GENETIC PARAMETERS OF BIRTH WEIGHT AND WEANING WEIGHT IN OVARIECTOMIZED AND INTACT RABBIT DOES

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Abstract - Litters from 130 does of a synthetic line were used in the experiment. The right ovary was removed before puberty in sixty-four of these females (ULO does). The offspring of the first and second parities of all the does was individually weighed at birth and at weaning. A total of 984 young rabbits from intact does and 786 young rabbits of ULO does were weighed. Litter size was higher in the intact line, but survival from birth to 1st week was the same for both groups. The relationship between survivals and average birth weight was slightly negative for intact females and null for ULO does. Survivals showed a low negative relationship with litter size in intact females, and null for ULO does. Individual birth weight was higher in ULO females. Individual weight at weaning was also higher for ULO females, but this difference disappears when correcting for litter size. The correlation between weights at birth and at weaning was 0.66 for ULO does and 0.53 for intact females. The correlation between number of born alive and the standard deviation within litter of individual birth weight was null for both groups. The heritabilites of individual birth weight were 0.17 and 0.16 for ULO and intact does, and 0.26 for individual weaning weight of ULO does. Genetic correlation between birth weights of ULO and intact females, considered as different traits, was 0.7. The same correlation for weaning weight was 0.91.

INTRODUCTION

As litter size is a difficult trait to be selected because of its low heritability (see review by ROCHAMBEAU, 1988), alternative selection programs have been proposed. BLASCO *et al.* (1994) proposed selection for litter size on unilaterally ovariectomized does (ULO) as a way to improve uterine efficiency in order to augment litter size. Uterine efficiency was defined by CHRISTENSON *et al.* (1987) as the maximum number of foetuses the dam can support at birth when the number of ova shed is not a limiting factor. Removing one ovary produces a duplication of the ovulation rate in the other ovary, leading to an overcrowding of embryos in the remaining uterine horn, (BLASCO *et al.*, 1994). However, an increment of litter size can lead to a reduction in birth weight, as was early shown in intact females by VENGE (1950). Also in intact females, BREUER and CLAUSEN (1977) found a correlation of -0.64 between litter size and individual weight of foetuses near birth, and VICENTE *et al.* (1995) found a correlation of -0.67 between litter size and individual weight at birth of live born rabbits. These negative relationships have been attributed by the authors to the competence among foetuses for the uterine space and nutrients. In a previous paper in which ULO and intact females were compared, GARCIA-XIMENEZ and VICENTE (1993) found that differences between ULO and intact females in the average weight of young rabbits per litter disappeared when correcting for litter size. Recently, BOLET *et al.* (1996) do not find differences between the offspring of ULO and intact females in individual birth weight. It would be relevant to asses the relationships between birth weight and neonatal survival and how the overcrowding of the uterine horn affects these relationships. The aim of this experiment is to compare the relationships between birth weight, and neonatal survival and to estimate the genetic parameters of birth weight in intact and ULO females.

MATERIAL AND METHODS

Animals and management

Litters from 130 does of the 11th generation of a synthetic line were used in the experiment. The right ovary was removed before puberty in sixty-four of these females. All the does had their first mating at 18 weeks of age. For the second gestation, they were mated 10 days after parity. Does were mated again every seven days if they did not become pregnant or they did not accept being mated the week before, which means that some of them will carry out gestation and lactation at the same time. Weaning took place at approximately 28 days of age.

The offspring of the first and second parities of all the does was individually weighed at birth and at weaning. A total of 984 young rabbits from intact does and 786 young rabbits of ULO does were weighed. The following traits were recorded: NBA: number of born alive. N1wk: number alive at first week of age. NW: number of weaned. IBW: individual birth weight of the rabbits born alive. IWW: individual weaning weight. Survival at birth:

SB = NBA/Total born alive. Survival from birth to the 1st week: S1wk=N1wk/NBA. Survival from first week to weaning SW=NW/N1wk. Average weight of the rabbits born alive in a litter: ABW=Total litter weight/NBA. Standard deviation of IBW within litter: sdIBW. Standard deviation of IWW within litter: sdIWW.

Statistical analyses

Least square means were computed for reproductive and survival traits, on a model with group effect (G: ULO or INTACT females), year-season effect (YS: only one year with Spring, Summer and Autumn), and lactation-parity effect (LP: nulliparous does, and females mated at 10, 17, 24 or 31 days after first parity). The model used for IBW also included a suckling effect (M: whether the young rabbits suckled or not in the first 24 hours after birth), a survival effect (S: whether the rabbits survived or not at first week), and a covariate for NBA. A model without the covariate NBA was also fitted. The same models were used for IWW, but they did not include the survival effect. Orthogonal contrasts allowed to estimate the effects of lactation and parity. The SAS program (SAS 1990) was used for computations

Residual maximum likelihood (REML) estimates of the heritability were obtained for IBW and IWW on a repeatability animal model in which YS and LP were the fixed effects, and the additive genetic effect and a common litter effect the random ones. The analyses were made separately for Intact and ULO females. Genetic correlation between IBW of ULO does and IBW of intact does, considered as separated traits, was also calculated, and the same procedure was applied for IWW. The relationship matrix included all generations from the beginning of the selection of the synthetic line. Finally, the heritabilites of IBW and IWW were calculated with the whole set of data. The VCE program (GROENEVELD, 1990) was used for computations.

RESULTS AND DISCUSSION

Table 1 shows the least-square means for litter traits, and table 2 the relationships between survivals, litter size and birth weight. Litter size was higher in the intact line, as expected (BLASCO *et al.*, 1994), although the variability of the traits was similar in both lines. No seasonal or lactation-parity effects were found for litter size, consistently with VENGE (1950), GARCIA *et al.*(1984) and ROBERTS and LUKEFAHR (1992). Conversely, POUJARDIEU and THEAU-CLEMENT (1995) did not find any relevant lactation effect, but POUJARDIEU *et al.* (1995) and BOLET *et al.* (1996) found relevant differences between 1st and 2nd parity for litter size. Survival from first week to weaning was higher in ULO females, but this is not attributable to a higher individual birth weight, because survival from birth to 1st week was the same for both groups. Moreover, the relationship between survivals and average birth weight is slightly positive for intact females and null for ULO does (table 2). Survivals showed a low negative relationship with litter size in intact females, and this relationship was null for ULO does.

Individual birth weight was higher in ULO females, showing that the overcrowding of a uterine horn did not have any effect in foetuses development, as it was also shown in other stages of gestation by SANTACREU *et al.* (1994). The difference in individual birth weight between ULO and intact does is attributable to a lower litter size, since ULO females had a lower birth weight when it was corrected by litter size. There is a higher variation in individual birth weight in ULO females, as the sdIBW and the CV of IBW show. BOLET *et al.* (1996) did not find differences between intact and ULO females, but their lines had a lower litter size.

Seasonal and lactation-parity effects affected both weights. Small negative effects of first parity (-3.13 ± 0.67) and lactation (-2.62 ± 1.08, lactating doe in comparison with non-lactating doe) were found for birth weight, but not for weaning weight. BOLET *et al.* (1996) also found a negative effect of first parity for birth weight. A positive effect of suckling was found for individual birth weight (7.10 ± 0.58) and for individual weaning weight (31.98 ± 7.49).

Litter size affected birth weight in both, intact and ULO does (table 2), as it was also shown by VENGE (1950) and VICENTE *et al.* (1995) in intact does. However, this effect does not seem to be related with survival from birth to weaning, since the relationships between survivals and the average weight at birth are null for ULO females and slightly positive for intact female, probably because of the higher litter size of intact does. Young rabbits that survived to first week had a higher birth weight in both ULO and intact groups (6.91 ± 1.45 and 8.58 ± 1.19 respectively). However it should be noted that the rank of weights of young rabbits that did not survive until the first week was very high (from 24.7 to 77.6 for ULO does and 22.0 to 73.3 for intact does). As the minimum weight of rabbits that survived and arrived to weaning was 29.2 and 25.9 for ULO and intact females respectively, it seems that birth weight is not such a critical factor for survival. Large litters do not have a higher

Table 1. Number of data (N), Least square means (LSM), residual standard deviation (rsd), coefficient of variation (CV), Group effect (G), year-season effect (YS) and lactation-parity effect (LP) of unilaterally ovariectomized (ULO) and intact does.

	ULO				INTACT						
	N	LSM	rsd	CV	N	LSM	rsd	CV	G	YS	LP
NBA	112	6.95	2.38	.34	110	8.86	2.72	.30	**	ns	ns
N1wK	112	6.55	2.47	.38	110	8.10	2.82	.35	**	ns	ns
NW	108	6.45	2.24	.35	104	7.52	2.44	.32	**	ns	ns
SB	112	.92	.15	.13	110	.92	.16	.18	ns	ns	ns
S1wk	112	.94	.19	.20	110	.94	.18	.20	ns	ns	ns
SW	108	.98	.11	.11	104	.94	.16	.17	*	ns	ns
sdIBW	107	8.63	3.20	.39	109	7.37	2.64	.38	**	ns	*
sdIWW	105	71.8	29.2	.44	100	71.0	27.7	.43	ns	ns	ns
IBW	786	53.2	11.0	.21	984	50.0	9.2	.17	**	**	**
IWW	697	574	125	.21	788	518	120	.23	**	**	**
IBWC	786	51.4	10.6	.18	984	53.7	8.3	.15	**	**	**
IWWC	697	553	107	.19	788	547	103	.20	ns	**	*

NBA: number of born alive. N1wk: number alive at first week of age. NW: number of weaned. Survival at birth: SB=NBA/Total number born. Survival from birth to 1st wk: S1wk=N1wk/NBA. Survival from first week to weaning SW=NW/N1wk. Standard deviation of IBW within litter: sdIBW. Standard deviation of IWW within litter: sdIWW. IBW: individual birth weight of the rabbits born alive. IWW: individual weaning weight. IBWC: individual birth weight of the rabbits born alive, corrected for litter size. IWWC: individual weaning weight, corrected for NBA

Table 2. Residual correlation of litter traits in ULO and intact females

		NBA	N1wk	ABW	sdIBW
ULO	S1wk	.05	.48**	.03	.11
	SW	.04	.03	-.05	-.03
	NBA		.87**	-.62**	.15
	N1wk			-.53**	.19*
	ABW				-.11
Intact	S1wk	-.31**	.46**	.30**	-.24*
	SW	-.19*	-.17	.26**	.21*
	NBA		.69**	-.61**	.03
	N1wk			-.36**	-.14
	ABW				-.16

NBA: number of born alive. N1wk: number alive at first week of age. Survival from birth to the 1st week: S1wk=N1wk/NBA. Survival from first week to weaning SW=NW/N1wk. Total litter weight at birth of the rabbits born alive: LWB. Average birth weight of a litter: ABW. Total weaning weight of the litter: LWW. Standard deviation of IBW within litter: sdIBW.

variation in birth weight, since the correlation between number of born alive and the standard deviation within litter of individual birth weight was null for both groups. The relationships between sdIBW and survivals are very small in intact females, and disappear in ULO females.

Table 3 shows the genetic parameters of individual birth and weaning weight. These parameters could be biased by selection. However, the estimated response to selection for litter size in the synthetic line during 11 generations of selection has been very low (0.03 rabbits per generation, BASELGA *et al.*, 1992). There are no reliable estimates in the literature for the heritability of birth weight. A review of BASELGA *et al.* (1982) gives an average of estimates of 0.20 for the heritability of individual weaning weight, which agrees with our result. The genetic correlation between individual birth weight and individual weaning weight is low. This result could be expected, since birth weight is only a 10% of weaning weight and IWW is influenced by mother characteristics, as its large maternal effect shows. Genetic correlation between birth weights of ULO and intact females, considered as different traits, is high but not 1, showing that the overcrowding genetically influenced birth weight. The same correlation for weaning weight gives a value near the unity, showing that the effect of the overcrowding was lost at weaning.

Table 3. Genetic parameters of individual birth weight (IBW), and individual weight at weaning (IWW) in ULO and intact females.

	IBW		IWW		IBW,IWW	IBW	IWW
	h^2	c	h^2	c	r_g	r_g(Intact,ULO)	r_g(Intact,ULO)
ULO	.17	.42	.26	.53	.25	.70	.91
INTACT	.16	.37	*	*	*		

*No convergence was found.

Large litter sizes have lower individual birth weights. This has lead to the question of whether selection for litter size could decrease the survival of the young rabbits. There is no information in rabbits, but in mice selection for litter size does not seem to have decreased individual birth weight (ENGELEN *et al.*, 1995). However, a generalisation of mice experiments should be taken with caution, because dam weight also increases by litter size selection, which could not be the case of rabbits (CAMACHO and BASELGA, 1991). Besides, unilateral ovariectomy produces an overcrowding in an uterine horn, which could have a higher effect in birth weight and survival. This does not seem to be the case. Uterus overcrowding of ULO does does not seem to affect birth weight and survival, although this cannot be concluded until both uterine horns would be functional. The relationship between litter size and survival is very low and birth weight does not seem to be a critical factor for surviving.

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