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Heritability Estimates of Lactation Traits in *Maltese* Goat

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***Abstract*—**Data on 657 lactation from 163 Maltese goat, collected over a 5-year period were analyzed by a mixed model to estimate the variance components for heritability. The considered lactation traits were: milk yield (MY) and lactation length (LL). Year, parity and type of birth (single or twin) were significant sources of variation for lactation length; on the other hand milk yield was significantly influenced only by the year. The average MY was 352.34 kg and the average LL was 230 days. Estimates of heritability were 0.21 and 0.15 for MY and LL respectively. These values suggest there is low correlation between genotype and phenotype so it may be difficult to evaluate animals directly on phenotype. So, the genetic improvement of this breed may be quite slow without the support of progeny test aimed to select Maltese breeders.

***Keywords*—H**eritability estimate, lactation traits, Maltese goat

I. Introduction

BREEDING programs to improve performances in dairy goats depend on selecting does with superior genetic merit. The knowledge of non-genetic factors and the estimation of genetic parameters affecting economically important traits are basics to select breeders for a certain trait. Unavoidably estimates of heritability of genetic and phenotypic traits is essential in predicting breeding values accurately as well as in developing efficient breeding schemes.

Dairy goats are of economic and social importance in southern Italy due to the goat's ability to use vegetation in marginal areas. In Italy as well as in Mediterranean regions goats milk is widely used to produce hard and soft cheese and other typical dairy products.

Maltese goat has white body with long hair, black head and large drooping ears; this breed has no horns. Kidding occurs throughout the whole year, concentrating in the months of November and February. Milk production is about 350 l with high fat (3.8%) and protein (3.3%) content; prolificacy is high (180%) [1].

The present study was undertaken to evaluate the effects of various non-genetic factors on milk production traits (milk yield and lactation length) and to estimates heritability for the same traits in Maltese goat. No previous information is available regarding the genetic and phenotypic parameters of milk production traits in this breed.

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II. Materials and Methods

A. Animals

Data concerning 163 Maltese purebred goats, progeny of 20 bucks, born over a 5-year period in a single farm located in Puglia region were collected aiming to study milk performances traits. The animals were reared following the traditional management practices of the area (animals are left to graze in daylight hours and return to the sheepfolds at sunset leaving the goats with their kids over the night).

In order to reduce the variability, the dataset (n=657) involved only the does kidded on February. Lactation records were calculated from a set of test-day records taken at monthly intervals. Milk test were initiated following weaning (40±3 days after kidding) and continued at monthly intervals thereafter, until individual daily production (the sum of morning and afternoon milkings) dropped below 0.2 kg/goat. Furthermore information on parity number, litter size and lactation length (days) was also available.

B. Statistical analysis

Variance components for milk yield (MY) and lactation length (LL) were estimated using the restricted maximum-likelihood method from Mixed Procedure of SAS software [2]. The data set was analyzed by the following model:

$$Y_{ijklm} = \mu + A_i + P_j + T_k + S_l + e_{ijklm}$$

where Y_{ijklm} = the individual observations for trait Y; μ = the overall mean for the trait; A_i = the fixed effect of i^{th} year (1,...,5), P_j = the fixed effect of j^{th} parity (1,...,3), T_k = the fixed effect of k^{th} type of kidding (single, twin), S_l = the random effect of l^{th} sire (1,…,16) and e_{ijklm} = the random error associated with measurement of each individual observation. The error was assumed to be randomly and independently distributed, with mean of zero and a variance of σ2e. Heritability estimates were based on sire component of variance (σ2s) as follow:

$$h2 = 4\,\sigma^2 s / (\sigma^2 s + \sigma^2 e).$$

The standard error of heritability was approximated using the method described by Becker [3].

III. Results And Discussion

Descriptive statistics for MY and LL and analysis of variance for the same traits are shown in Table 1. Average MY and LL were 352.34 kg and 230 days respectively.

As shown in Table 1, the effect of the year of lactation, parity number and litter size were important sources of variation for the considered traits. In particular, MY was affected by year of lactation ($P<0.001$), parity number ($P<0.001$) and type of birth ($P<0.05$); LL was influenced only by year of lactation ($P<0.01$). The importance of the various environmental effects on milk yield has been also examined in other studies Mavrogenis et al. [4] found that year of kidding, month of kidding, age of the goat and the year by month interaction had a significant effect on milk yield of Damascus goats in Cyprus. In a later study, Mavrogenis et al. [5] noted the importance of herd, season of kidding, season by year interaction and the lactation number on milk yield of Damascus goats. Boichard et al. [6] reported that month within year, age at kidding and birth type significantly affected milk yield of Alpine and Saanen goats. Kala and Prakash [7] found that year and season of lambing accounted for variation of milk yield in two Indian goat breeds while Rabasco et al. [8] found that production year, lactation number and birth type but not herd, were significant effects for milk yield in the Spanish Verata goats. More recently, Valencia et al. [9]-[10] reported that age, season of kidding and year significantly affected milk yield and lactation length while litter size was significant only for milk yield.

Estimates of sire's and environmental variance components and heritability estimates are reported in Table 2. MY and LL showed low values of heritability (0.21 and 0.15 respectively). Early literature reviews of heritabilities of milk yield in dairy goats [11]-[12] reported estimates ranging from 0.16 to 0.60. Later references reported heritabilities of milk yield in the range of 0.18-0.40 [4], [5]-[8], [10], [13]-[19]. Our MY heritability estimate, although in its lower part, was within the range of published values for different goat populations. Only few reports were carried out on heritability estimate of lactation length in goat: a very low value of heritability for LL (0.04) was found by Valencia et al. [10] in a flock of Saanen goat reared in Mexico. On the other hand, Pimenta Filho et al. [20] and Constantinou et al. [14] estimated the heritability for LL as 0.20 and 0.16 respectively being similar to that reported in the present study (0.15).

These low values suggest there is low correlation between genotype and phenotype so it may be difficult to evaluate animals directly on phenotype. So, the genetic improvement of this breed may be quite slow without the support of progeny test aimed to select Maltese breeders.

Table I
Descriptive statistics for milk yield (MY) and lactation length (LL) and analysis of variance

		MY (kg)	LL (days)
Mean		352.34	230
S.D.		34.36	27.14
Analysis of variance			
	d.f.		
Years	4	***	**
Parity	2	***	n.s
Type of birth	1	*	n.s

*** P<0.001, ** P<0.01, * P<0.05 d.f. = degree of freedom

Table II
Estimates of sire's (Σ^2_S) and environmental (Σ^2_E) variance components, heritability (H^2) and standard error (SE_{H^2}) for *Maltese* goat lactation traits

Traits	σ^2_s	σ^2_e	h^2	SE_{h^2}
MY	428.40	7723.14	0.21	0.04
LL	62.76	1584.05	0.15	0.02

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