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Genetic parameters for milk yield, composition and rheological traits in Murciano-Granadina goats

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INTRODUCTION

Estimates of genetic parameters for milk yield and composition has been published for several breeds of goats (see for example review by Gall, 1981 and Kennedy et al. 1982, Analla et al. 1996, Belichon et al. 1999, Manfredi et al. 2000 and Delgado et al. 2006) . However, estimates of these parameters for rheological (milk coagulation properties) have been reported only for cows (Oloffs et al. 1992; Ikonen et al. 1999). The objective of this work is to estimate heritability and phenotypic and genetic correlations of these traits in Murciano-Granadina goats.

MATERIAL AND METHODS

Experimental design Milk records and samples were taken bimonthly during one whole lactation from 324 Murciano-Granadina goats distributed in six different herds under a milk recording scheme. Milk collected from each individual goat was used to elaborate a single cheese at an experimental cheese factory. Milk composition (fat, lactose, protein, total casein, α_{S1}-casein and α_{S2}-casein contents) was measured in 958 samples using an spectrophotometer NIR SYSTEM 6.500 (Foss Electric) previously calibrated. From each sample of milk used to elaborated cheese, coagulation measurements related with the time to coagulation onset (R), curd firmness at different times (AR, A2R, A20 and A30) after coagulation onset and rate of curdling (S2, S4, S6 and S8) were taken with a coagulometer Optigraph® (YSEBAERT, France).

Parameters estimation A first analysis was carried out to determine significant fixed factors using the MIXED procedure of SAS (V8e 2007) with a model including a combination of herd, year and 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 goats (random factor) as repeated measures of the same trait.

Heritability estimates were obtained using the REML method in the VCE5 program (Groeneveld *et al.* 2003) with a repeatability models including fixed factors found significant for each variable in previous analysis. Genetic and phenotypic correlations were estimated with the same method and program used to estimate heritability, but using a single model including all fixed effects.

RESULTS and DISCUSSION

TABLE 1. Heritabilities (diagonal), phenotypic (lower triangle) and genetic (upper triangle) correlations between the traits studied. (Estimates are upper values and tandard errors are lower values).

	MY	**PC**	**CNC**	**CSN1S1**	**CSN1S2**	**LC**	**R**	**AR**	**A2R**	**A20**	**A30**	**Af**	**S2**	**S4**	**S6**	**S8**
MY	**0.37** **0.19**	-0.21 0.05	-0.29 0.10	-0.17 0.10	-0.15 0.10	0.87 0.03	0.17 0.10	-0.10 0.10	-0.11 0.10	-0.10 0.10	-0.12 0.10	-0.10 0.10	0.15 0.20	0.20 0.25	0.18 0.20	0.22 0.20
PC	-0.40	**0.30** **0.08**	0.90 0.10	0.65 0.10	0.55 0.15	-0.27 0.10	0.30 0.10	0.85 0.12	0.85 0.10	0.85 0.15	0.87 0.10	0.77 0.15	-0.65 0.35	-0.55 0.35	-0.66 0.30	-0.58 0.30
CNC	-0.35	0.88	**0.13** **0.08**	0.91 0.08	0.57 0.13	-0.08 0.08	0.16 0.06	0.68 0.03	0.69 0.05	0.60 0.08	0.62 0.05	0.55 0.15	-0.45 0.35	-0.40 0.30	-0.39 0.30	-0.42 0.30
CSN1S1	0.01 **ns**	0.04	0.01	**0.10** **0.07**	-0.39 **0.05**	**(1)**	0.08 0.05	0.36 0.10	0.40 0.10	0..42 0.10	0.35 0.10	0.30 0.10	0.22 0.25	0.18 0.20	0.15 0.20	0.10 0.20
CSN1S2	0.08 **ns**	0.27	0.32	0.57	**0.08** **0.05**	-0.47 **0.20**	0.28 0.03									
LC	-0.30	0.19	0.18	0.18	-0.04	**0.09** **0.06**	-0.35 0.10	-0.41 0.04	-0.43 0.06	-0.53 0.09	-0.64 0.07	-0.30 0.10	-0.15 0.18	-0.11 0.10	-0.18 0.20	-0.11 0.10

	MY	PC	CNC	CSN1S1	CSN1S2	LC	R	AR	A2R	A20	A30	Af	S2	S4	S6	S8
R	0.18	-0.06 **ns**	-0.06 **ns**	0.13	0.17	-0.34	**0.09** **0.04**	-0.22 0.04	-0.12 0.04	-0.45 0.19	-0.48 0.23	-0.35 0.19	0.11 0.15	0.15 0.10	0.18 0.20	0.20 0.10
AR	-0.25	0.60	0.55	-0.004	0.17	0.13	-0.01	**0.16** **0.07**	-0.97 0.07	0.98 0.05	0.85 0.05	0.80 0.05	-0.60 0.40	-0.55 0.30	-0.45 0.35	-0.55 0.35
A2R	-0.27	0.54	0.49	0.02	0.14	0.21	-0.08	0.92	**0.20** **0.06**	0.96 0.03	0.91 0.05	0.85 0.05	-0.65 0.40	-0.55 0.30	-0.45 0.35	-0.45 0.55
A20	-0.34	0.61	0.60	-0.01	0.10	0.28	-0.26	0.77	0.81	**0.12** **0.06**	0.84 0.09	0.80 0.05	-0.55 0.40	-0.50 0.30	-0.42 0.35	-0.45 0.50
A30	-0.30	0.59	0.54	0.05	0.13	0.25	-0.13	0.86	0.89	0.89	**0.14** **0.06**	0.95 0.05	-0.45 0.40	-0.48 0.30	-0.45 0.35	-0.40 0.50
Af	-0.29	0.60	0.50	0.06	0.12	0.19	-0.09	0.89	0.90	0.94	0.95	**0.19** **0.05**	-0.40 0.40	-0.45 0.30	-0.46 0.35	-0.45 0.50

	MY	PC	CNC	CSN1S1	CSN1S2	LC	R	AR	A2R	A20	A30	Af	S2	S4	S6	S8
S2	0.21	-0.44	-0.45	0.21	-0.02 **ns**	-0.15	0.29	-0.50	-0.46	-0.51	-0.46	-0.35	**0.10** **0.30**	0.77 0.55	0.47 0.45	0.65 0.50
S4	0.22	-0.49	-0.46	0.18	-0.02 **ns**	-0.12	0.28	-0.54	-0.50	-0.56	-0.51	-0.38	0.90	**0.09** **0.15**	0.65 **0.35**	0.55 **0.50**
S6	0.23	-0.53	-0.54	0.11	-0.12	-0.03	0.16	-0.61	-0.57	-0.62	-0.56	-0.40	0.85	0.92	**0.10** **0.30**	0.60 **0.50**
S8	0.39	-0.53	-0.57	0.10	-0.07 **ns**	-0.12	0.19	-0.62	-0.59	-0.65	-0.61	-0.37	0.87	0.84	0.93	**0.12** **0.25**
FC[(2)]	-0.35	0.09 **ns**	0.04 **ns**	-0.05 **ns**	-0.13	0.04 ns	0.008 **ns**	0.23	0.23	0.15	0.19	0.20	-0.15	-0.16	-0.16	-0.15

MY: Milk yield. **PC**: Protein content. **CNC**: Total casein content. **CSN1S1**: α_{S1}-casein content. **CSN1S2**: α_{S2}-casein content **LC**: Lactose content. **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). All estimates were obtained from test day measures.

(1) Empty spaces correspond to estimates close to zero or with very high standard errors.

(2) **FC**: Fat content (heritability=0.15±0.03)

It is worth noting that the heritability of curd firmness variables is of a magnitude similar to that of FC, while the heritability of variables measuring rates of curdling is lower.
Genetic and phenotypic correlations between these two groups of variables are negative. Correlations of protein and casein contents are positive with curd firmness variables and negative with rates of curding. CSN1S1 content shows positive correlations with all rheological variables.

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