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SELECTION FOR OVULATION RATE IN RABBITS. PRELIMINARY RESULTS

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SELECTION FOR OVULATION RATE IN RABBITS. PRELIMINARY RESULTS

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ABSTRACT

An experiment of selection for ovulation rate was carried out. Animals were derived from a synthetic line first selected for litter size for 12 generations, then for uterine capacity for 11 generations, and then 5 generations in which selection was relaxed. Selection was based on the phenotypic value of ovulation rate with a selection pressure on does of a 30%. Males were selected from litters of does with the highest ovulation rate. Males were selected within sire families in order to reduce inbreeding. Ovulation rate was measured in the second gestation by a laparoscopy, 12 days after mating. Each generation had about 80 females and 20 males. Results of the first and second generation of selection were analysed using Bayesian methods. Marginal posterior distributions of all unknowns were estimated by using Gibbs Sampling. Heritabilities of Ovulation rate (OR), number of implanted embryos (IE) and litter size (LS) were 0.50, 0.28 and 0.08 respectively. Genetic correlations between OR and IE and between OR and LS were 0.86 and 0.65 respectively. Response to selection for OR in both generations of selection was 0.97 ova. Correlated response in IE and LS were 0.79 and 0.32 respectively. These results have wide high posterior density intervals, and should be considered as preliminary results. If results are confirmed in further generations, selection for ovulation rate might be an alternative to improve litter size.

Key words: selection, ovulation rate, Bayesian analysis, litter size.

INTRODUCTION

Selection for ovulation rate has been proposed as an indirect way to improve litter size in pigs and mice. However, the experiments of selection for ovulation rate although improving ovulation rate, did not lead to a correlated response for litter size. Nevertheless, this result is based in few experiments; two in mice (Lᴀɴᴅ and Fᴀʟᴄᴏɴᴇʀ, 1969; Bʀᴀᴅғᴏʀᴅ, 1969) and two in pigs (Jᴏʜɴsᴏɴ, 1992; Bɪᴅᴀɴᴇʟ *et al.*, 1998) and no experiments have been carried out in rabbits. Besides, several experiments in pigs were successful by increasing litter size through indirect selection on its components. Lᴀᴍʙᴇʀsᴏɴ *et al.* (1991) increased litter size for direct selection on litter size in a line previously selected for ovulation rate, Jᴏʜɴsᴏɴ *et al.* (1999) increased litter size using a selection index for ovulation rate and survival until 50 days of pregnancy, and Rᴜɪᴢ-

FLORES and JOHNSON (2001) improved litter size selecting ovulation rate and litter size by independent levels. It seems that when ovulation rate is high enough, selection for litter size increases uterine capacity. In this experiment we selected for ovulation rate a line previously selected for uterine capacity.

MATERIAL AND METHODS

Animals

Animals were derived from a synthetic line (V) first selected for litter size for 12 generations, then for uterine capacity for 11 generations, and then 5 generations in which selection was relaxed. Founders were chose at random. Animals were bred at the experimental farm of the Universidad Politécnica de Valencia. Selection was based on the phenotypic value of ovulation rate with a selection pressure on does of a 30%. Males were selected from litters of does with the highest ovulation rate. Males were selected within sire families in order to reduce inbreeding. Ovulation rate was measured in the second gestation by a laparoscopy, 12 days after mating (surgical technique is described with detail by ARGENTE *et al.*, 1997). Two cycles of selection were analysed. Base generation (founders) was constituted by 80 females and 34 males, the first generation by 75 females and 20 males and the second generation by 85 females and 20 males.

Traits

The following traits were analyzed: OR: ovulation rate estimated as number of corpora lutea. IE: number of implanted embryos estimated as number of implantation sites. LS: litter size (total number of kits born). All traits were measured only in the second parity with the exception of LS, which was measured up to four parities.

Statistical Analysis

The genetic analysis was based on Bayesian methods. Ovulation rate was included in all analysis to take into account the effect of selection. An animal model was fitted for the bivariate analysis of OR and IE, and a repeatability animal model for the bivariate analysis of OR and LS. The environmental effects considered in the analyses were year-season (8 levels) and lactation state of the doe (3 levels: nulliparous does, and lactating or not lactating multiparous does during pregnancy). Marginal posterior distributions of all unknowns were estimated by using Gibbs Sampling. After some exploratory analyses we used three chains of 500,000 samples each one, with a burning period of 200,000. Only one sample each 60 was saved. Convergence was tested for each chain separately using the Z criterion of Geweke. Details of the procedure can be found in SORENSEN and GIANOLA (2002).

RESULTS AND DISCUSSION

Means and standard deviations (sd) for the traits measured in the base generation were 15.3 (2.5) for ovulation rate, 12.6 (3.0) for implanted embryos and 8.9 (2.9) for litter size. The phenotypic correlations between traits were 0.51 for ovulation rate and implanted embryos, -0.26 for ovulation rate and litter size, and 0.61 for implanted embryos and litter size.

Features of the estimated marginal posterior distributions of heritabilities and genetic correlations are presented in tables 1 and 2 respectively. Marginal posterior distributions had a very small Monte Carlo error. The Geweke test did not detect lack of convergence. Posterior distributions of heritabilities of OR and IE were slightly asymmetrical, and posterior distributions of genetic correlations were highly asymmetrical. This is reflected in the different values for means and medians, and in the asymmetrical high posterior density interval around the mean.

An advantage of the Bayesian approach trough MCMC procedures is the possibility of easy construction of all kind of confidence intervals. We can find intervals of the type [k, 1] having a 95% of the probability area of the marginal posterior distribution. With these intervals we know that the probability of the trait of being lower than k is a 5%. These preliminary results do not have high accuracies, but we can state, for example, that the heritability of ovulation rate was at least 0.28 with a probability of 95% (see k-value in table 1). Heritability of ovulation rate was higher than the heritabilities estimated in rabbits by ARGENTE et al. (2000) (0.20), BOLET et al. (1994) (0.24), and BLASCO et al. (1993b) (0.21).

The heritability of litter size was low. Similar estimations were reported in rabbits (BLASCO et al., 1993a; ARGENTE et al., 2000; GARCIA and BASELGA, 2002). Number of implanted embryos had an intermediate heritability, as in BOLET et al. (1994).

There was a high genetic correlation between ovulation rate and litter size (table 2). This correlation was higher than the estimation given by BLASCO et al. (1993b) (0.36 ± 0.31). However, it is difficult to compare these results, since in both cases the estimates had low precision. In pigs and mice the available estimates of this correlation are very variable (BLASCO et al., 1993a; ROTHSCHILD and BIDANEL, 1998).

Table 1. Features of the estimated marginal posterior distributions of heritabilities.

Trait	Median	Mean	sd	HPD(95%)	k	MCse	Z
OR	0.56	0.50	0.10	0.25, 0.76	0.28	0.0006	0.33
IE	0.26	0.28	0.10	0.09, 0.51	0.14	0.0004	0.37
LS	0.08	0.08	0.04	0.01, 0.16	0.02	0.0014	-0.09

OR: Ovulation rate, IE: number of implanted embryos, LS: total number of kits born. sd: standard deviation, HPD: highest posterior density region at 95%, k: limit of the interval [k,1] containing a probability of 95%.MCse: Monte Carlo standard error, Z: Z-score of the Geweke test.

Table 2. Features of the estimated marginal posterior distributions of genetic correlations with ovulation rate.

	Median	Mean	sd	HPD(95%)	MCse	Z
IE,OR	0.90	0.86	0.11	0.64, 0.98	0.0004	-0.01
LS,OR	0.70	0.65	0.26	0.14, 0.99	0.0042	-0.10

IE: number of implanted embryos, LS: total number of kits born.
sd: standard deviation, HPD: highest posterior density region at 95%.
MCse: Monte Carlo standard error, Z: Z-score of the Geweke test.

Direct and correlated response for ovulation rate.

Table 3 contains features of the estimated marginal posterior distributions of direct response for ovulation rate and correlated genetic responses for number of implanted embryos and litter size. As before, posterior distributions had a small Monte Carlo error and the Geweke test did not detect lack of convergence. Posterior distributions were approximately normal. Direct genetic response for ovulation rate in two generations was high, near 1 ovum. In spite of the high HPD(95%), the k of the interval [k, ∞) shows that the genetic response for ovulation rate was at least 0.38 ova with a probability of 95%. Our results are in agreement with previous experiments of selection for ovulation rate in mice and pigs (BLASCO *et al.*, 1993a; BLASCO *et al.*, 1998).

Table 3. Features of the estimated marginal posterior distributions of direct and correlated genetic response to selection.

Trait	Median	Mean	sd	HPD(95%)	k	P>0	MCse	Z
OR	0.97	0.97	0.35	0.28, 1.53	0.38	1.00	0.0058	-0.64
IE	0.79	0.79	0.30	0.25, 1.42	0.32	1.00	0.0018	0.37
LS	0.30	0.32	0.19	-0.01, 0.72	0.04	0.97	0.0051	-0.08

OR: Ovulation rate, IE: number of implanted embryos, LS: total number of kits born. sd: standard deviation, HPD: highest posterior density region at 95%, k: limit of the interval [k,∞) containing a probability of 95%. P>0: Probability >0. MCse: Monte Carlo standard error, Z: Z-score of the Geweke test.

There was a correlated genetic response for litter size, although due to its wide HPD(95%) this result should be taken with caution. There are no experiments of selection for ovulation rate in rabbits. GARCIA and BASELGA, (2002) in an experiment of selection for litter size at weaning, found a correlated response on ovulation rate. Given the high correlation between OR and LS found in these provisional results, if confirmed, selection for ovulation rate will increase litter size with a higher efficiency than direct selection for litter size.

CONCLUSION

Selection for ovulation rate has been successful and might be an alternative to improve litter size.

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REFERENCES

ARGENTE M.J., SANTACREU M.A., CLIMENT A., BLASCO A., BOLET G. 1997. Divergent selection for uterine efficiency in rabbits. *J. Anim. Sci.* **75**: 2350 - 2354.

ARGENTE M.J., SANTACREU M.A., CLIMENT A., BLASCO A. 2000. Genetic correlation between litter size and uterine capacity. 7th World Rabbit Cong. Valencia-España. Vol B: 333-338.

BIDANEL J.P., TRIPART C., BLASCO A., GOGUE. 1998. Direct and correlative responses to six generations for ovulation rate and prenatal survival In Large White pigs. *49th Annual Meet. EAAP. Varsovia.*

BLASCO A., BIDANEL J.P., BOLET G., HALEY C.S., SANTACREU M.A. 1993a. The genetics of prenatal survival of pigs and rabbits: a review. *Livest. Prod. Sci.* **37**: 1-21.

BLASCO A., SANTACREU M.A., THOMPSON R., HALEY C.S., 1993b. Estimates of genetics parameters for ovulation rate, prenatal survival and litter size in rabbits from a elliptical selection experiment. *Livest. Prod. Sci.* **34**: 163-174.

BLASCO A., SORENSEN D., BIDANEL J.P. 1998. Bayesian inference of genetic parameters and selection for litter size components in pigs. *Genetics.* **149**: 301-306.

BOLET G., SANTACREU M.A., ARGENTE M.J., CLIMENT A., BLASCO A. 1994. Divergent selection for uterine efficiency in unilaterally ovariectomized rabbits. I. Phenotypic and genetic parameters. 5th *World Cong. Genet. Appl. Lives. Prod.* Guelph, Canada1994. Vol. **19**: 261-264.

BRADFORD G.E, 1969. Genetic control of ovulation and embryo survival in mice. I. Response to selection. *Genetics.* **61**: 905-921.

GARCIA M.L, BASELGA M. 2002. Estimation genetic response to selection in litter size of rabbits using a cryopreserved control population. *Livest. Prod. Sci.* **74**: 45-53.

JOHNSON R. K. 1992. Selection for fertility in swine. *Pig News Inform.* **13**: 59-61.

JOHNSON R.K., NIELSEN M.K, KITTOK R.J. 1999. Responses in ovulation rate, embryo survival, and litter size traits swine to 14 generations of selection to increase litter size. *J. Anim. Sci.* **77**: 541-557.

LAMBERSON W.R., ZIMMERMAN D.R., ELDRIDGE F.E., KOPF J.D. 1991. Direct responses from selection for increased litter size, decreased age at puberty or relaxed selection following selection for ovulation rate in swine. *J. Anim. Sci.* **69**: 3129-3143.

LAND R.B., FALCONER D.S. 1969. Genetics of ovulation rate in the mouse. *Genet. Res.* **13**: 25-45.

Rothschild M.F., Bidanel J.P. 1998. Biology and genetics reproduction. *In: The genetics of the pig. Chapter 11. M.F. Rothschild and A. Ruvinsky (Ed.) C.A.B. International.*

Ruiz-Flores A., Johnson R.K. 2001. Direct and correlated responses to two-stage selection for ovulation rate and number of fully formed pigs at birth in swine. *J. Anim. Sci*. **79**: 2286-2297.

Sorensen D., Gianola D. 2002*.* Likelihood, Bayesian, and MCMC Methods in Quantitative Genetics. Springer. New York.