Between and within breed variation for lean growth and intramuscular fat content and fatty acid composition in pigs

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Abstract

A first experiment in 229 barrows examined the effect of the genetic type on growth, carcass composition and intramuscular fat (IMF) content and composition. Four genetic types were used: Landrace x Large White (LSLW), Duroc, either inseminated with boars from the same (D1D1) or a different line (D1D2), and Duroc x Iberian (D1IB). All pigs were reared until 200 days under the same conditions. IMF was analysed in the gluteus medius muscle. The LSLW barrows grew faster than the other types. IMF displayed an inverse relationship with carcass lean content, with values being 5.6, 4.4, 3.4, and 1.9% for D1IB, D1D1, D1D2, and LSLW, respectively. The most saturated IMF was observed in D1IB whereas the most polyunsaturated in LSLW. Purebred D1D1 showed a higher proportion of monounsaturated fatty acids than D1D2, where IMF was instead more polyunsaturated. A second experiment has been initiated in D1 to test whether selection against backfat depth at restrained body weight and IMF content is a useful strategy for reducing backfat but not IMF. Preliminary results at hand indicate that selected pigs (n=106) showed lower backfat depth than controls (n=110), with no significant change in IMF content and composition.

Introduction

IMF content and composition are associated to meat eating quality, organoleptic characteristics and human health, being particularly important in the production of high quality cured products, as is the case of Spanish traditional cured ham. There is an important genetic variation in IMF content and composition both between and within breed (Serra et al., 1998; Wood et al., 2004, Estany and Tor, 2007). Although Iberian and Duroc were amongst those breeds showing a higher level of IMF, there can be important differences between lines (Cilla et al., 2006), with those with higher IMF displaying also higher backfat depth (BF). This study investigates the effect of the breed, the line, and the selection group within a line on IMF content and composition, as well as their relationship with growth and carcass composition traits. Thus, we first examine the differences between four genotypes specialised in cured ham production, i.e. two Duroc lines were compared against white and Iberian crossbred pigs. In a second experiment, two groups of the same Duroc line, differing only in the predicted genetic value for backfat depth, were compared.

Material and methods

Experimental designs and animals. In Experiment 1 Landrace x Large White (LSLW) crossbred pigs were compared with purebred Duroc (D1D1), crossbred Duroc (D1D2), where sows (D1) were sired by boars from a different line (D2), and Duroc x Iberian crossbreds (D1IB) pigs. A total of 229 barrows, evenly distributed into the four genotypes were use in the experiment. Pigs were produced by 95 sows and 32 boars and were reared until 200 days in two batches under commercial conditions. In experiment 2, 125 litters produced by 53 boars from Duroc D1 were selected in order to be grouped into two classes differing in the predicted mid-parent breeding value for BF at 180 days but not for the predicted breeding values for average daily gain (ADG) up to 180 days and IMF content. Litters in class S (n=64) were selected against BF while litters in group C (n=61) were randomly chosen. Linear programming was used to select the litters satisfying the above constraints. Approximately two barrows per litter were chosen at random and then raised in two batches until 215 days of age. Differences between groups in the predicted breeding value for BF, ADG, and IMF were -0.8 mm, -4.8 g/d, and 0.0%, respectively. Pigs were given ad libitum access to pelleted feed.

Measurements and data analysis. Live backfat and loin thickness were measured at 5 cm off the midline at the position of the last rib (Piglog 105®, SFK-Technology) while carcass backfat and loin measurements were done at 6 cm off the midline between the third and fourth last ribs (Autofom®, SFK-Technology). The carcass lean content was estimated using the Spanish officially approved equation. After chilling for about 24 h at 2ºC, carcasses were divided into standardized commercial joints and the hams weighted. A sample of 50 g of the gluteus medius muscle (GM) from the left ham was taken from all slaughtered pigs. GM samples were minced and a representative aliquot from the pulverized freeze-dried muscle was used for chemical analyses. IMF was determined in duplicate by quantitative determination of the fatty acids by gas chromatography with capillary column. Data were analysed using a model that included the batch, the genetic type and the age (or carcass weight) by genetic type as a covariate. Least square means differences were assessed by the Tukey-Kramer test.

Results and discussion

The least-square means for performance, carcass and IMF traits by genotype are shown in Table 1. The LSLW barrows grew faster and were leaner than the other genotypes. No differences in growth were found among the other genotypes but D1IB pigs were fatter than D1D1 and these fatter than D1D2. A similar trend was observed for the weight of hams at fixed carcass weight. Results on IMF content displayed the inverse relationship, with the D1IB pigs showing the highest IMF content. D1IB pigs also showed the most saturated IMF, with values around 2% higher than the others, which did not differ among them. More differences were found for monounsaturated (polyunsaturated) fatty acids, which increased (decreased) with the IMF content. IMF in D1D1 was 1.4% more monounsaturated than in D1D2 but 2% less polyunsaturated. These results confirm that there is an important variation for IMF content between both breed and line but also that, among commonly used genotypes for ham production, IMF content is unfavourably related with carcass lean content, although favourably with the monounsaturated fatty acid percentage.

Table 1. Least-square means for performance, carcass and intramuscular fat traits by genotype

Trait	Genetic Type			
	LSxLW	D1xD2	D1xD1	D1xIB
Live measurements at 165 days				
Body weight, kg	105.72±1.56^{a}	94.62±1.52^{b}	92.20±1.63^{b}	93.44±1.54^{b}
Backfat thickness, mm	11.69±0.43^{a}	13.01±0.42^{a}	14.83±0.45^{b}	25.17±0.43^{c}
Loin thickness, mm	51.85±0.66^{a}	45.72±0.64^{b}	43.06±0.69^{c}	41.51±0.66^{c}
Live measurements at 200 days				
Body weight, kg	136.04±1.52^{a}	124.42±1.88^{b}	121.49±1.64^{b}	122.22±2.19^{b}
Backfat thickness, mm	16.85±0.46^{a}	18.15±0.56^{ab}	19.80±0.49^{b}	31.70±0.66^{c}
Loin thickness , mm	55.84±0.54^{a}	51.56±0.64^{b}	47.53±0.58^{c}	46.81±0.69^{c}
Carcass measurements at 95 kg				
Carcass weight , kg	104.83±1.25^{a}	95.98±1.27^{b}	94.14±1.35^{b}	93.98±1.46^{b}
Backfat thickness, mm	17.18±0.51^{a}	19.58±0.39^{b}	22.52±0.41^{c}	32.46±0.41^{d}
Loin thickness, mm	52.45±0.51^{a}	50.09±0.46^{b}	46.76±0.49^{c}	46.44±0.88^{c}
Weight of hams, kg	26.21±0.17^{a}	25.05±0.11^{b}	24.34±0.12^{c}	21.62±0.18^{d}
Lean content, %	54.81±0.46^{a}	52.24±0.35^{b}	49.13±0.38^{c}	40.33±0.41^{d}
IMF Gluteus medius, %	1.88±0.24^{a}	3.38±0.17^{b}	4.40±0.18^{c}	5.62±0.19^{d}
IMF FA composition at 95 kg				
Saturated FA	35.46±0.37^{a}	35.40±0.33^{a}	35.94±0.35^{a}	37.95±0.33^{b}
16:0	22.86±0.23^{a}	22.90±0.21^{a}	23.28±0.22^{a}	24.61±0.21^{b}
18:0	10.79±0.19^{ab}	10.54±0.16^{b}	10.68±0.18^{b}	11.39±0.17^{a}
Monounsaturated FA	43.11±0.43^{a}	47.42±0.32^{b}	48.85±0.34^{c}	49.50±0.34^{c}
16:1	3.22±0.09^{a}	3.72±0.07^{b}	3.81±0.07^{b}	3.69±0.07^{b}
18:1	39.20±0.40^{a}	42.92±0.29^{b}	44.22±0.31^{c}	45.03±0.31^{c}
Polyunsaturated FA	21.86±0.45^{a}	17.20±0.33^{b}	15.22±0.35^{c}	12.55±0.35^{d}
18:2	17.68±0.35^{a}	14.03±0.26^{b}	12.39±0.28^{c}	10.35±0.27^{d}
18:3	0.93±0.02^{a}	0.87±0.02^{ab}	0.80±0.02^{b}	0.70±0.02^{c}

[a,b,c,d] LSM estimates with different superscripts whitin a row differ, $p<0.05$

The least-square means for performance, carcass and IMF traits between groups S and C are shown in Table 2. Groups differed for BF at 165 and 180 days but not at 210 days ($p=0.06$). Differences between groups were maintained when BF was adjusted at 85 kg ($p<0.001$), 105 kg ($p<0.05$) and 120 kg ($p=0.17$) live weight. No significant differences were found for growth adjusted for age, as wells as for carcass BF, carcass lean content and IMF content and composition adjusted for carcass weight. Results at hand indicate that there is genetic variation for BF at restrained growth and IMF content but also that selection response can be sensitive to the age (or weight) at which measurements are taken. Therefore, it would be advisable to develop the selection criteria according to the target slaughter weight.

Table 2. Least-square means for performance, carcass and intramuscular fat traits by genetic group

Trait	Genetic Group S	Genetic Group C
Measurements at 165 days		
Body weight, kg	85.01±2.13	85.22±2.15
Backfat thickness, mm	14.87±0.79[a]	17.01±0.79[b]
Loin thickness , mm	39.63±0.67	39.08±0.67
Measurements at 180 days		
Body weight, kg	99.81±1.23	101.31±1.28
Backfat thickness, mm	16.78±0.41[a]	17.86±0.43[b]
Loin thickness , mm	44.55±0.55	45.57±0.58
Measurements at 210 days		
Body weight, kg	118.69±1.24	120.96±1.23
Backfat thickness, mm	20.45±0.41	21.54±0.40
Loin thickness , mm	48.24±0.48	48.58±0.48
Carcass Measurements at 95 kg		
Carcass weight , kg	92.87±1.08	94.94±1.04
Backfat thickness, mm	24.01±0.29	23.94±0.29
Loin thickness, mm	42.35±0.69	43.31±0.68
Weight of hams, kg	24.48±0.08[a]	24.18±0.08[b]
Lean content, %	47.13±0.32	47.34±0.31
IMF gluteus medius, %	4.33±0.19	4.52±0.19
IMF fatty acid composition		
SFA	29.96±0.30	29.67±0.29
16:0	19.32±0.19	19.13±0.18
18:0	8.63±0.13	8.50±0.13
MUFA	53.47±0.36	53.98±0.36
16:1	4.07±0.15	3.87±0.15
18:1	48.34±0.33	49.02±0.33
PUFA	16.58±0.34	16.35±0.34
18:2	12.88±0.24	12.96±0.24
18:3	0.85±0.01	0.86±0.01

[a,b] LSM estimates with different superscripts whitin a row differ, $p<0.05$

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