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DIVERGENT SELECTION ON 63-DAY BODY WEIGHT in rabbit: PRELIMINARY RESULTS

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ABSTRACT

A selection experiment based on rabbit live body weight at 63 age was carried out at the INRA experimental farm. The aim of the experiment was to determine the effect of selection for growth rate on carcass characteristics and meat quality. Animals were selected on their breeding value estimated by BLUP applied on an animal model in order to create 2 divergent lines, for high and low weights. At the 3rd generation of selection, 80 males of the second parity litters were weighed each week from weaning to slaughtering at 63 days of age. They were measured for carcass and perirenal fat weights, colour and ultimate pH on *longissimus* and thigh muscles. Phenotypic differences in 63-day body weight between both lines appeared in the 3rd generation, whereas genetic differences appeared in generation 2, and reached 160g in generation 3. Phenotypic differences between both lines were significant for all weights, high line being heavier than low line. No significant differences were found for perirenal fat percentage. For meat quality traits, significant differences between low and high lines were found for ultimate pH in *longissimus* muscle (5.77 vs 5.81) and for redness a* in *gracilis* muscle (−−3.47 vs −−4.98).

INTRODUCTION

In rabbit population, development of artificial insemination made it possible to use heavy males with a large muscular development. Selection experiments on body weight or on weight gain are conducted in several places (ROCHAMBEAU, 1997 for references), but knowledge about effect of this kind of selection on meat quality is not very large. From these experiments it appears that it is possible to modify the development and the muscular characteristics in rabbits by selection. In other species such as mouse, pig or chicken, selection for growth rate is also able to modify the age-related development of muscle characteristics and the ultimate meat quality.

This study aims to determine the consequences of growth rate on carcass composition, muscular characteristics and meat quality, by comparison of animals from divergent lines selected on body weight. In the present study, we present the preliminary results from the 3rd generation of selection concerning breeding and slaughtering.

MATERIAL AND METHODS

Origin

Rabbits were obtained from a commercial heavy sire line (Grimaud Frères). They were introduced on the INRA experimental farm (Langlade) after hysterectomy of females. These animals were considered as the founder population of the selection experiment (F0).

Selection

Rabbits were selected on their body weight at fixed age. Animals were weaned at 28 days of age and were weighed at 63 days of age. Reproducers were selected on their individual

genetic value, estimated by BLUP applied on an animal model. Animals were distributed within 11 families constituted by one male and 7 females. Animals from the first generation of selection (G1) were selected intra-litter: the males, as well as females, for high line and low line, were selected within litter. From the 2nd generation onwards, animals were selected within family: its extreme son replaced the male reproducer, and females were chosen within sire progeny. The selected male was kept in its original group, and the females were distributed in the other groups. This intra-family selection was applied in order to limit inbreeding.
Rabbits selected as reproducers were originated from two batches. Females were also conducted in two bands: one band was inseminated six weeks after the first one. Animals selected as reproducers were chosen from 3- and 4-parity progeny.

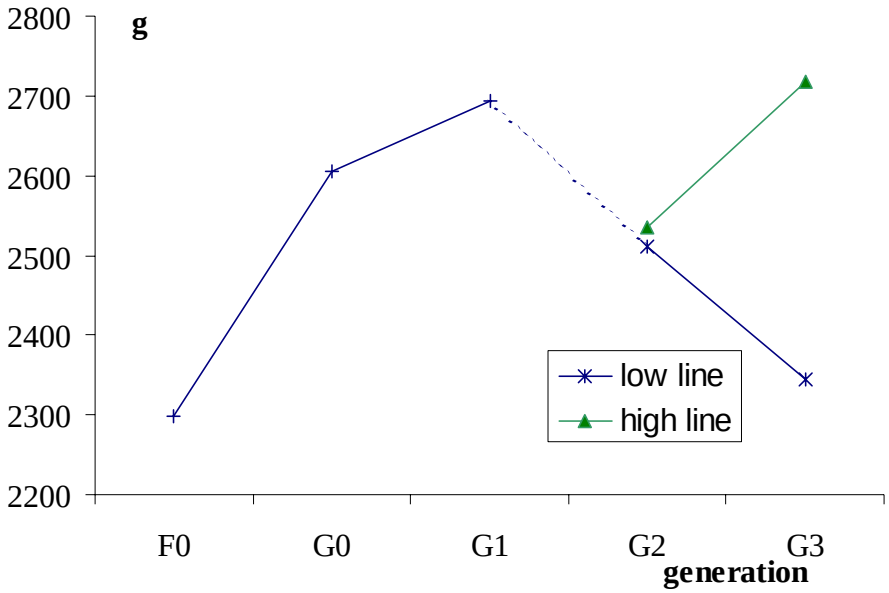
Animals slaughtered and traits measurement
At the third generation of selection, animals from the 2nd parity progeny were slaughtered to estimate the differences between both lines for carcass and meat quality traits.
Rabbits were progeny from all the females of the 2nd generation of selection and from males from the first batch of the 2nd generation. As the reproducers, kits were weaned at 28 days and 40 pairs of male full sibs were kept after weaning. In one cage, two males from the same litter were put in order to have progeny from all families. Animals were fed ad libitum a commercial feed. They were weighed every week and the consumption per cage was measured for the whole period from weaning to slaughtering.
At 63 days of age, animals were weighed, then were conducted to the slaughterhouse (15 km). They were electrically stunned (6s 24 V 90W direct current), and bled. Animals were skinned, and eviscerated. Hot carcass and skin were weighed.
Carcass were kept at 4°C for 24 hours. Chilled carcass and legs were weighed as described by BLASCO et al. (1993). Dressing out percentage was calculated as the ratio of chilled carcass over slaughter weight (BLASCO et al., 1993). Carcass drip loss was calculated as well as drip loss percentage (BLASCO et al., 1993). We weighed perirenal fat. Then, pH was measured on the *longissimus* muscle (on the fresh back cross section at the level of the 5th lumbar vertebra) and in the left *biceps femoris* muscle. Color was measured by a Minolta Chromameter on *longissimus* muscle (1st lumbar vertebra) and on the left *gracilis* muscle on the internal face, after *semitendinosus* muscle was removed, restrained on flat stick, and immediately frozen in isopentane cooled with liquid nitrogen for later histochemical measurements (not presented). The right thigh was removed from the carcass and kept at 4°C. The day after (48h post mortem, *semitendinosus* muscle was removed from the thigh and ultimate pH was measured in Na-iodoacetate (1:9, w/v) (Ouhayoun and Dalle-Zotte, 1996).

Statistical analyses
Traits were analysed using the SAS GLM procedure. For weight at 63 days of age, we kept the fixed effects of batch, year, line and sex. For carcass traits, we kept only line effect. Weights at 63 days of age were also analysed using BLUP methodology applied to an individual model in order to estimate the evolution of the traits in both lines. We set the model with sex, batch*year, and birth litter size (8 levels) as fixed effects, and common environment (dam) and animal as random effects. Variance were estimated in the base population from which lines were obtained. Heritability value was set at 0.18 as well as environmental value. Breeding values were estimated using the PEST package (GROENEVELD and KOVAC, 1990).

RESULTS AND DISCUSSION

Phenotypic and genetic evolution of body weight measured at 63 days of age through all generations were shown in figure 1 and 2. Phenotypic differences between both line appears in the last generation, whereas genetic differences appeared in generation 2. The genetic difference between both lines in generation 3 was 160 g that is $1.1\sigma\sigma_g$.

Figure 1 Phenotypic evolution of the body weight measured at 63 days of age.
Figure 2 Genetic evolution of the body weight measured at 63 days of



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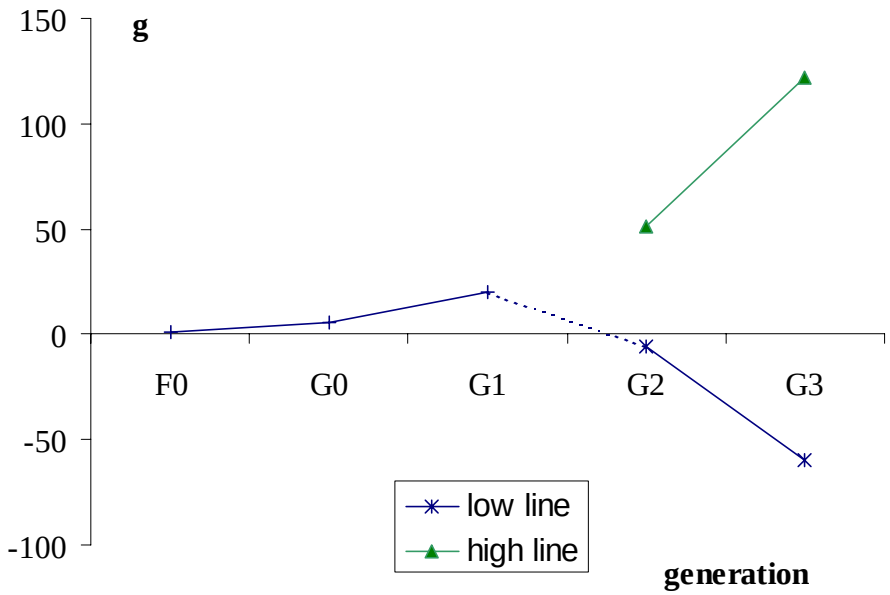

The phenotypic differences between Low and High lines (table 1) were significant (P=0.001) for weights and average daily gain between 28 and 63 days of age. The difference between the two lines appeared at weaning and increased during the next weeks.
Results from literature presented high phenotypic and genetic correlations between weight at weaning and following weights (KHALIL et al., 1986). LUKEFAHR et al. (1996) found a slight increase in weaning weight in rabbit selected for high 70-day body weight, but in their

study, the genetic correlation between weight at weaning and at 70 days of age was only moderate (r_g=0.58).

Table 1 Differences between Low and High lines at the 3rd generation of selection for growth, carcass and meat traits.

Traits[1]	Low line[2]	High line[2]	P[3]
Growth traits			
Body weigh at 28 days (g)	737	908	0.001
Body weigh at 35 days (g)	958	1156	0.001
Body weigh at 42 days (g)	1360	1633	0.001
Body weigh at 49 days (g)	1748	2049	0.001
Body weigh at 56 days (g)	2110	2434	0.001
Body weigh at 63 days (g)	2414	2730	0.001
Body weigh before slaughtering (g)	2403	2725	0.001
Daily gain 35-63 days	50.5	56.2	0.001
Feed conversion ratio	3.11	3.23	0.13
Carcass traits			
Skin and legs weight (g)	428	499	0.001
Hot carcass weight (g)	1424	1611	0.001
Chilled carcass weight (g)	1379	1554	0.001
Drip loss weight (g)	44.9	55.1	0.06
Perirenal fat weight (g)	20.5	23.5	0.06
Dressing out percentage %	59.4	59.1	0.57
Drip loss percentage %	3.14	3.42	0.38
Perirenal fat/chilled carcass %	1.47	1.50	0.74
Meat traits			
pH *longissimus*	5.77	5.81	0.05
pH *biceps femoris*	5.94	5.92	0.84
pH *semitendinosus*	5.94	5.90	0.21
L* *longissimus*	105	105	0.78
a* *longissimus*	−−3.54	−−3.92	0.47
b* *longissimus*	9.92	9.55	0.47
L* *gracilis*	99.7	101.2	0.08
a* *gracilis*	−−3.47	−−4.98	0.002
b* *gracilis*	7.34	6.94	0.47

[1]: N=80 for all traits except pH *semitendinosus* (N=40); [2]: Lsmeans for the low and high lines; [3]: Probability of Low and High line are not different.

When considering the feed:conversion ratio, no significant difference between lines was found (P=0.13). Previous study showed that animals selected on increased daily gain, heavier than animals from lines selected on other criterion, had a lower feed:conversion ratio (FEKI et al. 1996). Our result were in disagreement with previous results presented by MOURA et al. (1997). Rabbits selected for high average daily gain had a lower feed conversion ratio than animals selected for low average daily gain and genetic correlation between both traits was highly negative (r_g=−−0.82). As average daily gain and weight at fixed age were highly related, it should have been expected a decrease in the high line for feed conversion ratio in comparison with the low line.

For carcass traits, differences were found for weights but proportions were the same in both lines. High line animals presented significantly higher values for all weights than low line animals (P=0.001 or P=0.06). Dressing out percentage, drip loss percentage and perirenal fat percentage were not significantly different. Even though weights were all higher in the high line, the ratios were identical, and carcass was not deteriorated concerning carcass yield or carcass fatness. GÓMEZ et al. (1998) found that animals from a line selected on daily gain had a higher carcass weight than animals selected on a different criterion and a lower dressing out percentage. SU et al. (1999) estimated a low genetic correlation between carcass yield and daily gain (r_g=––0.226 with daily gain 35-90 days, and r_g=––0.153 with daily gain 1-90 days). Associated with a low heritability, the authors concluded that selection on daily gain or weight at market age would have little effect on dressing percentage. In the present study, during the first three generations, no significant differences were found between lines for dressing percentage. At fixed age, dressing percentage and perirenal fat percentage were the same. In this experiment, rabbits were slaughtered at fixed age, thus the results would be different if lines were compared at fixed slaughtering weight. In that case, animals from the high line would be slaughtered one week earlier than animals from the low line.

For meat traits, significant differences between lines were found only for ultimate pH measured in *longissimus* muscle at 24 hours *post mortem* (P=0.05) and for color traits of the *gracilis* muscle (a*, P=0.002; L*, P=0.08). Ultimate pH values reported in our study for the three different muscles are closed to those presented by HULOT and OUHAYOUN (1999). In this review, the authors reported genetic correlations between growth rate (28-70 days) and ultimate pH. They varied from –0.05 to ––0.55 for the *longissimus* muscle and –0.42 for the *biceps femoris* muscle (HULOT and OUHAYOUN, 1999). They concluded that selection on growth rate would decrease ultimate pH, thus leading to a more glycolytic metabolism, and in general a lower meat quality. In the present study, we did not observe any difference in the *biceps femoris* muscle, whereas ultimate pH in the *longissimus* muscle tended to be higher in the high line. The difference in the *semitendinosus* muscle was opposite to the *longissimus* difference but in this muscle the difference was not significant. Thus, it appeared that changes in ultimate pH by selection on body weight could differ from one muscle to another.

All these results need to be confirmed by later generations of this selection experiment. Further studies are also needed in order to determine the effect of selection for live body weight at 63 days on myofiber characteristics and meat structure, and meat tenderness to verify the statement that selection on growth rate would harden rabbit meat (Pla et al., 1998). A comparison at fixed weight should also be carried out in order to completely evaluate the consequences of body weight selection on meat quality traits.

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