DIRECT AND CORRELATED RESPONSES TO SELECTION FOR DAILY GAIN IN RABBITS

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ABSTRACT

In a selection experiment for daily gain, direct and correlated responses were estimated, using a cryopreserved population as control. The difference between the selected and control group was 15 generations. The direct response for daily gain was 0.18 g./d. per generation and we did not find correlated response for feed conversion. These results are worse than expected. This could be due to the effect of the special diet used to control the enterocolitis disease.

Key words: selection, response, daily gain.

INTRODUCTION

The objective of selection of paternal lines in rabbits is the conversion index, that is indirectly evaluated through daily gain (ROCHAMBEAU *et al*., 1989) or weight at the end of the fattening period (LUKEFAHR *et al*., 1996; LARZUL *et al*., 2003), which are negatively correlated with the first one and are easily recorded (MOURA *et al*., 1997; PILES *et al*., 2004).

In order to estimate the response to selection several methodologies have been proposed. One of them is based on estimates of the mean of the breeding values along generations. However, this approach depends on the genetic parameters of the model and the model itself. (ESTANY *et al*., 1992; PILES and BLASCO, 2003). Other methodology, which does not depend on the genetic parameters and the model, uses control populations which could be an unselect population (ROCHAMBEAU *et al*., 1989; LUKEFARH *et al*., 1996), a population selected divergently (MOURA *et al*., 1997; LARZUL *et al*., 2003) or a cryopreserved population (PILES and BLASCO, 2003). The cryopreserved populations are free of the genetic drift.

The objective of this paper is to estimate the direct and correlated responses on growth related traits between two separated generations (15 generations apart) of a line of rabbits selected for daily gain, using frozen embryos.

MATERIAL AND METHODS

Animals

The rabbits belonged to line R, a synthetic strain selected individually during 23 generations for daily gain, between weaning (28 days) and slaughter (63 days). Males were selected within sire families in order to reduce inbreeding. Another practice to reduce inbreeding was the avoidance of mating between animals having common grandparents.

The experiment was carried out since February 2002 until May 2003, in the experimental farm of the Polytechnic University of Valencia (Spain). Embryos from the 7th generation were frozen and thawed to have offspring contemporary to rabbits of the 22 generation. The cryopreservation methodology was the one used by VICENTE *et al*. (2003). The offspring of rabbits from cryopreserved embryos was the control group (C) and the animals of the 22nd generation were the selected group (S). The control group (482 animals) was the offspring of 17 males and 42 females, and the selected group (454 animals) was the offspring of 47 males and 81 females. After weaning the animals were housed in collective cages, 9 rabbits per cage; and they were fed *ad libitum* on a commercial diet till 63 days old.

Traits and models

All the traits were analysed using an animal model, with permanent effects of the dam as an environmental effect. The used variance components were taken from literature (García *et al*., 2000). The fixed effects included in all the models were genetic group (GG; selected (S) or control (C)), kindling order (KO; from 1 to 6) and year season (YS; every 2 moths). Also, for different traits, different covariates were used. When weight at weaning (WW) was analysed, number born alive was included as covariate. For weight at 63 days (WS) and for daily gain between weaning and 63 d., the covariate was WW.

Other traits were studied as mean of the cages. Consumptions from weaning to the end of every week of fattening (C_i, i=1,…,5) and daily gains at the end of every week of fattening (DG_i, i=1,…,5) were analysed using WW as covariate. Feed conversions (FC_i, i=1,…,5) were analysed with weight at the end of every week as covariate. In theses analyses only the cages with a minimun of 7 rabbits were included. To calculate the means by cage and week for theses traits the number of live animals and the date in which the animals died were taken into account. For C_i, it was supposed that the dead animals stopped eating 3 days before their death. For DG_i the weight of dead animals was added until the date of their death, and FC_i was calculated as the ratio between C_i and DG_i.

RESULTS

Weaning Weight

The differences between selected and control group are shown in Table 1, and no differences were found between the selected and the control group. For this trait the

covariate number born alive was significant ($p<0.05$) and its value (standard error) was -38.90 g./rabbit (2.21). The first kindling showed a negative significant effect ($p<0.05$) respect to the mean of the other levels (-86.69 g.), and between the other levels there were not significant differences.
Several authors (ESTANY *et al*., 1992; ROCHAMBEAU *et al*., 1989; PILES *et al*., 2003) did not find correlated response when the animals were selected for daily gain. LUKEFAHR *et al*. (1996) also did not find significant differences between control and selected groups for weight at 70 days. However, LARZUL *et al*. (2003) in a divergent selection experiment for body weight found differences in weaning weight between high and low lines. In an experiment comparing lines selected for litter size or daily gain FEKY *et al*. (1996) found significant differences.

Weight at 63 days

For this trait, the difference between S and C groups was 94.57 g. (Table 1), which is 6.30 g. per generation ($p<0.05$). The regression coefficient for the covariate WW was 1.392 g./g. (0.038), and was significant. No effect of the first kindling was observed, but the 6th kindling showed a lower significant effect than the 2nd, 3rd or 4th.
Correlated responses have also reported for other authors when selection for daily gain was carried out (ESTANY *et al*., 1992; ROCHAMBEAU *et al*., 1989; PILES and BLASCO, 2003). There also was response when the selection criterion was the weight at the end of the fattening period (LUKEFARH *et al*., 1996; LARZUL *et al*., 2003).

Individual daily gain between weaning and 63 days

The difference between S and C groups was 2.732 g./d. ($p<0.05$) (Table 1). This difference supposes a genetic response of 0.18 g./d. per generation. For this trait, the same effect than for Weight at 63 days was observed at the 6th kindling and the covariate WW also had a significant effect.
In experiments of selection for daily gain, direct response was always found for this trait (PILES and BLASCO, 2003; MOURA *et al*., 1997; ROCHAMBEAU *et al*., 1989; ESTANY *et al*., 1992). Indirect response was also found when the criterion was either feed conversion (MOURA *et al*., 1997) or weight at market time (LARZUL *et al*. 2003; LUKEFAHR *et al*., 1996).

Table 1- Effects of groups (S,C) and coefficients of the covariates for Weight at Weaning (WW (g.)), Weight at 63 days (W63 (g.)) and Individual Daily Gain (IDG (g./d.)).

	WW (g.)	W63 (g.)	IDG (g./d)
S	686.1 (11.2)	2397 (14)	49.2 (0.4)
C	677.2 (14.4)	2302 (19)	46.5 (0.5)
S-C	8.735	94.57**	2.732**
Cov	-38.90 (2.21)**	1.392 (0.038)**	0.011 (0.001)**

**, ($p<0.05$)

Daily Consumption along the fattening

The generalized least square means for S and C groups and their standard error are showed in Table 2 from weaning to the end of every week. In this table, the value of the covariate WW is also showed.

Table 2- GLSM for S and C groups (S.E) for Consumption.

	C_1	C_2	C_3	C_4	C_5
S (g./d.)	73.8 (2.7)	89.4 (2.7)	103.3 (2.1)	116.6 (1.9)	126.5 (1.8)
C (g./d.)	71.8 (3.3)	82.5 (2.7)	97.0 (2.6)	110.4 (2.3)	120.2 (2.2)
S-C (g./d.)	1.99	6.95	6.34	6.18**	6.31**
Cov. (g./d.)/g.	0.032 (0.011)**	0.049 (0.009)**	0.039 (0.009)**	0.033 (0.008)**	0.024 (0.007)**

**, ($p<0.05$)

Significant differences were only observed in consumption for the 4th and the 5th week of the fattening period.

This trait was previously studied by FEKI *et al*. (1996) showing significant differences between genetic lines selected for different criteria, independently of the recording method (individual or collective).

Daily Gain along the fattening

Results for this trait (DG_i, i=1,…,5) are in agreement with the previous obtained in the individual analysis but here the differences are higher, and are found significant only at the last week of the fattening period.

Feed Conversion along the fattening

The generalized least square means for S and C group and their standard errors for every week are shown in table 3; the effect of the covariate Weight at the end of every week is also showed.

Table 3.- GLSM for S and C groups (S.E) for Feed conversion.

	FC_1	FC_2	FC_3	FC_4	FC_5
S	1.85 (0.092)	1.96 (0.051)	2.12 (0.042)	2.40 (0.047)	2.57 (0.036)
C	1.80 (0.114)	1.90 (0.063)	2.08 (0.052)	2.36 (0.058)	2.62 (0.044)
S-C	0.05	0.06	0.04	0.04	-0.05
Cov.	$-0.4x10^{-3}$ ($0.3x100^{-3}$)	$-0.3x10^{-3}$ ($0.1x10^{-3}$)**	$-0.3x10^{-3}$ ($0.1x10^{-3}$)**	$-0.1x10^{-3}$ ($0.1x10^{-3}$)	$0.1x10^{-3}$ ($0.1x10^{-3}$)

**, ($p<0.05$)

No significant differences between S and C groups were found. Besides the negative genetic correlation between this and daily gain reported in previous studies (MOURA *et al*., 1997; PILES *et al*., 2004) we did not find correlated response. The covariate was negative for the 4 first weeks and positive but very low for the 5th.

For this trait direct response was found by MOURA *et al*. (1997), this authors also found higher correlated response when the selection criterion was daily gain. FEKI *et al*. (1996) also found significant differences between selected lines for different objectives.

DISCUSSION

The results in this experiment are poorer than expected from indirect evidences involving the same line (TORRES *et al*., 1992; FEKI *et al*., 1996) that suggested a response per generation of 0.5 g./d. for daily gain, and from direct estimate (PILES and BLASCO, 2003) of the response between the generation 3-4 and the generation 10, being this estimate 0.6 g./d. per generation. In our case the comparison is between the generation 7 and 22, overlapping with the second half of the generations of the experiment of PILES and BLASCO (2003). The principal difference is that the first experiment was carried out when the enterocilitis was not yet present but the second was carried out after the appearance of the disease. The consequence of its appearance was that the commercial feed had some antibiotics incorporated to prevent severe outbreaks of the disease. It seems that these drugs can affect negatively the growth, with different intensity depending on the level of consumption. Under this hypothesis the animals of the more advanced generation, having a higher consumption, would be more affected and their growth and feed conversion correspondingly impaired. An indicator that the growth has been no normal is the value of the regression coefficient of the weight at the end of fattening on the conversion index. Negative or very low positive values indicate that some abnormalities have occurred because the expectation is a relatively moderate and positive value of the coefficient (TORRES *et al*., 1992; FEKI *et al*., 1996), indicating that the rabbits with lower final weights have a lower conversion index.

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REFERENCES

ESTANY, J., CAMACHO, J., BASELGA, M., BLASCO, A. 1992. Selection response of growth rate in rabbits for meta production. Genet. Sel. Evol. **24**:527-537.

FEKI, S., BASELGA, M., BLAS, E., CERVERA, C., GÓMEZ, E.A. 1996. Comparison of growth and feed efficiency among lines selected for different objectives. Livest. Prod. Sci. **45**: 87-92.

GARCÍA M..L., BASELGA M., PEIRÓ R. 2000. Correlated response on growth traits in a line selected for litter size at weaning. 7th World Rabbit Congress, Valencia (Spain), July 4-7.

LARZUL, C., GONDRET, F., COMBES, S., DE ROCHAMBEAU, H. 2003. Anlyse d'une expérience de sélection sur le poids á 63 jours : I- Déterminisme génétique de la croissance. 10èmes Journées de la Recherche Cunicole, 19-20 nov. 2003, Paris.

LUKERFAHR, S.D., ODI, H,B., ATAKORA, J.K.A. 1996. Mass Selection for 70 day body weight in rabbits. J. Anim. Sci. **74**:1481-1489.

MOURA, A.S.A.M.T., KAPS, M., VOGT, D.W., LAMBERSON, W.R. 1997. Two-Way selection for daily gain and feed conversion in a composite rabbit population. J. Anim. Sci. 75:2350-2354.

PILES, M. AND BLASCO, A. 2003. Reponse to selection for growth rate in rabbits estimated by using a control cryopreserved population. World Rabbit Sci., **11**:53-62.

PILES, M., GÓMEZ, E.A., RAFEL, O., RAMON, J., BLASCO, A. 2004. Elliptical selection experiment for the estimation of genetics parameters of the growth rate and feed conversión ration in rabbits. J. Anim. Sci. **82**:654-660.

DE ROCHAMBEAU, H., DE LA FUENTE, L.F., ROUVIER, R. , OUHAYOUN, J. 1989. Sélection sur la vitesse de croissance post-sevrage chez le lapin. Genet. Sel. Evol. **21**:527-546.

TORRES, C., BASELGA, M., GÓMEZ, E. 1992. Effect of weight daily gain selection on gross feed efficiency in rabbits. J. Appli. Rabbit Res. **15**:884-888.

VICENTE, J.S., VIUDES-DE-CASTRO, M.P., GARCÍA, M.L., BASELGA, M. 2003. Effect of rabbit line on a program of cryopreserved embryos by vitrification. Reprod. Nutr. Dev., **43:**137-143.