EFFECT OF SELECTION ON BODY SIZE AT FIXED AGE ON MUSCLE CHARACTERISTICS IN RABBIT

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INTRODUCTION

The recent introduction of artificial insemination in rabbit makes it possible to use males from heavy lines with increased growth rate, muscularity and feed efficiency (Rochambeau, 1997). Effects of changing live body weight by selection on muscle characteristics and meat quality must be evaluated in rabbit. The incidence of weight variation at fixed age on muscle histological, biochemical, and rheological characteristics, that are predictors of final meat quality, remains largely unstudied in rabbit. In order to study thoroughly this point, a divergent selection experiment on body weight at fixed age has been carried out for 5 generations. Differences between heavy (HW) and low weight (LW) lines are presented for growth performance, carcass composition, and muscle histochemical and rheological characteristics.

MATERIAL AND METHODS

Animals

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). The selection procedure on body weight at 63 days of age was previously described (Larzul et al., 2000).

Animals slaughtered and traits measurement.

At the fifth generation of selection, animals from the 2nd parity progeny were slaughtered to estimate the differences between both lines for carcass and meat quality traits. 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. 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. One animal from each pair was slaughtered first by alternating animals from each line, then full sibs were slaughtered. Animals were skinned, and eviscerated. Skin was weighed. Carcasses were kept at 4°C for 24 hours. Chilled carcass, legs and perirenal fat 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). Then, ultimate pH1 was measured on the longissimus muscle (on the fresh back cross section at the level of the 5th lumbar vertebra). On one animal from each pair (40 animals), semitendinosus muscle was removed from the left thigh within 15 min post mortem, restrained on flat stick, and immediately frozen in isopentane cooled with liquid nitrogen for later histochemical measurements (Gondret et al., 1997).
remaining left thigh and the forepart were then frozen for ToBEC (Cauquil et al., 2001) and dry matter measurement. The right thigh was kept at 4°C during 24 h. Then, semitendinosus muscle was removed from the right thigh and Warner-Bratzler shear force and ultimate pH in Na-iodoacetate (1 : 9, w/v) (Ouhayoun and Dalle-Zotte, 1996) were measured. The remaining right thigh was frozen for later measurement of Warner-Bratzler shear force on a core muscle (1 cm²).

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 x 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
The selection for divergent weight at fixed age was successful. At 63 days of age, body weight (+16 %), carcass weight (+14 %) were heavier in HW than in LW rabbits (table 1). Perirenal fat percentage was higher in HW than in LW animals (+23 %). Ultimate pH, in LD or ST muscle, was not affected by selection on body weight. For muscle fibre measurements, it appeared that only fibre size was altered by selection: cross sectional area was largely higher in HW rabbits than in LW rabbits; whereas no significant difference could be found between lines for total muscle fibre number. It means than increasing weight (and adult size) at fixed age by selection favoured fibre hypertrophy, without changing fibre hyperplasia during early stage. This result confirmed observations made on a previous generation (Gondret et al., 2002). In superficial white part as in deep red part of semitendinosus muscle, the relative fibre type composition, was similar in both lines.

The Warner-Bratzler shear force value was not affected by selection, whatever it was measured on a standardised core muscle or on the entire semitendinosus muscle. That leads to the conclusion of no effect of body weight selection on muscle instrumental toughness. As the shear force measurement was realised on crude muscle, it should not be extrapolated to final cooked meat toughness.

For meat composition, selection induced an increase of dry matter percentage as well as a decrease of ToBEC value in the forepart in the HW line compared with the LW line. In hindpart, no significant differences could be found for the same measurements. Intramuscular fat content in the semitendinosus muscle was not affected by selection. Thus, the increase in perirenal fitness in HW line compared to LW line was not accompanied by an increase in the intramuscular fat deposit. However, it should be remembered that intramuscular fat is the latest to be deposited in rabbit (mainly from 14 weeks onwards, Gondret et al., 1998). Therefore, the age at slaughter of the rabbits in this experiment does not allow us to study potential differences between the two lines.
Table 1: Growth, carcass and muscle characteristics from heavy and light weight lines

<table>
<thead>
<tr>
<th>Traits</th>
<th>HW</th>
<th>LW</th>
<th>Std</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Body weight 63 days (g)</td>
<td>2394</td>
<td>2773</td>
<td>221</td>
<td>***</td>
</tr>
<tr>
<td>Carcass weight (g)</td>
<td>1371</td>
<td>1567</td>
<td>135</td>
<td>***</td>
</tr>
<tr>
<td>Perirenal fat %</td>
<td>1.36</td>
<td>1.67</td>
<td>0.34</td>
<td>***</td>
</tr>
<tr>
<td>pH LD</td>
<td>5.80</td>
<td>5.80</td>
<td>0.06</td>
<td>NS</td>
</tr>
<tr>
<td>pH ST</td>
<td>6.04</td>
<td>6.07</td>
<td>0.08</td>
<td>NS</td>
</tr>
</tbody>
</table>

Semitendinosus traits

**Muscle fibres**

Mean cross sectional area (µm²) | 2654 | 2374 | 327 | **
Total number (x1000) | 75876 | 73942 | 12147 | NS

% fibre type in the superficial part

% I | 16.9 | 17.5 | 3.7 | NS
% IIa | 19.5 | 19.2 | 4.3 | NS
% IIb | 63.6 | 63.3 | 5.9 | NS

% fibre type in the deep part

% I | 0.82 | 1.05 | 0.93 | NS
% IIa | 6.75 | 6.28 | 3.98 | NS
% IIb | 92.4 | 92.7 | 4.6 | NS

**Warner Bratzler parameters on entire muscle**

F max (N) | 35.9 | 33.4 | 5.4 | NS
X max (mm) | 6.13 | 6.64 | 0.96 | NS
A max (mJ) | 128 | 130 | 3 | NS
F rupture (N) | 7.52 | 7.21 | 1.22 | NS
X rupture (mm) | 12.5 | 18.8 | 1.9 | NS
A rupture (mJ) | 253 | 241 | 5 | NS

**Warner Bratzler parameters on core muscle**

F max (N) | 46.1 | 42.7 | 8.5 | NS
X max (mm) | 8.07 | 7.84 | 2.58 | NS
A max (mJ) | 170 | 160 | 5 | NS
F rupture (N) | 6.80 | 8.49 | 2.74 | NS
X rupture (mm) | 27.9 | 28.8 | 4.4 | NS
A rupture (mJ) | 560 | 540 | 10 | NS

**Intramuscular fat (%)**

<table>
<thead>
<tr>
<th>HW</th>
<th>LW</th>
<th>Std</th>
<th>P</th>
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<tr>
<td>1.6</td>
<td>1.4</td>
<td>0.46</td>
<td>NS</td>
</tr>
</tbody>
</table>

**Forepart traits**

weight (g) | 502 | 427 | 50.3 | ***
Tobec value | 297 | 308 | 9.3 | ***
Dry matter (%) | 36.3 | 35.0 | 1.8 | *

** Hindpart traits**

Tobec value | 339 | 340 | 5 | NS
Dry matter (%) | 25.9 | 25.8 | 7.0 | NS

(A) : HW : heavy weight, LW low weight, std standard error of the mean, *** P < 0.001, ** P < 0.01, * P < 0.05, NS P > 0.05 ; (B) : F max = maximal shear force, X max = distance covered until F max, A max = Energy

**CONCLUSION**

Selection on live body weight at a fixed age greatly affected the weights of the marketed carcass and the retail cuts. Increased muscle weight mostly resulted from myofibre...
hypertrophy. Muscle fibre type composition, ultimate pH and intra-muscular lipid content were not affected by selection and only dry matter in the fore part was different between heavy and low lines. Rheological properties, measured on entire or on a standardised core of semitendinosus muscle were similar in animals from both lines. Thus, at the same age, heavy or light animals had very similar properties, and meat quality should not be greatly affected by this selection.

AKNOWLEDGEMENT
Thanks are due to the staff of the rabbit experimental unit in Langlade (SELAP) for their technical assistance.

REFERENCES