Estimation of Genetic parameters for post-weaning growth traits of Gabali rabbits in Egypt

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Abstract

Records on 1251 rabbits produced in the period from 2003 to 2006 fathered by 48 sires and mothered by 114 dams of Sinai Gabali were used to evaluate body weight at weaning (BW4), 8 (BW8) and 12 weeks (BW12) as well as daily gain during the periods from 4-8 (DG4-8) and 8-12 (DG8-12) weeks of age. Data were analyzed using a multi-trait animal model to estimate additive (heritability), common litter effects and residual variances. Model included the fixed effects (sex, parity, litter size born alive) and random effects (additive genetic and common litter) in addition to random error.

Estimates of heritability were 0.05, 0.38 and 0.20 for BW4, BW8 and BW12, respectively, while these estimates were 0.23 and 0.19 for DG4-8 and DG8-12, respectively. The estimate of common litter effects for body weight at weaning was higher (77%) compared to that at later ages (36% at 8 weeks and 47% at 12 weeks). Estimates of direct genetic correlation ranged from 0.08 to 0.89 among body weight traits, while, the estimates of common litter correlations were low among the same traits (ranged from – 0.1 to 0.02). Most estimates of environmental correlations were positive and higher than those of additive genetic and common environmental correlations.

In practice, it is safely to give an attention for Sinai Gabali breed to save these animals from extinction since these animals have great genetic diversity for post-weaning growth.

Keywords: common litter effect, genetic correlations, heritability

Introduction

Native breed of Gabali rabbits raised under the Egyptian conditions is characterized by heavy body weight of 3.5-4.5 kg (Galal and Khalil 1994), their ability to afford environmental conditions and high resistant to many diseases. Recently, Iraqi et al (2007) reported that Gabali rabbits had superiority in total milk yield (3486 g) and fat in milk (25%) comparable to V-line (3042 g and 23%, respectively). This breed till now did not get enough genetic study to be acquainted in genetic improvement program particularly for improving post-weaning growth traits. Some authors have made studies on genetic parameters of several traits of rabbits. An earlier review article written by Khalil et al (1986) concerning this subject. However, most of these studies have used the sire or dam model of analysis. Moreover, most of these studies have neglected the effects of common litter effects on post-weaning growth traits in rabbits, although, these effects may be more important than additive genetic effects (Ferraz et al 1992; Ferraz and Eler 1996; Iraqi et al 2002, Khalil et al 2002; Iraqi et al 2006). Several other studies have used mixed models, like Lukefahr et al (1992). Nowadays, the animal model is the best model because it increases the accuracy of selection when the genetic and environmental correlations between traits as well as other relevant information are included.

The main objectives of the present study were to estimate genetic parameters (e.g. variance components, heritability and all genetic and non-genetic correlations) for body weight at weaning (4-weeks), 8 and 12 weeks of age and daily gain during the periods from 4-8 and 8-12 weeks of age in Gabali rabbits.

Materials and methods

This experiment was carried out in the period from 2003 to 2006at the Rabbit Farm of the Department of Animal Production, Faculty of Agriculture at Moshtohor, Benha University, Egypt in a crossbreeding project involving Sinai Gabali and V-line rabbits. Animals used in this study were Sinai Gabali breed bought from Bedouins living in the north of Sinai. Fifteen bucks and 40 does were used as the base population for this work. Bucks and does were individually housed in wire cages with standard dimensions arranged in one-tire batteries allocated in rows along the rabbitry with passages suitable for service. In the rabbitry, temperature ranged from 15 to 35°C, the relative humidity ranged from 30 to 70 % and photoperiod was 16 L: 8D. Each buck was randomly mated with 3 or 4 does based on available numbers (at 4.5 month of age). Does were mated in the bucks' cage and lodged individually. Sire-daughter, full and half sib matings were avoided. Each doe was palpated 10 days thereafter to detect pregnancy. Those which failed to conceive were returned to the same mating-buck at the day of test. Metal nest boxes were provided at 25 days after fertile mating. Within 24 hours of kindling, does and their litters were weighed and recorded. At weaning age (28 days after kindling), the young rabbits were separated from their dams' cage, sexed, weighed, ear-tagged and lodged in collectives cages in groups having automatic water fountains. Breeding animals and young litters were fed *ad libitum* a pelleted rabbit ration containing 15.8 % crude protein, 14.9% crude fiber, 2.5% fat. Cages of all does were cleaned and disinfected before each kindling regularly. Manure was collected daily and removed outside the rabbitry. All animals were treated and medicated similarly throughout the work period under the same managerial and climatic conditions.

Data and models of analysis

Data of individual body weight for 1251 animals were recorded at weaning (BW4), 8 (BW8) and 12 weeks (BW12) of age and daily gain were computed at intervals of 4-8 (DG4-8) and 8-12 (DG8-12) weeks of age. The rabbits were produced from 48 bucks and 114 does of Sinai Gabali breed (Table 1).

Table 1. Structure of the data analyzed for Sinai Gabali Breed

Item	Number

Sires without records (in the base population)	15
Sires with records	33
Dams without records (in the base population)	40
Dams with records	74
Animals weaned	1251
Total number of animals in the pedigree file	1306

Data were analyzed using multi-trait animal model (three traits of body weight at the same time and two traits for daily gain at another time) using MTDFREML programs of Boldman et al (1995). Variances and covariances obtained by REML method of VARCOMP procedure (SAS 1996) were used as starting (guessed) values for the estimation of variance and covariance components. Analyses were done according to such general model:

$$y = Xb + Z_1a + Z_2c + e,$$

where:

y = vector of observation;
X= incidence matrix of fixed effects;
b = vector of fixed effects including parity (7 levels), season-year combination (11 levels), sex (2 levels) and litter size born alive at birth (11 levels);
Z_1 and Z_2 = incidence matrices corresponding to random effects of additive (a) and common litter (c, dam x litter size at birth x parity combination), respectively;
e = vector of random errors.

All estimates of BLUP were derived by multi-trait animal model (MTAM) using the MTDFREML program (Boldman et al 1995) adapted to use the sparse matrix package, SPARSPAK (George and Ng 1984). The MTAM considered the relationship coefficient matrix (A^{-1}) among animals in the estimation (Boldman et al 1995). Convergence was assumed when the variance of the log-likelihood values in the simplex reached <10^{-9}. Occurrence of local maxima was checked by repeatedly restarting the analyses and checking that the point of convergence did not change. Heritability was computed as:

$$h^2 = \frac{\sigma_a^2}{\sigma_p^2}$$

where σ_a^2 and σ_p^2 are the variances due to effects of additive genetic and phenotypic ($\sigma_a^2 + \sigma_C^2 + \sigma_e^2$), respectively.

Results and discussion

Means, standard deviations and coefficient of variability for body weight traits in Sinai Gabali rabbits are given in Table 2 to characterize phenotypically the population used.

Table 2. Means, standard deviations (SD) and coefficients of variation (V%) for

post-weaning growth traits in Sinai Gabali rabbits.

Trait	Mean	SD	V%
Body weight at:			
4 weeks (BW4)	483.9	155.4	32.1
8 weeks (BW8)	1134.3	276.7	24.4
12 weeks (BW12)	1838.2	342.7	18.7
Daily gain during:			
4-8 week (DG4-8)	23.3	8.91	38.2
8-12 week (DG8-12)	25.4	11.3	44.6

Heritability (h^2)

Estimates of h^2 shown in Table 3 were 0.05, 0.38 and 0.20 for BW4, BW8 and BW12 traits, respectively, 0.23 and 0.19 for DG4-8 and DG8-12, respectively. Moderate heritabilities obtained here for body weights and gains were similar to those estimates obtained in some studies in Egypt (Khalil et al 2000; Iraqi et al 2002), in Spain (Estany et al 1992; Gomez et al 2000), and in Brazil (Ferraz and Eler 1994 and 1996). While, these estimates were higher than results of 0.007, 0.043 and 0.082 for BW4, BW8 and BW11 weeks of age, respectively, as reported by Ferraz et al (1992). Also, Lukefahr et al (1996) reported heritability of 0.04 for weaning weight based on animal model estimates. Khalil et al (2000) and Iraqi et al (2002) found direct heritability of 0.09 and 0.26; 0.10 and 0.25 for body weight at 8 and 12 weeks, respectively. Recently, Gad (2007) studied the post-weaning growth traits in Gabali rabbits in North-western coast of Egypt. He found that estimates of h^2 were 0.11, 0.10 and 0.0 for BW4, BW8 and BW12 traits, respectively. Conversely, Akanno and Ibe (2005) with NZW and Dutch breeds rabbits found that higher heritability estimates (0.43 for 6-week body weight and 0.36 for 12-week body weight, respectively) than presented in this study. High estimates of h^2 (0.38 for BW8) in this study could be an encourage factor to be select the Gabali breed at 8 week of age. Another point of view, higher estimates of h^2 in Gabali breed may be due to this breed are not subjected to any program of selection because there are a small numbers of breeding animals are available. Now, there are a few rabbitry farms of breeding stations (i.e. in Faculty of Agriculture at Moshtohor, Benha University, Egypt) introduced the purebred rabbits of Sinai Gabali to be distributed the small holders of rabbits and some breeding stations of research centers in Egypt.

Table 3. Proportions and standard error of additive genetic **(h^2) ,** common litter effect (c^2) and error (e^2) relative to phenotypic variance for post-weaning growth traits in Sinai Gabali rabbits.

Trait	h^2± SE	c^2 ± SE	e^2 ± SE
Body weight:			
BW4	0.05±0.059	0.77± 0.034	0.18±0.037
BW8	0.38±0.027	0.36±0.048	0.26±0.029
BW12	0.20±0.007	0.47±0.016	0.33±0.022
Daily gain:			
DG4-8	0.23±0.141	0.44±0.072	0.34±0.093
DG8-12	0.19±0.193	0.46±0.098	0.34±0.122

$^+$*Traits as defined in table 2.*

Proportion of common litter effects

The estimate of common litter effects (c^2) to the phenotypic variance for body weight at weaning in Table 3 was higher (77%) compared to that at later ages (36% at 8 weeks and 47% at 12 weeks). The ratios of common litter effects were always higher than the heritabilities, and the common litter effects decrease over the time. These tendencies agree with the results reported by McNitt and Lukefhar (1996) and García and Baselga (2002).

The proportions in the present study were 44% for DG4-8 and 46% for DG8-12. The same trend was observed (ranging from 31 to 50% and 41 to 79% for post-weaning body weights, respectively) by Ferraz et al (1992) and Iraqi et al (2002). However, percentages of c^2 in this study were higher than those reported by Gad (2007) with Gabali rabbits, which ranged from 15% for weaning weight to 28% for 8-week weight. This indicates the weights of the Gabali rabbits in this study were subjected to a high variability in common litter effects at early age (at weaning) because individuals in the same litter were being nursed by the same dam and reared in the same cage. Lukefahr et al (1996) found that c^2 accounted for 72% of the phenotypic variance for weaning weight of rabbits. Su et al (1999) also found that c^2 accounted for 60% of the total variance for daily litter gain during the period from one to 35 days of age in Danish White rabbits. On the other hand, estimates of c^2 were higher than those of additive and residual variance (except for body weight at 8 weeks). Also, Lukefahr et al (1996) reported that estimates of c^2 for weaning weight and mature weight were considerably larger than either additive or residual variance. Moreover, Ferraz and Eler (1996) and McNitt and Lukefahr (1996) noted that common litter effects were important for growth traits, and they recommended that they should be considered in animal models of such traits. Argente et al (1999) reported higher common litter effects with a range between 0.52 and 0.58.

Correlations

Estimates of genetic (r_G), common litter (r_C) and environmental (r_E) correlations between body weight traits and daily gain traits are given in Table 4. Estimates of r_G were very different (ranged from 0.08 to 0.89) when the multi-trait animal model was used. Similarly, there are a wide variations in estimates of r_G between body weight traits (ranged from -0.50 to 1.25 in Giza White and from 0.85 to 1.34 in Bouscat rabbits) as reviewed by Khalil et al (1986). Based on animal model, Iraqi et al (2002) estimated r_G between the two body weight traits at 8 and 12 weeks of age which was high and positive in both NZW and Z-line rabbits (0.73 and 0.69, respectively). Recently, Gad (2007) found that genetic correlations were low (0.01 between BW8 and BW12) and high (0.61 between BW4 and BW8) in Gabali rabbits using animal model analysis. Due to the highest r_G (0.89) obtained between body weight at 8 and 12 weeks of age, one can conclude that selection for body weight is more effective at 8 weeks to improve post weaning growth in Gabali rabbits. Also, for daily gain, the estimate of r_G between DG4-8 and DG8-12 was 0.56.

Table 4. Genetic correlation (r_G), common litter correlation (r_C) and environmental correlation (r_E) estimates for post weaning growth traits in Gabali rabbits

Traits correlated	r_G	r_C	r_E
Body weight:			
BW4&BW8	0.52	0.02	0.91
BW4&BW12	0.08	-0.10	0.68
BW8&BW12	0.89	0.10	0.71
Daily gain:			
DG4-8&DG8-12	0.56	0.19	0.24

Estimates of r_C were low and positive ranging from -0.10 (between BW4 and BW12) to 0.02 (between BW4 and BW8). Iraqi et al (2002) found that estimate of r_C between BW8 and BW12 were 0.49 and 0.64 in New Zealand White and Z-line rabbits, respectively. Also, Iraqi (2003) found that estimate of r_C between BW4 and both BW8 and BW12 was 0.57 and 0.50, in NZW rabbits, respectively. While, it was 0.68 between BW8 and BW12. Gad (2007) estimated higher r_C (0.73 to 0.92) between body weight at different ages in Gabali rabbits than comparable the estimates in the present study. All estimates of environmental correlations between body weights were positive and higher than r_C.

Conclusions

- Since the estimate of heritability was higher for body weight at 8 weeks than other ages as well as the highest genetic correlation (0.89) was obtained between 8 and 12 weeks, selection of animals will be more effective at 8 weeks of age to improve post weaning growth traits in Gabali rabbits.

- Because the common litter effect is very important for post-weaning growth traits, one can conclude that the common litter effect should be included in the genetic evaluation of breeding programs.

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