype means using a t distribution. The Bonferroni correction for multiple comparisons was applied.

RESULTS and DISCUSSION

No significant interaction between *CSN1S1* and *CSN3* genotypes was found. Results (Table 1) showed that *CSNS1* polymorphisms can affect S2 and S4 parameters, both related with the rate of curdling process, BB milks had lower speed of curdling than EE milks (P< 0.05). Parameter S4 showed the same tendency (BB milks > EE). These results agreed with those obtained by Remeuf (1993) with milk samples from genotyped goats for *CS1S1* with a Formagraph® (AA *CS1S1* had lower speed of curdling than EE and FF *CS1S1*).. However, Clark and Sherbon (2000) reported that *CSN1S1* genetic variants were no correlated with coagulation properties in one experiment carried out in one dairy goat herd of mixed breeds (n=93). Vassal et al. (1994) evidenced differences between AA and EE and AA and FF fresh cheese yields, but we have not observed in our study any difference for this variable between *CSN1S1* variants. Other relevant and novel finding of this study was that *CSN3* polymorphisms has an effect on the onset of coagulation (R parameter) (BB >AB goats). These results suggest that both loci should be taken into account when studying and using the casein genes polymorphisms in goats selection programs.

TABLE 1. Least square means (up) and standard errors (down) of milk coagulation traits in Murciano-Granadina goats (n=number of goats , nr=number of records) with different *CSN1S1* and *CSN3* genotypes. Different letters indicate significant differences at *P*< 0.05 after Bonferroni´s correction.

Genotype(n;nr)		**R**	**S2**	**S4**	**S6**	**S8**	**AR**	**A2R**	**A20**	**A30**	**DA**	**CT**	**CY**
CSN1S1	***CSN3***												
BB (32;80)		12.39 1.36	6.40 2.10[a]	15.37 5.50[a]	10.72 3.01	16.23 4.24	4.29 1.08	6.81 1.54	2.71 1.01	1.97 0.40	14.87 1.67	48.56 3.63	6.03 0.42
EE (35;96)		11.61 1.47	3.18 2.11[b]	7.76 5.53[b]	11.91 2.93	18.04 4.17	4.22 1.15	5.35 1.63	2.51 1.08	1.8 0.48	14.68 1.80	45.34 3.86	6.14 0.44
EF (7;17)		12.06 2.12	4.66 3.23	11.23 8.38	11.56 5.31	16.21 7.52	3.38 1.61	3.08 2.28	0.67 1.48	1.4 0.67	18.70 2.62	45.83 5.40	7.14 0.63
	AA (15;36)	12.09 1.48	6.35 2.69	15.60 7.42	14.26 3.74	19.77 5.39	2.94 1.33	4.02 1.88	1.69 1.23	1.42 0.50	15.66 2.050	47.85 4.43	6.66 0.51
	AB (29;76)	11.22 1.19[b]	4.88 2.45	12.00 6.54	9.34 3.56	15.73 4.97	4.40 1.18	5.59 1.71	2.59 1.10	1.84 0.50	17.46 1.77	46.00 3.96	6.34 0.45
	BB (30;81)	13.43 1.35[a]	4.42 2.90	11.09 7.54	10.60 4.05	14.98 5.66	4.55 1.32	5.64 1.83	1.61 1.21	1.94 0.50	15.13 2.24	45.88 4.42	6.31 0.52

R: Time to coagulation onset. **AR, A2R**: Curd firmness one R and two R, respectively, after starting curding. **A20, A30**: Curd firmness at 20 and 30 minutes, respectively, after adding rennet. Af: Curd firmness when curding process has finished. **S2, S4, S6, S8**: Time elapsed to get different degrees of curd firmness (measured through the change of voltage which takes place during the curdling process). **DA**: Dornic acidity. **CT**: Curding time. **CY**: Cheese yield. All estimates were obtained from test day measures.

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