Egyptian Journal of Sheep & Goat Sciences, Vol. 4 (2), 2009, 55-64

ESTIMATION OF GENETIC PARAMETERS AND SOME NON-GENETIC FACTORS FOR LITTER SIZE AT BIRTH AND WEANING AND MILK YIELD TRAITS IN ZARAIBI GOATS

Hamed[1], A., M. M. Mabrouk[2]., I. Shaat[1] and S. BATA[2]

1- Sheep & Goats Research Department, Animal Production Research Institute, Agriculture Research Center, Nadi El-said St., Dokki, Cairo, Egypt, 2- Animal Production Department, Faculty of Agriculture, Al-Azhar University

Abstract

Data were collected from El-Serw research station belonging to Animal Production Research Institute (APRI) to estimate genetic parameter for Litter Size at Birth (LSB), Litter Size at Weaning (LSW) and Total Milk Yield (TMY) in Zaraibi goats. There were 156 half-sib families over the period 1987-2007 which developed 4784 records obtained from 1770 does, progeny of 156 sires and 924 dams. Analysis of variance and least squares means for the fixed effect were obtained using (SAS, 1999) with GLM procedure. MTDFREML program of Boldman et al. (1993) was used to estimate covariance components. Overall means ± SE for LSB, LSW and TMY were 2.10±0.01 kids, 1.28±034 kids and 253.14±1.5 kg, respectively. Effect of parity, season and year of kidding, litter size and interaction between year and season were significant ($p<0.0001$) for TMY. Effects of parity, season and year of kidding and the interaction between year and season were also significant ($P < 0.0001$) for LSB and LSW. Heritability estimates ± SE for the studied traits were; 0.08±0.01 for LSB, 0.05±0.01 for LSW and 0.26±0.05 for TMY, while the repeatability ± SE were 0.15±0.04, 0.09±0.06 and 0.31±0.06 for LSB, LSW and TMY, respectively. Genetic and phenotypic correlations between studied traits were positive and moderate.

Introduction

Recently, goats became an important aspect of animal production in Egypt. A large number of rural households raise goats with a herd size varying from 3 to 5 heads . These herds represent more than 90% of total goat population in Egypt. Therefore increasing productivity of goats will contribute to improve the standard of living of the rural people. Considering the possible improvement in productivity that has been reported due to changes in management practices (Van Vlaenderen, 1989; Adu et al., 1988; Odubote, 1992), genetic improvement of goats in Egypt is imperative. To optimize gain from environmental influences, the genetic parameters and attributes of the animals for economic traits should be appraised regularly to enable breeders determine the breeding tools of their choice. This study was aimed to get recent estimates of the most economic traits of Zaraibi goats especially with the availability of more records on the research stations and this will allow clear and appropriate breeding strategies for this breed in Egypt. The objective of this study was to estimate genetic parameter of litter size at birth, litter size at weaning and total milk yield for Zaraibi goats.

MATERIALS & METHODS

Data and herd management

This study was carried out on the Zaraibi goat herd kept in El-Serw experimental station located in the north eastern part of the Nile Delta, Egypt. The station belongs to APRI, Agriculture Research Center, Ministry of Agriculture. Data used in this study included 4784 records obtained from 1770 does, progeny of 156 sires and 924 dams. Data were collected from years 1987 to 2007. Management of data was illustrated recently by Shaat and Maki-Tanila (2009) and Hamed (2005). Goats were housed in semi-open pens and fed on Egyptian clover (*Trifolum alexandrinum*) from December to May. For the rest of the year they fed on rice straw and green fodder, if available as supplement to concentrate mixture. There was one mating season per year (at October) from year 1987 until 1992 and starting from year 1993, the herd was divided into two groups to apply two mating seasons per year (June and October). Does were randomly divided into mating groups of 30–35 does and each was randomly assigned to a fertile buck but care was taken to avoid full sibs and half sibs mating. Bucks were also selected from the herd based on yearling weight, total milk yield of their dam and body conformation. Bucks were changed after 3 to 4 mating seasons with replacements from the same herd. Mating period lasted for 45 days. Does not allowed to join the buck before being approximately 18 months age. At kidding, newborns were identified and their type of birth, gender and pedigree were recorded.

Statistical analysis

Data were analyzed using General Linear Model (GLM procedure) of SAS, 1999, to estimate fixed effects of *l*th parity, *i*th year, *k*th season and *j*th litter size and interaction between year and season on litter size at birth, litter size at weaning and total milk yield traits. The fixed effects on total milk yield included in the model were litter size (single, twins and triplets or more), season of kidding (March and October), doe parity (1, 2, 3, 4, ≥5) and year of kidding (1987, 1988 ….2007). The assumed model was:

$$Y_{ijklm} = \mu + A_i + L_j + S_k + P_l + AS_{jk} + e_{ijklm}, \qquad \text{(Model 1)}$$

Where,

Y_{ijklm} is the total milk yield m^{th} record of the i^{th} , j^{th} litter size, year of Kidding, k^{th} season of kidding and l^{th} parity;

μ the overall mean;

A_i the effect of i^{th} year of kidding, i = 1987, 1988 ….2008;

L_j the effect of j^{th} litter size, j=1, 2 and 3 for single, twice and triplet or more;

S_k the effect of k^{th} season of kidding, k=1 and 2 for winter and autumn respectively;

P_l the effect of l^{th} parity, l, 2 …. ≥5;

AS_{jk} the interaction between year and season of kidding and

e_{ijklm} the effect of random error associated with the m^{th} individual assumed normally distributed with $(0, I\sigma^2_e)$.

Litter size at birth and weaning was affected by the same fixed effect except litter size. The assumed model was:

$$Y_{ijkn} = \mu + A_i + S_j + P_k + AS_{jk} + e_{ijkn}, \qquad \text{(Model 2)}$$

Where,

Y_{ijkm} is the litter size at birth and weaning m^{th} record of the i^{th} year of Kidding, j^{th} season of kidding and k^{th} parity;

Other terms in the model are defined as in Model 1.

A Multiple-trait derivative-free restricted maximum likelihood (DFREML) with animal model analysis (Boldman et al., 1993) using records to estimate variance and covariance components. Local convergence was considered attained when the variance of the -2log likelihood in the simplex was less than 10^{-6}. Global convergence was considered attained when the -2log likelihood did not change to the third decimal after restarting. The assumed animal model was:

$$Y = X\beta + Z_a a + Z_c c + e \qquad \text{(model 3)}$$

Where,

Y is vector of observations;

X is the incidence matrix that associates the fixed effects to the observations;

B is the vector of fixed effects including litter size, year and season of kidding and doe parity on total milk yield and year and season of kidding and doe parity on litter size at birth and weaning;

Z_a is the incidence matrix that associates additive genetic random effects to the observations;

a is the vector of additive genetic effects of does;

Z_c is the incidence matrix that associates the random permanent environmental effects to the observations;

C is the vector of the permanent environmental effect of does; and

e is the vector of random errors ~ $N(0, I\sigma^2_e)$ where I is identity matrix and the residual variance is σ^2_e.

RESULTS & DISCUSSION

Least squares means for litter size at both birth and weaning and total milk yield are presented in Table 1. Estimates of variances, heritability, repeatability and genetic correlation are given in Table 2.

Litter size at birth

In the present study 17.1% of the total goats gave birth only of one kid, whereas multiple births were recorded in 82.9% of total goats (Twins: 55.7%; triple: 30% and quadruplets: 4.2%). Some authors reported different figures for litter size in different goat breeds. The percentages of single, twins, triplets and quadruplets were 24.5, 59.2, 15.3 and 1.0% in Boer goats (Cambell, 1994); 40.6, 50.4, 8.0 and 1.0% in Korean native goats (Song et al. 2006), respectively. Overall mean for LSB obtained in this study was 2.10 kids, which is in contrary to that early report by Abdel-Raheem (1998) working on the same herd. It was observed that triplets and quadruplets were increased during the period of the present study. The birth type ratios were 17, 56, 23 and 4% for single, twins, triplets and quadruplets, respectively. Mean litter size compared favorably with reports of other workers on the Zaraibi goat. Litter size at birth was affected ($p<0.0001$) by year and season of kidding and parity. It was observed that there was an increase (Table 1) in litter size at birth as parity progresses until the fourth parity. This may be due to improved efficiency of reproduction as the doe matures (Levasseur and Thibault, 1980). Secondly, the management system permitted to cull does with low litters, which could partially account for the significant increase in litter size. It must be stressed that litter size is not directly influenced by management only but by both genetic and environmental factors (Wilson et al., 1989). Steine (1975) in Norway found larger litter size in goats kid during December/January season.

Heritability estimate obtained in this study (Table 2) for LSB was lower (0.08) than the earlier estimate of Abdel-Raheem (1998) for the same herd (0.10). Moreover, the estimate was higher than those reported by (Mourad, 1994; 0.017; Ricordeau et al. 1981; 0.02 to 0.03) and Wilson et al. (1989) for other goat breeds.

The results showed that selection would lead to improve litter size at birth. However, this may lead to a higher incidence of triplets and quadruplets and it should be evaluated in terms of pre-weaning survival of kids, dystocia, kidding interval and birth weight (Odubote, 1996). In the present study, no cases observed with problems associated to multiple births in the research station herd.

Repeatability estimates obtained for litter size at birth, in the present study, was 0.15±0.04, which conform with the genetic principals that repeatability sets an upper limit for heritability estimate (Odubote, 1996). Repeatability in this study was also higher than estimates reported by Mourad (1996), being 0.06 for crossbred of Common African with Alpine in Rwanda and by Mourad (2001) being 0.01 in Alpine goats. The results of this study suggests that culling of unproductive animals might be the most important management practice to increase the litter size at birth.

Litter size at weaning

The overall mean obtained in this study for litter size at weaning was 1.60 kids. This result was higher than the figure reported by Song et al. (2006) of 1.31 kids for Korean native goats. Litter size at weaning was affected ($p<0.0001$) by year and season

Table 1. Least square means ± standard errors for litter size at birth (LSB), litter size at weaning (LSW) and total milk yield (TMY) in Zaraibi goats.

Items	No	LS B	LSW	TMY
		LSM ± SE	LSM ± SE	LSM ±SE
Overall mean	4784	2.10±0.01	1.60±0.01	253.14±1.52
Year of kidding		**	**	**
1987	36	2.04±0.29 [a]	1.28±0.34 [dc]	200.35±36.16[fhg]
1988	76	2.12±0.08 [abc]	1.40±0.10 [dc]	178.65±10.3[1kj]
1989	147	1.92±0.06[bc]	1.57±0.07 [bc]	297.12±7.5[cb]
1990	178	1.89±0.05[c]	1.37±0.06 [dc]	338.35±6.8[a]
1991	187	2.02±0.05 [abc]	1.93±0.06[a]	355.62±6.68[a]
1992	174	2.19±0.05 [a]	1.73±0.06 [ba]	270.31±6.92[cbd]
1993	327	2.33±0.04 [a]	1.23±0.04 [d]	263.68±5.09[ed]
1994	290	2.33±0.04 [a]	1.86±0.05[a]	352.19±5.3[a]
1995	255	2.31±0.04 [a]	1.87±0.05[a]	307.33±5.62[b]
1996	253	2.82±0.04 [a]	1.75±0.05 [ba]	241.54±5.64[feg]
1997	309	2.18±0.04 [abc]	1.22±0.04[d]	223.43±5.12[ihg]
1998	284	2.171±0.04 [ab]	1.77±0.05 [ba]	248.52±5.32[fed]
1999	316	2.16±0.04 [abc]	1.74±0.04 [ba]	261.62±5.05[ed]
2000	286	2.09±0.04 [abc]	1.51±0.05 [bc]	254.87±5.30[fed]
2001	271	2.18±0.04 [abc]	1.73±0.05 [ba]	195.05±5.45[ikj]
2002	237	2.32±0.05 [a]	1.89±0.05[a]	244.34±5.83[feg]
2003	234	2.14±0.05 [abc]	1.67±0.05 [ba]	227.34±5.82[fhg]
2004	297	2.29±0.04 [a]	1.79±0.04 [ba]	177.81±5.25[k]
2005	216	2.14±0.05 [abc]	1.49±0.05 [bc]	202.15±6.08[ij]
2006	216	2.25±0.05 [a]	1.79±0.06 [ba]	243.11±6.08[feg]
2007	195	2.24±0.05 [a]	1.81±0.06 [ba]	277.91±6.42[d]
Season of kidding		**	**	**
March	2837	2.21±0.02 [a]	1.61±0.02 [a]	264.07±2.48 [a]
October	1947	2.13±0.02 [b]	1.67±0.03 [b]	246.53±3.00 [b]
Parity		**	**	**
1	1614	1.92±0.02 [c]	1.39±0.03[c]	218.69±2.95 [c]
2	1183	2.14±0.02 [b]	1.64±0.03[b]	255.16±3.22 [b]
3	787	2.25±0.03 [a]	1.75±0.03[a]	266.31±3.69 [a]
4	526	2.28±0.03 [a]	1.71±0.04[ab]	269.76±4.3 [a]
≥5	674	2.23±0.03 [a]	1.71±0.04[ab]	266.57±3.94 [a]
Litter size				**
Single	823			245.83±3.65[a]
Twins	2658			258.39±2.56[b]
Triplet or more	1403			261.68±3.08[c]

of kidding, parity and interaction between year and season. It seems to be an increase (Table 1) in litter size at weaning as parity progresses until the third parity. No, number of observations; [a, b, c, d, k, I, j, g] means within each class and in each column with different superscripts ($P<0.05$). ** $p<0.0001$

Table 2. Estimates of heritability (on diagonal), genetic correlation (above diagonal) and phenotypic correlation (below diagonal) for LSB, LSW and TMY

Traits	LSB	LSW	TMY
LSB	**0.08**	0.91	0.29
LSW	0.63	**0.05**	0.28
TMY	0.08	0.14	**0.26**
Additive genetic variance	0.0335	0.3323	2133.49
Environmental variance	0.4452	45281	6158.15
Repeatability	0.15	0.09	0.31

Litter size at weaning was higher for does kidding in October than those kidding in March. These results are in agreement with that reported by Boujenane et al. (1998) and Gbangboche et al. (2006).

Heritability estimate of LSW in this study (Table 2) are higher than those reported for the same herd by Abdel-Raheem (1998; 0.02) or breed like West African Dwarf goats (Odubote, 1996; 0.03). Neopane, (2000) applied two different analysis to estimate the litter size at weaning and found the LSW in first analysis (Harvey) as 0.05±0.097 while in second analysis (REML) was lower (0.03±0.083). Estimates of repeatability for litter size at weaning found in this study (0.09) was lower than that calculated by Abdel-Raheem (1998) (0.11) working on the same herd.

Total milk yield

The overall mean of TMY was 253.14 kg, which considerably higher than that obtained by Abdel-Raheem, (1998) and Bata (1989), but close to the figure published by Hamed (2005) and Shaat et al. (2007). Total milk yield was significantly ($p<0.0001$) affected by parity. TMY increased gradually with the increase of parity until fourth parity, in the present study. Season and year of kidding affected significantly ($p<0.0001$) TMY. Means of the TMY was higher in March season compared with October season, which agree with the finding of Caricella et al. (2008). Litter size was highly significantly ($p<0.0001$) affecting TMY and the results showed that does with multiple kids produced more milk (Table 1).

Heritability estimate for TMY is presented in Table 2. The results show that heritability was moderate for total milk yield (0.26). This estimate is higher than the finding of Abdel-Raheem (1998)(0.10) who worked on part of the data used in this study. Moreover, many authors working on various breeds of goat have found different estimates being 0.14, 0.22, 0.18 and 0.24 as reported by Kominakis et al (2000) for Skopelos goat; Valencia et al., (2007) for Saanen goat; Analla et al. (1995) for Granadina goat and Rabasco et al. (1993) for Verata goat, respectively. However, Grossman et al. (1986) reported higher estimates of TMY heritability in Alpine, LaMancha, Nubian, Saanen and Toggenburg goat breeds being 0.42, 0.38, 0.45, 0.44 and 0.41, respectively. Repeatability estimates for TMY was 0.31, which is in the neighborhood of the estimates of 0.29 and 0.32 found by Portolano et al. (2001) for

Barbaresca goat and Mourad (2001) on Alpine goat. However, estimate of repeatability obtained in this study was higher than that given by Abdel-Raheem (1998) for Zaraibi goat (0.20) and lower than that reported by Valencia (2007) for Saanen goat (0.40).

Genetic correlations between litter size at birth and total milk yield, litter size at birth and litter size at weaning and litter size at weaning with total milk yield were positive, being 0.29, 0.91 and 0.28, respectively which are higher than those published by Ligda et al. (2000) on Chios sheep and Hamann et al., (2003) on East Friesian sheep. Discrepancies among studies included litter size and total milk yield of goats may be attributed to differences in fixed factors, relationships between litter size, endocrine profiles and total milk yield (Browing et al., (1995).

CONCLUSIONS

This study has shown the importance of some non-genetic factors on TMY, LSB and LSW which could be accounted for genetic evaluations. An estimate of heritability and repeatability of traits is important in a breeding program because it determines at what stage the selection would affect the subsequent herd performance. Heritability and repeatability estimates obtained from LSB and LSW were low, indicating that selection for LSB and LSW will take a long time. While heritability and repeatability for TMY was moderate. Genetic correlation between LSB, LSW and TMY were positive, which indicate that the selection for one trait such as total milk yield may tend to improve the others, despite that heritability for LSB and LSW in this study were low.

REFERENCES

Abdel-Raheem, A.A., **(1998).** Genetic studies on Zaraibi goats. Ph.D. thesis, Fac. of Agric, Ain Shams, Univ., Egypt, PP.38-55.

Adu, I.F., Odeniyi, A.O and Taiwo, B.B.A., (1988). Production characteristics of a herd of west African Dwarf goats at Ubiaja, Bendel State of Nigeria. In: O.B. Smith and Bosman, H.G. (Editors), Goat production in the humid tropics. Proceedings of a workshop at the University of Ife, Ile-Ife, July 1987, pp 140-144.

Analla, M., I. Jimenez-Gamero, A.Munoz-Serrano, J.M.Serradillo, and A. Falagans, **(1995)** Estimation of genetic parameters for milk yield and protein contents of milk from Murciano-Granadino goats. J.Dairy Sci. 79:1895-1898.

Bata, S.S., **(1989).** Phenotypic and genetic parameters for of some productive triats of Zaraibi goats. Ph.D. thesis, Fac. of Agric, Al-Azhar, Univ., Egypt Pp 67-174.

Boldman, K.G., L.A. Krises, L.D. Van velck, C.P. Van Tassell and S.D. Kachman **(1993).** A Manual for use of MTDFREML. A set of programs to obtain estimates of variances and covariances. (DRAFT). US. Department of agriculture, agricultural research service, Clay center, NE. pp.120

Boujenane, I. D. berrada, S. Mihi, M. Jamai, (1998). Reproductive performance of ewes and preweaning growth of lambs from three native Moroccan breeds mated to rams from Moroccan and improved breeds. Small. Rumin. Res., 27: 203-208.

Browing, R.Jr; ML. Leite-Browning and T. Sahlu (1995). Factors affect standardized milk and fat yields in Alpine goats. Small Ruminant Research., 18: 173-178.

Carnicella D., M. Dario, Maria Consuelo Caribe Ayres, V. Laudadio and C. Dario (2008). The effect of diet, parity, year and number of kids on milk yield and milk composition in Maltese goat. Small. Rumin. Res., 77: 71-74.

Gbangboche, A.B, M. Adamou-Ndiaye, A.K.I Youssao, F. Farnir, J., Detilleux, F.A., Abiola, P.L Leroy, (2006). Non-genetic factors affecting the reproduction performance, lamb growth and productivity indices of Djallonke sheep. Small. Rumin. Res., 64: 133-142

Grossman. M., R.L., Fernando, W.., Mohammad, Ali and R.D., Shanks, (1986). Correlations between parities for lactation traits in United States dairy goats. J. Dairy Sci. 69: 1917-1921.

Hamann, H., A. Horstick, A. Wessels and O. Distl (2003). Estimation of genetic parameters for test day milk production, somatic cell score and litter size at birth in East Friesian ewes. Livestock Production Science. 87:163-160.

Hamed, A., (2005). Non genetic factors and genetic parameters for total milk yield and growth in Zaraibi goats. M.Sc. thesis, Fac. of Agric, Al-Azhar, Univ., Egypt PP56-96.

Kominakis, A., E. Rogdakis, CH. Vasiloudis and O. Liaskos, **(2000).** Genetic and environmental sources of variation of milk yield of Skopelos dairy goats. Small. Rumin. Res. 36: 1-5.

Levasseur, M. and Thibault C., **(1980).** Reproductive life cycles. In: E.S.E. Hafez (Editor), reproduction in farm animals, Lea and Febiger, 4^{th} edn., Philadelphia, PA, pp 130-149.

Ligda, Ch., G. Gabriilidis, Th. Papadopoulos and A. Georgoudis (2000). Estimation of genetic parameters for production traits of Chios sheep using a multi trait animal model. Livestock Production Science 66:217-221.

Mourad, **M., (1994).** Estimation of genetic and phenotypic parameters of some reproductive traits of African Common goats in Rwanda. Small. Rumin. Res., 15: 67-71.

Mourad, **M., (1996).** Estimation of repeatability of litter size of Common African goats and cross with Alpine in Rwanda. Small. Rumin. Res., 19: 263-266.

Mourad, **M., (2001).** Estimation of repeatability of milk yield and reproductive traits of Alpine goats under an intensive system of production in Egypt. Small. Rumin.Res., 42: 1-4.

Neopane, S. P**. (2000).** Selection for improvement of the productivity of Hill goats in Nepal. Proceedings of the 7th International Conference on Goats. Organized by International Goat Association, France, pp 206-208.

Odubote, I. k, (1996). Genetic parameters for litter size at birth and kidding interval in the West African Dwarf goats. Small. Rumin. Res., 20: 261-265.

Odubote, I.k., Akinokun, J.O. and Ademosun, A.A., **(1992).** Production characteristics of West African Dwarf goats under improved management system. In: A.AO. Ayeni and H.G.Bosman (EDITORS), systems goat production. Proceedings of an international workshop held at the Obafemi Awolowo University, Ile-Ife, 6-9 july 1992, pp. 202-207.

Portolano, B., Montalbano, L and Militi, W, **(2001).** Genetic and environmental source of variation for milk yield traits in Barbaresca siciliana breed. Small. Rumin. Res., 41: 195-202.

Rabasco, A., J.M. Serradilla, J.A. Padilla and A. **Serrano (1993).** Genetic and non-genetic sources of variation in yield and composition of milk in Verata goats. Small. Rumin. Res.,11: 151-161.

Ricordeau, C., Razungles, J., Tchamittchian, C., Lefevre, C. and Brunel, J.C., **(1982).** Genetic and phenotypic characters of growth and reproduction of cross-bred ewes of Cher Romanov F1 to f4. An. Genet. Sel. Anim., 14: 327-352.

SAS. 1999. SAS/STAT User Guide. SAS Ins., Inc., Cary, NC.

Shaat, I, Mabrouk, M, Abdel-Raheem, A and Hamed, (A 2007). Estimations of heritability and correlation for milk and growth traits in Zaraibi goat. Egyptian J. Anim. Prod., 44(2): 161-171.

Song, H.B. I.H.JO, H.S.Sol, **(2006).** Reproductive performance of Korean native goats under natural and intensive conditions. Small. Rumin. Res., 65: 284-287.

Steine, T.A., (1975). Fkorar med innverknad pa oekonomisk viktige eigenskapar hos geit (Factors affecting characters of economic importance in goats). Meldinger fra Norges Landbrushoegskole 54(2), 30.

Valencia M., J. Dobler, H.H. Montaldo (2007). Genetic and phenotypic parameters for lactation traits in a flock of Saanen goats in Mexico. Small. Rumin. Res., 68:318-322.

Van Vlaenderen, G., (1989). Togo: a study of Village level sheep and goat development. In: sheep and goat meat production in the humid tropics of West African. Animal Production and Health paper FAO, Rome, 70: 142-169.