

Heritability Estimates of Lactation Traits in *Maltese Goat*

R. Pesce Delfino, M. Selvaggi, G. V. Celano, C. Dario

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—Heritability 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.

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 σ^2_e . Heritability estimates were based on sire component of variance (σ^2_s) as follow:

$$h^2 = 4 \sigma^2_s / (\sigma^2_s + \sigma^2_e).$$

A.R. Pesce Delfino, Department of Animal Health, University of Study Bari Aldo Moro, ITALY (phone: +39 0805443836; fax: +39 0805443925; email: arpd@libero.it)

M. Selvaggi, Department of Animal Health, University of Study Bari Aldo Moro, ITALY (phone: +39 0805443836; fax: +39 0805443925; email: mariaselvaggi@libero.it).

G.V. Celano, Department of Animal Health, University of Study Bari Aldo Moro, ITALY (phone: +39 0805443854; gv.celano@veterinaria.uniba.it).

C. Dario, Department of Animal Health, University of Study Bari Aldo Moro, ITALY (phone: +39 0805443918; fax: +39 080-5443925; email: c.dario@veterinaria.uniba.it).

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 | *** |
| 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_s^2) AND ENVIRONMENTAL (σ_e^2) VARIANCE COMPONENTS, HERITABILITY (h^2) AND STANDARD ERROR (SE_{h^2}) FOR MALTESE GOAT LACTATION TRAITS

| TRAITS | σ_s^2 | σ_e^2 | h^2 | SE_{h^2} |
|--------|--------------|--------------|-------|------------|
| MY | 428.40 | 7723.14 | 0.21 | 0.04 |
| LL | 62.76 | 1584.05 | 0.15 | 0.02 |

REFERENCES

- [1] D. Carnicella, M. Dario, M. C. C. Ayres, V. Laudadio, C. Dario, "The effect of diet, parity, year and number of kids on milk yield and milk composition in Maltese goat," *Small Rum. Res.* vol. 77, June 2008, pp. 71-74.
- [2] SAS, 1999. SAS/STAT, User's Guide, Version 8, (SAS Institute, Cary, NC).
- [3] W. A. Becker, "Estimation of variance components and heritability". in: *Manual of Procedures in Quantitative Genetics*. 2nd ed. The Program in Genetics. Washington State University, Puyallup, WA, 1968, pp 7-59.
- [4] A. P. Mavrogenis, A. Constantinou and A. Louca, "Environmental and genetic causes of variation in production traits of Damascus goats. 2. Goat productivity," *Anim. Prod.* vol. 38, 1984, pp 99-104.
- [5] A. P. Mavrogenis, C. Papachristoforu, P. Lysandrides and A. Roushias, "Environmental and genetic effects of udder characteristics and milk production in Damascus goats," *Small Rum. Res.* vol 2, July 1989, pp 333-343.
- [6] D. Boichard, N. Bouloc, G. Ricordeau, A. Piacere and F. Barillet, "Genetic parameters for first lactation dairy traits in the Alpine and Saanen goat breeds," *Genet. Sel. Evol.* vol 21, 1989 pp 205-215.
- [7] S. N. Kala and B. Prakash, 1990. "Genetic and phenotypic parameters of milk yield and milk composition in two Indian goat breeds," *Small Rum. Res.* vol 3, Sept 1990, pp. 475-484.
- [8] A. Rabasco, J. M. Serradilla, J. A. Padilla and A. Serrano, "Genetic and non-genetic sources of variation in yield and composition of milk in Verata goats," *Small Rum. Res.* vol 11, July 1993, pp 151-161.
- [9] P. M. Valencia, L. J. Dobler and S. I. Arbiza, "Sources of environmental variation affecting lactation and pre-weaning growth characteristics in Saanen goats," *Cuban J. Agric. Sci.* vol 36, 2002, pp. 117-122.
- [10] M. Valencia, J. Dobler and H. H. Montaldo, "Genetic and phenotypic parameters for lactation traits in a flock of Saanen goats in Mexico," *Small Rum. Res.* vol 68, Apr 2007, pp 318-322.
- [11] M. U. Iloeje and L. D. van Vleck, "Genetics of dairy goats: A review," *J. Dairy Sci.* vol 61, Nov 1978, pp 1521-1528.
- [12] M. Shelton, "Reproduction and breeding of goats," *J. Dairy Sci.* vol 61, July 1978, pp 994-1010.
- [13] B. W. Kennedy, C. M. Finley and G. E. Bradford "Phenotypic and genetic relationships between reproduction and milk production in dairy goats," *J. Dairy Sci.* vol 65, Dec 1982, pp 2373-2383.
- [14] A. Constantinou, R. Beuing and A. P. Mavrogenis, "Genetic and phenotypic parameters for some reproduction and milk production characters of the Damascus goat," *Z. Tierzuechtg. Zuechtgsbiol.* vol 102, 1985, pp 301-307.

- [15] B. P. Sullivan, B. W. Kennedy and L. R. Schaeffer, "Heritabilities, repeatabilities and correlations for milk, fat and protein yields in goats," *J. Dairy Sci.* 69 (suppl. 1), 1986, p. 100.
- [16] A. Constantinou, "Genetic and environmental relationships of body weight, milk yield and litter size in Damascus goats," *Small Rum. Res.* vol 2, July 1989, pp 163–174.
- [17] S. Bishop, B. Sullivan and L. R. Schaeffer, "Genetic evaluation of Canadian dairy goats using test-day data," in: *Milk and Beef Recording State of the Art, Proc. of the 29th Biennial Session of the International Committee for Animal Recording*, Ottawa, Canada, 1994, pp. 299-302.
- [18] S. Andonov, M. Kovac, D. Kompan and V. Dzabirski, "Estimation of covariance components for test day production in dairy goat," *Proc. of 6th World Cong. Genet. Appl. Livest. Prod.*, 1998, pp 145-148.
- [19] C. A. Morris, M. Wheeler and M. Lanuzel, (2006) "Genetic trend and parameter estimates for milk yield traits and kidding date in a Saanen goat herd in New Zealand". *N.Z. J. Agric. Res.* vol 49, June 2006, pp 175–181.
- [20] E. C. Pimenta Filho, J. L. R. Sarmiento, M.N. Ribeiro, "Efeitos genéticos e ambientais que afetam a produção de leite e duração da lactação de cabras ,estíças no estado da Paraíba," *Rev. Bras. Zootec.* vol 31, Nov/Dec, 2004 pp 1426-1431.