GENETIC CORRELATION BETWEEN LIVEWEIGHT AND OVULATION RATE IN RABBITS

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INTRODUCTION

Very little is known about the estimates of genetic correlations between growth traits and ovulation rate in prolific species. In rabbits, Agea et al. (2007) gave a phenotypic correlation of 0.15 between weaning weight and OR; Argente et al. (1999) and Agea et al. (2007) reported phenotypic correlations of 0.10 of 0.29 between OR and mature weight, respectively, but not genetic correlations have been published hitherto with the exception of some preliminary results of this work (Ibáñez et al. 2006). In mice, Land (1970) has reported genetic correlations of 0.33 and 0.45 between ovulation rate and body weight at 6 and at 8 weeks respectively, but these estimates have large standard errors. In swine, Genetic correlations were reported by Newton et al. (1977) and Rosendo et al. (2007) between daily gain and ovulation rate (-0.13 and 0.03, respectively).

The aim of this study is to estimate genetic parameters for ovulation rate and growth traits in rabbits.

MATERIAL AND METHODS

Animals

The animals used in the experiment came from a line selected for ovulation rate during their second gestation. Ibáñez et al (2006) have previously described the population structure and the selection procedures.

Does were mated first at 18 weeks of age and 10 days after each parturition thereafter. A laparoscopy was performed on all does during their second gestation, 12 d after mating, and the number of corpora lutea and weight of the doe were recorded. A total of 675 laposcopies were performed. The laparoscopic technique is described in detail by Santacreu *et al.* (1990).

The animals were kept under constant photoperiod of 16:8 h and controlled ventilation. Young rabbits for all parities were weaned at 4 wk old, weighed and placed in flat-deck cages, 8 rabbits per cage, and fed ad libitum with a commercial diet. The fattening period was 5 weeks. At 9 wk old, rabbits were weighed and selected animals were placed in individual flat-deck cages and fed ad libitum with a commercial diet and they stead there up to their reproductive age; the other rabbits were slaughtered for commercial purposes. A total of 15,151 rabbits were recorded.

Does were slaughtered during their last gestation (3^{rd} to 6^{th} gestation) and number of corpora lutea was recorded. A total of 1,184 records from 675 females was taken between second and last gestation.

Traits

Ovulation rate (OR), measured as the number of corpora lutea. Individual weight at 4 wk old (IW4), individual weight at 9 wk old (IW9), individual growth rate (IGR= IW9-IW4) and individual female weight at laparoscopy time (WOR).

Statistical analysis

All analyses were performed using Bayesian methodology. A repeatability model was used to analyze OR:

$$y_{ijklm} = YS_i + PO_j + L_k + a_{ijkl} + p_{ijkl} + e_{ijklm}$$

where: y_{ijklm} is OR; YS_i is the effect of year-season of the mating day (25 levels); PO_j is the effect of the parity order (5 levels); L_k is the effect of lactation status (2 levels); a_{ijkl} is the additive value of the animal, p_{ijkl} is the permanent environmental effect and e_{ijklm} is the residual effect.

For individual weights and IGR, the animal model used was:

$$y_{ijklm} = YS_i + PO_j + ßLS + p_{ijk} + c_{ijkl} + a_{ijklm} + e_{ijklm}$$

where: y_{ijklm} = is IW4, IW9, IGR; YS_i is the fixed effect of year-season in which the animal was growing (21 levels); PO_j is the effect parity in which the animal was born (6 levels); a_{ijklm} is the additive value of animal; p_{ijk} is the random female effect between parities (645 levels); c_{ijk} is the common litter effect (1982 levels); *LS* is the covariate litter size at birth and e_{ijklm} is the residual effect.

For WOR, the model used was:

$$y_{ijk} = YS_i + L_j + a_{ijk} + e_{ijk}$$

where: y_{ijk} is WOR; YS_i is the effect of year-season of the mating day (25 levels); L_j is the effect of lactation status (2 levels); a_{ijk} is the additive value of the animal and e_{ijk} is the residual effect.

Univariate analysis for OR and bivariate analyses always including OR, were performed. Marginal posterior distributions were estimated using the Gibbs sampling algorithm. Gibbs sampling was combined with the data augmentation step to sample from a predictive distribution of missing data (Sorensen and Gianola, 2002). After some exploratory analysis, two chains were used, each of 1,000,000 iterations, with a burning period of 200,000 iterations. Only every 100th iteration was saved. Convergence was tested using the Z criterion of Geweke and Monte Carlo sampling errors were computed using time-series procedures as described by Geyer (1992).

RESULTS AND DISCUSSION

Raw means, coefficients of variation and number of data are presented in Table 1. The mean values of OR, IW4, IW9, IGR and WOR were within the range of those presented in the literature for rabbits (Blasco et al. 1993, Piles and Blasco, 2003, Ibáñez et al, 2005).

Table 1 – Raw means, coefficients of variation (CV) and number of data (N) for ovulation rate (OR), individual weight at 4 wk old (IW4), individual weight at 9 wk old (IW9), individual growth rate (IGR), individual female weight at laparoscopy (WOR)

Trait	Means	CV	N
OR	15.75	0.15	1,184
IW4	0.52	0.18	15,151
IW9	1.76	0.11	14,361
IGR	1.24	0.13	14,354
WOR	4.33	0.83	676

Table 2 shows the features of the estimated marginal posterior distributions of heritability for the traits studied. All Monte Carlo standard errors were very small and lack of convergence was not detected by the Geweke test in all the analyses.

The heritability of OR was 0.17 and the marginal posterior distribution was symmetric. This heritability was at least 0.10 with a probability 95%. The value of heritability for our study was lower than the value of 0.23 cited by Blasco et al. (1993), although this research was made with few animals and s.e. were large.

The heritabilities of IW4, IW9 and IGR were low and in all cases, the marginal posterior distributions were symmetric. The heritability value of IW4 was 0.09. This result is in agreement with previous studies of Estany et al. (1982) and Garcia & Baselga (2002) of 0.15 and 0.13, respectively. However, Lukefahr et al. (1996) found a lower value (0.04).

The estimate of heritability of IW9 (0.12) was lower than the heritabilities estimated in rabbits by Estany et al.(1992), and Garcia & Baselga (2002) who provide a heritability of 0.19 and 0.20, respectively. Lukefahr et al. (1996) give a similar value (0.12).

The heritability of individual gain rate was 0.12, in agreement with Piles and Blasco (2003). Johnson et al. (1988) reported heritabilities of 0.22 for individual gain rate from 28 to 56 day and Rochambeau et al (1997) and Lukefahr et al. (1996) presents heritabilities of 0.23 and 0.17 for individual gain rate for 28 to 70 days, respectively.

The heritability for WOR was high, 0.56 and it was at least 0.43 with a probability 95%. We do not have estimate of heritability of WOR in rabbits in the literature. A value of, 0.53, was reported by Lukefahr & Hamilton (1997) for doe body weight at birth.

In general, estimations of heritabilities for individual body weight tend to increase with age, with an average value below of 0.12 for individual weaning weight and above 0.50 for slaughter weight; this is in according with the review of Rochambeau (1997).

Table 2 - Features of the estimated marginal posterior distributions of the heritability (h^2) for ovulation rate (OR), individual weight at 4 wk old (IW4), individual weight at 9 wk old (IW9), individual growth rate (IGR) and individual female weight at laparoscopy (WOR)

Trait	Median	$HPD_{95\%}$	$K_{95\%}$	$P_{0.10}$
OR	0.17	0.08 , 0.27	0.10	0.94
IW4	0.09	0.04 , 0.15	0.05	0.37
IW9	0.12	0.07 , 0.19	0.08	0.79
IGR	0.11	0.06 , 0.17	0.07	0.71
WOR	0.56	0.41 , 0.70	0.43	1.00

$HPD_{95\%}$: highest posterior density region at 95%; $k_{95\%}$: limit of the interval [k, 1] with probability of 95%; $P_{0.10}$: probability of $h^2 > 0.10$.

Estimates of genetic correlation between OR and growth traits are given in Table 3. The estimates of genetic correlation between ovulation rate and individual weights were small in magnitude (from 0.11 to 0.28). The genetic correlation between OR and IW4 was 0.11. Similar results were obtained for the correlation between OR and IGR and the genetic correlation between OR and WOR was high and positive, 0.49. All high posterior density regions for genetic correlations between OR and growth traits were large. There are no works about genetic correlations between OR and weights in rabbits. In swine, Young et al. (1974) and Rosendo (2007) report that OR was not correlated with weaning weight (ranging of 0.07 to 28) and with daily gain (ranging 0.12 to 0.15). In conclusion, genetic correlations between ovulation rate and growth traits are low but positive, except for WOR.

Table 3 - Features of the estimated marginal posterior distributions of the genetic correlations between ovulation rate (OR) and growth traits

Trait	Median	HPD95%	P	$P_{0.10}$
OR-IW4	0.11	-0.26 , 0.50	0.71	0.68
OR-IW9	0.23	-0.13 , 0.56	0.90	0.81
OR-IGR	0.28	-0.12 , 0.63	0.93	0.86
OR-WOR	0.49	0.22 , 0.74	1.00	1.00

$HPD_{95\%}$: highest posterior density region at 95%; P: probability of the correlation >0; $P_{0.10}$: probability of the correlation > 0.10 when positive, or <-0.10 when negative; IW4: individual weight at 4 wk old, IW9: individual weight at 9 wk old, IGR: individual growth rate, WOR: individual female weight at laparoscopy.

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