**PROCEEDINGS OF THE 11th WORLD RABBIT CONGRESS**
Qingdao (China) - June 15-18, 2016
**ISSN 2308-1910**

Session
# Breeding and Genetics

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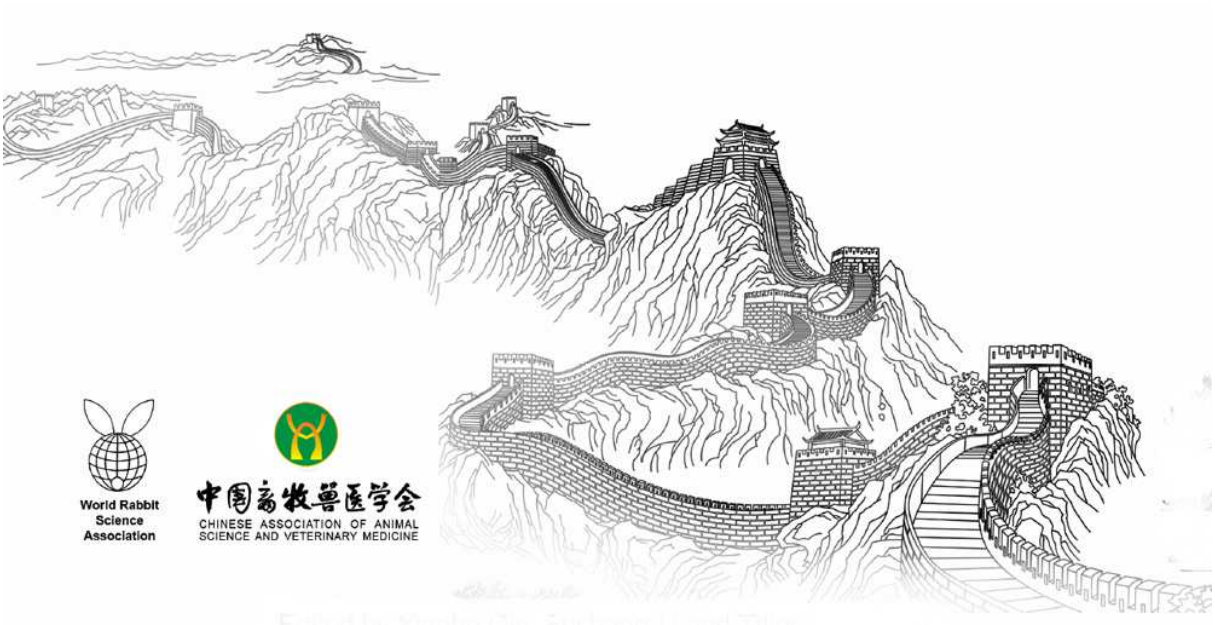
**Full text of the communication**

*How to cite this paper :*
*Martínez-Álvaro M., Blasco A., Hernández P., 2016* - Effect of selection for intramuscular fat on fatty acid composition of several muscles in rabbits.. *Proceedings 11th World Rabbit Congress - June 15-18, 2016 - Qingdao - China, 77-80.*



# EFFECT OF SELECTION FOR INTRAMUSCULAR FAT ON FATTY ACID COMPOSITION OF SEVERALMUSCLES IN RABBITS

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## ABSTRACT

The aim of this work was to study the correlated responses in intramuscular fat (IMF) and fatty acid composition in muscles with different metabolism after six generations of divergent selection for IMF in *Longissimus dorsi*in rabbits.Sixty rabbits from the lines selected for high and low IMF were slaughtered at 9 wk.From each animal, *Longissimus dorsi*, *Biceps femoris*and *Supraspinatus*muscles were obtained. Intramuscular fat (expressed as g/100g of muscle) and fatty acid composition (expressed as a percentage of total fatty acids) were measured in each muscle.Differences between high and low lines for IMF were 0.30 g/100g in *Longissimus dorsi*, 0.45 g/100g in*Biceps femoris*and0.43g/100g in *Supraspinatus*.Selection did not affect saturated fatty acid (SFA)percentage but increased monounsaturated (MUFA) and decreased polyunsaturated fatty acid (PUFA) percentagesin the three muscles studied.Individual fatty acid percentages showed a similar pattern as the fatty acid groups.Selection for high IMF lead to unfavourable changes for PUFA/SFA and n-6/n-3 PUFA ratios in all muscles.

**Key words**: intramuscular fat, rabbit, fatty acid composition, correlated responses in muscles.

## INTRODUCTION

Intramuscular fat content (IMF) is one of the main factors affecting meat quality. Selection experiments on IMF are scarce (Sapp et al., 2002 in cattle; Zhao et al., 2007 in chickens and Schwab et al., 2009 in pigs).Only a divergent selection experiment on IMF is being carried out in rabbits, showing the high line 58% higher IMF than low line in the sixth generation (Martínez-Álvaro et al., 2016).
Selection for IMF has consequences on other quality traits and also could lead to different responses in muscles with different metabolism. The aim of this work is to study the correlated responses in IMF and fatty acid composition in muscles with different metabolism after selection for IMF in *Longissimus dorsi* in rabbits.

## MATERIALS AND METHODS

### Animalsand chemical analysis

This study was performed with rabbits from the sixth generation of a divergent selection experiment for IMF in *Longissimus dorsi*muscle. Selection was based on the phenotypic value of IMF measured by NIRS in 2 full sibs of the candidate (a male and a female) at 9 wk, as described inZomeño et al., (2013). A total of 60 rabbits from the lines selected for high IMF (H) and low IMF (L) were slaughtered at 9 wk (30 per line). After slaughter, carcasses were chilled for 24h at 4ºC. From each animal, *Longissimus dorsi*, *Biceps femoris*and *Supraspinatus*muscles were ground, freeze-dried and scanned withNIRS to measure IMF (expressed as g/100g of muscle on a fresh basis) and fatty acid composition(expressed as a percentage of total fatty acids). Calibration equations previously developed by Zomeño et al., (2012)were applied.Saturated fatty acids (SFA) wasestimated as the sum of C14:0,C15:0,C16:0,C17:0 and C18:0;monounsaturated fatty acids (MUFA) was estimated as the sum of C16:1,C18:1n-7 and C18:1n-9; and polyunsaturated fatty acids (PUFA) was estimated as the sum of n-6 (C18:2n-6,C20:2n-6,C20:3n-

6,C20:4n-6,C20:5n-6 and C22:4n-6) and n-3 (C18:3n-3,C20:5n-3,C22:5n-3 and C22:6n-3).All the individual fatty acids were measured, but only the more relevantones are reported in tables.

**Statistical Analysis**

All the traits were analyzed fitting a model including the line, sex and season (3 levels) as fixed effects and common litter (34 levels) as a random effect. Bayesian inference was used. Normal priors for the random effects and flat priors for the remaining effects were used.

## RESULTS AND DISCUSSION

Table 1 presents the descriptive statistics of traits. Muscles *Longissimus dorsi*, *Biceps femoris* and *Supraspinatus*have different metabolism, as observed byDelmas and Ouhayoun, (1990) in rabbits. These authors reported a high glycolytic activity in *Longissimus dorsi* and a high oxidative activity in *Supraspinatus*, whereas*Biceps femoris*was intermediate between them. Muscles *Biceps femoris* and *Supraspinatus* presented higher IMF and MUFA percentage and lower PUFApercentage than *Longissimus dorsi* (Table 1).

**Table 1**.Descriptive statistics of traits

| | *Longissimus dorsi* | | *Biceps femoris* | | *Supraspinatus* | |
|---|---|---|---|---|---|---|
| | Mean | CV[1]x100 | Mean | CV[1]x100 | Mean | CV[1]x100 |
| IMF[2] | 1.05 | 13.3 | 2.08 | 23.1 | 2.08 | 17.3 |
| C16:0 | 15.1 | 14.5 | 17.7 | 6.15 | 16.7 | 7.74 |
| C18:0 | 9.77 | 8.43 | 7.97 | 5.56 | 8.04 | 4.79 |
| SFA[3] | 36.9 | 5.55 | 36.1 | 3.38 | 31.8 | 4.60 |
| C16:1 | 1.22 | 40.2 | 2.31 | 26.4 | 1.62 | 33.7 |
| C18:1 n-9 | 19.0 | 10.5 | 25.3 | 5.79 | 24.8 | 5.26 |
| MUFA[4] | 21.4 | 12.9 | 29.9 | 7.33 | 29.0 | 6.47 |
| C18:2 n-6 | 28.2 | 6.84 | 27.1 | 5.66 | 32.7 | 10.0 |
| C18:3 n-3 | 1.80 | 12.4 | 2.40 | 4.42 | 2.99 | 7.76 |
| C20:4n-6 | 6.99 | 15.9 | 3.53 | 22.2 | 3.30 | 19.7 |
| C20:5n-3 | 1.86 | 18.0 | 0.82 | 24.1 | 0.61 | 21.1 |
| C22:6n-3 | 2.53 | 23.2 | 1.13 | 26.7 | 1.12 | 27.4 |
| PUFA[5] | 43.4 | 9.33 | 33.4 | 7.37 | 35.7 | 8.51 |
| PUFA/SFA | 1.18 | 10.5 | 0.93 | 8.06 | 1.13 | 11.6 |
| n-6/n-3 | 6.19 | 5.91 | 8.01 | 4.77 | 8.07 | 6.10 |

[1]CV: coefficient of variation.[2]IMF; intramuscular fat expressed as g/100g muscle; [3]SFA, saturated, [4]MUFA,monounsaturated and [5]PUFA polyunsaturated fatty acids. Groups and individual fatty acids are expressed as a percentage of total fatty acids.

Table 2 shows the response to selection and correlated responses in fatty acid composition estimated as differences between lines. Response to selection for IMF of *Longissimus dorsi* was 0.30 g/100g, representing a 28.6% of the mean, with a probability of the difference between lines being higher than 0 (P) equal to 1.00. Correlated responses in IMF of *Biceps femoris* and *Supraspinatus* were positive. Differences between lines were0.45 g/100g in *Biceps femoris*and 0.43g/100gin *Supraspinatus*, representing a 21.6% and 20.7% of their means, respectively (P=1.00).Zhao et al., (2007) carried out a selection experiment for high IMF of breast in broilers showing a positive correlated response in the hind leg, in agreement with our results. Ros-Freixedes et al., (2014) estimated a positive and high genetic correlation between IMF in *Gluteus medius*and *Longissimus dorsi*in a selection experiment for an index including growth rate, back fat depth and IMF in pigs.

Selection did not affect SFA percentage but increased MUFA (P=1.00) and decreased PUFA percentages (P=1.00) in thethree muscles studied. Although lines were similar for SFA percentage, theyshowed differences in SFA C16:0 and C18:0. High line showed higher C16:0percentages in *Longissimus dorsi*(P=0.99) and *Biceps femoris* (P=0.96) but not in *Supraspinatus*. In contrast, high line had lower percentage of C18:0 in the three muscles (P=1.00). Selection for IMF changed the main individual MUFA fatty acids percentages (C16:1 and C18:1n-9) in the three muscles (P=1.00).All the muscles showed lower individual PUFA percentages in the high line (P ≥0.98), except for C18:3n-3 that showed different patterns in the three muscles.The decrease in PUFA percentage when increasing IMF is explained by the increase of triacylglycerols in comparison to phospholipids in muscle lipids of animals with high IMF (De Smet et al., 2004; Sellier et al., 2010).

**Table 2**. Features of the marginal posterior distributions ofthe differences between lines for intramuscular fat (IMF) and fatty acid composition (expressed as a percentage of total fatty acids) of*Longissimus dorsi*, *Biceps femoris* and *Supraspinatus* muscles.

| | *Longissimus dorsi* | | | *Biceps femoris* | | | *Supraspinatus* | | |
|---|---|---|---|---|---|---|---|---|---|
| | $D^1_{H-L}$ | $HPD_{95\%}{}^2$ | $P^3$ | $D^1_{H-L}$ | $HPD_{95\%}{}^2$ | $P^3$ | $D^1_{H-L}$ | $HPD_{95\%}{}^2$ | $P^3$ |
| IMF[4] | 0.30 | 0.23, 0.38 | 1.00 | 0.45 | 0.19, 0.72 | 1.00 | 0.43 | 0.21, 0.66 | 1.00 |
| C16:0 | 1.87 | 0.52, 3.22 | 0.99 | 0.59 | -0.10, 1.26 | 0.96 | -0.13 | -0.94, 0.59 | 0.63 |
| C18:0 | -1.78 | -2.26, -1.34 | 1.00 | -0.47 | -0.76, -0.21 | 1.00 | -0.45 | -0.69, -0.20 | 1.00 |
| SFA[5] | 0.15 | -1.07, 1.43 | 0.59 | 0.13 | -0.63, 0.88 | 0.64 | -0.19 | -0.99, 0.68 | 0.67 |
| C16:1 | 1.00 | 0.69, 1.34 | 1.00 | 0.60 | 0.24, 0.98 | 1.00 | 0.63 | 0.29, 0.99 | 1.00 |
| C18:1 n-9 | 4.82 | 3.68, 5.89 | 1.00 | 1.49 | 0.63, 2.34 | 1.00 | 1.67 | 0.83, 2.46 | 1.00 |
| MUFA[6] | 6.73 | 5.17, 8.29 | 1.00 | 2.25 | 0.93, 3.50 | 1.00 | 2.48 | 1.27, 3.66 | 1.00 |
| C18:2 n-6 | -2.77 | -3.87, -1.69 | 1.00 | -1.29 | -2.18, -0.47 | 1.00 | -3.78 | -5.81, -1.84 | 1.00 |
| C18:3 n-3 | 0.29 | 0.15, 0.43 | 1.00 | 0.03 | -0.03, 0.10 | 0.84 | -0.23 | -0.36, -0.08 | 1.00 |
| C20:4n-6 | -2.53 | -3.17, -1.90 | 1.00 | -0.75 | -1.23, -0.29 | 1.00 | -0.72 | -1.15, -0.32 | 1.00 |
| C20:5n-3 | -0.81 | -0.99, -0.63 | 1.00 | -0.24 | -0.35, -0.11 | 1.00 | -0.19 | -0.26, -0.11 | 1.00 |
| C22:6n-3 | -1.16 | -1.53, -0.8 | 1.00 | -0.29 | -0.49, -0.1 | 1.00 | -0.20 | -0.39, 0.01 | 0.98 |
| PUFA[7] | -9.56 | -11.9, -7.25 | 1.00 | -2.57 | -4.05, -1.12 | 1.00 | -3.57 | -5.41, -1.75 | 1.00 |
| PUFA/SFA | -0.26 | -0.32, -0.18 | 1.00 | -0.07 | -0.12, -0.02 | 1.00 | -0.11 | -0.19, 0.03 | 0.99 |
| n-6/n-3 | 0.72 | 0.51, 0.94 | 1.00 | 0.33 | 0.10, 0.57 | 1.00 | 0.26 | -0.03, 0.55 | 0.96 |

[1]$D_{H-L}$: median or the difference between high (H) and low (L) lines;[2]$HPD_{95\%}$: highest posterior density region at a 95% of probability;[3]P: probability of the difference being >0 when is positive or <0 when is negative; [4]IMF; intramuscular fat expressed as g/100g muscle; [5]SFA, saturated, [6]MUFA, monounsaturated and [7]PUFA, polyunsaturated fatty acids. Groups and individual fatty acids are expressed as a percentage of total fatty acids.

Selection for IMF lead to changes for PUFA/SFA and n-6/n-3 PUFA ratios in all muscles. The high line showed 0.26, 0.07 and 0.11 lower PUFA/SFA ratios than the low line in *Longissimus dorsi*, *Biceps femoris* and *Supraspinatus*, respectively (P=1.00). The n-6/n-3 ratio was 0.72, 0.33 and 0.26 higher in the high line than in the low line in *Longissimus dorsi*, *Biceps femoris* and *Supraspinatus*, respectively (P≥0.96). However, due to the low amount of IMF of the rabbit (Table 1) these changes will not compromise human health when eating rabbit meat.

No previous studies about the effect of selection for IMF in fatty acid composition of the meat have been published. Nevertheless, some studies compared the fatty acid composition in several lines of rabbit differing in their IMF. Gašperlin et al.,(2006) and Polak et al., (2006) found no difference in the fatty acid profile of their lines, whereas Hernández et al., (2008)did not find any pattern between IMF and fatty acid composition.

## CONCLUSIONS

Selection for intramuscular fat in muscle *Longissimus dorsi* showed a positive correlated response in IMF inmuscles having different metabolism. Selection for IMFmodified the fatty acid composition,increasing the percentage of MUFA and reducing the percentage of PUFA in all the muscles.

## ACKNOWLEDGEMENTS

This work was supported by project AGL2011-29831-C03-01 from the Spanish National Research Plan. M. Martínez-Álvaro acknowledges a FPI grant (BES-2012-052655) from the Economy Ministry of Spain. The authors thank VerónicaJuste and Federico Pardo for their technical assistance.

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