RELATIONSHIPS BETWEEN GOAT κ-CASEIN (CSN3) POLYMORPHISM AND MILK COMPOSITION

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Summary
The relationships between goat κ-casein (CSN3) variants and milk composition were studied in 1143 goats from 4 breeds (Camosciata, Frisa, Orobica, Verzasca). Individual milk samples were analysed by isoelectrofocusing. The effect of CSN3 type on protein and casein content was evident, B^{IEF} variant being associated to higher levels of both traits. Since the B^{IEF} variant is mainly present in local caprine breeds, the relevance of its favourable effect on milk composition for the conservation and valorisation of the autochthonous resources is evident.

Keywords
Goat, κ-casein, genetic polymorphism, milk, composition

Contribution
Since the discovery of two protein κ-casein (CSN3) variants in goat [1], successively confirmed both at the protein and DNA level [2], further polymorphisms were identified by DNA analysis [3, 4, 5, 6, 7]. The number of alleles identified in domesticated goat has grown to 16, of which 13 are protein variants and 3 silent mutations and thus DNA variants only, involving a total of 15 polymorphic sites in *CSN3* exon 4. By isoelectric focusing (IEF) of milk samples, all *CSN3* variants found in domesticated goat so far cluster in two groups on the basis of the isoelectric point (IP): *D*, *E*, *K*, *M* (IP = 5.66) and *A*, *B*, *B'*, *B''*, *C*, *C'*, *F*, *G*, *H*, *I*, *J*, *L* (IP = 5.29). The nomenclature of the protein level typing can be thus classified in two patterns, corresponding two the IP groups: A^{IEF} (IP = 5.26) and B^{IEF} (IP = 5.29) [7].
An interesting difference was suggested between the two CSN3 IEF variants, as B^{IEF} seems to be associated with higher casein content in milk than A^{IEF} [8]. This finding could be due to the fact that B^{IEF} has been observed until now only in haplotypes with strong alleles at α_{s1}-casein (*CSN1S1*) and α_{s2}-casein (*CSN1S2*) loci [9]. Otherwise, a direct effect of CSN3 polymorphism could ascribe for the association found.
Aiming to confirm the relationships between CSN3 variants and milk composition, 1143 individual milk samples from 4 breeds (Camosciata, Frisa, Orobica, Verzasca) were analysed by IEF [2]. Goats were reared in 62 flocks of Lombardy enrolled in the recording scheme of the Regional Association of Breeders (ARAL) milk quality program. For each goat, data were available on milk protein, fat, lactose, and casein daily content. A statistical analysis was carried out by GLM procedure [10] to evaluate the effect of CSN3 IEF phenotype on milk composition trait, with simultaneous adjustment for breed, lactation number, days in milk, herd, and the expression level of CSN1S1. IEF allows discriminating for CSN1S1 expression levels without giving further details of the goat's genotype at this locus, for which typing at the DNA level is necessary. The CSN1S1 content was classified in three levels: 0 (comprising

null alleles and the faint *CSN1S1*F*); 1 (genotypes resulting in an intermediate CSN1S1 expression); 2 (genotypes homozygous or heterozygous for the strong alleles: *A*, *B*, *C*, *H*).

Table 1. Least-square means (LS-mean) and standard error (SE) of the milk composition traits for CNS3 IEF phenotype. Bonferroni adjustment for multiple comparison was applied. Means with different superscripts significantly differ (P < 0.05).

	CSN3 IEF phenotype					
Milk trait %	AA (n =767)		AB (n = 318)		BB (n = 58)	
(g/100 ml)	LS-mean	SE	LS-mean	SE	LS-mean	SE
Protein	3.04[a]	0.05	3.09[a]	0.05	3.18[b]	0.06
Casein	2.19[a]	0.04	2.23[a]	0.04	2.29[b]	0.05
Fat	3.38	0.12	3.49	0.13	3.39	0.15
Lactose	4.51	0.07	4.51	0.07	4.53	0.08

The effect of CSN3 type on protein and casein content is evident (table 1), B^{IEF} variant being associated with higher levels of both traits. This trend was observed also in the breeds analysed separately, and was independent from CSN1S1 level, which was simultaneously accounted for by the linear model fitted. Since the B^{IEF} variant is mainly present in the local caprine breeds [1, 2, 6], the relevance of its favourable effect on milk composition for the conservation and valorisation of autochthonous resources is evident. Genetic improvement of goat breeds and populations should take into account the CSN3 protein polymorphism in the future.

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