

# ISU IMF Selection Project

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## INTRODUCTION

Intramuscular fat (IMF) percentage is receiving greater attention in breeding programs due to its role in consumer acceptance (DeVol et al., 1988; Van Oeckel et al., 1999). Until recently, identification of genetically superior breeding stock for IMF was limited to use of sib and progeny testing. Recent developments in real-time ultrasound technology have allowed accurate prediction of IMF in the live animal, and IMF has been reported to be moderately heritable and genetically associated with other indicators of meat quality (Newcom et al., 2003). However, the development of optimal selection criteria requires knowledge of expected correlated responses among other economically important traits. In order to study the responses to selection for IMF, a large-scale selection experiment involving purebred Duroc swine was initiated in 1998. The primary objective of this investigation was to evaluate the efficacy of selection for IMF as determined by direct phenotypic response. A second objective was to determine correlated phenotypic effects in other economically important traits.

## MATERIALS AND METHODS

### *Derivation of Lines*

A large-scale selection project was initiated in 1998 through the purchase of 40 registered Duroc gilts from 10 midwest Duroc breeders. Using semen from Duroc boars available in regional U.S. boar studs, 2 generations of random mating were conducted to expand the population and produce the base generation of 56 litters. At weaning, 2 boars in each litter (when available) were randomly selected to remain intact while all other males were castrated. Littermate pairs of gilts from the base generation were randomly designated to either the control (CL) or select line (SL). Littermate pairs of females were then mated to the same boar (via natural mating or AI) to establish sufficient genetic ties between lines before selection was initiated. A total of 24 sires from 14 different sire families were utilized to generate 50 CL and 45 SL litters in generation 1. All boars and females utilized within the base generation were tested to ensure the absence of the recessive mutant HAL<sup>1843</sup> allele (Fujii et al., 1991). In subsequent generations, up to 4 boars in each SL litter (when available) were randomly selected to remain intact to increase selection intensity.

### *Progeny Test and Ultrasound Measurements*

Pigs were housed in a mechanically ventilated, curtain-sided finishing building with fully slatted floors and were provided 0.77 m<sup>2</sup> of floor space each in pens of 20 to 25 pigs from 34 kg until they were weighed and scanned off test at a pen average weight of 110 kg. A 17.5% CP, 1.15% lysine corn-soy diet was provided ad libitum from 34 to 68 kg, followed by a 16.0% CP, 0.85% lysine corn-soy diet from 68 to 91 kg, and a 15.0%

CP, 0.70% lysine corn-soy diet from 91 kg to market weight. All generation 6 progeny were weighed on test at a mean live weight of 42 ( $\pm 9$ ) kg. The total number of pigs evaluated within each line and generation are presented in Table 1. Off-test ultrasonic measurements of 10<sup>th</sup> rib LM area (ULMA), off-midline backfat (UBF), and intramuscular fat percentage (UIMF) were collected at a mean live weight of 110 ( $\pm 14$ ) kg. Ultrasonic images were collected with an Aloka 500V SSD ultrasound machine fitted with a 3.5 MHz, 12.5 cm linear-array transducer (Corometrics Medical Systems, Inc., Wallingford, CT) by a National Swine Improvement Federation certified technician (Bates and Christian, 1994). Off-midline UBF and ULMA were measured from a cross-sectional image taken at the 10<sup>th</sup> rib. A minimum of 4 longitudinal images were collected 7 cm off-midline across the 10<sup>th</sup> to 13<sup>th</sup> ribs. Final image parameters were generated using texture analysis software (Amin et al., 1997) and were included in a regression equation developed by Newcom et al. (2002) to estimate intramuscular fat percentage within the initial 3 generations. The regression equation used initially ( $R^2 = 0.32$ ) included five image parameters along with an individual measure of ultrasonic backfat. Updates to model parameters were then performed utilizing the most current carcass information ( $n = 770$ ) and the resulting model (Schwab and Baas, 2006) was used in prediction of intramuscular fat in generations 4 to 6. A greater amount of variation was described with final prediction equation ( $R^2 = 0.36$ ; RMSE = 1.31) which utilized 9 image parameters and with backfat information not included.

Kilograms of lean at market weight and at test entry were estimated for generation 6 progeny using the following fat-free lean equations (NPPC, 2000):

$$\text{Market weight lean (kg)} = 0.3782 \times \text{sex (barrow and boar} = 1; \text{ gilt} = 2) - 2.9488 \times (\text{UBF, cm}) + 0.3817 \times (\text{ULMA, cm}^2) + 0.291 \times (\text{off-test weight, kg}) - 0.2424$$

$$\text{Trial entry lean (kg)} = 0.188 \times (\text{on-test weight, kg}) - 1.644$$

Lean gain per day on test (LGOT) was calculated by subtracting the estimate of trial entry lean from market weight lean and dividing by days on test.

### ***Carcass Evaluation***

Upon completion of the performance test period, all available barrows and randomly selected gilts were sent to a commercial abattoir (Hormel Foods, Austin, MN) for carcass evaluation. Standard carcass collection procedures (NPPC, 2000), were followed to obtain measurements of 10<sup>th</sup> rib backfat (CBF10), last rib backfat (CLRBF), last lumbar backfat (CLLBF), loin muscle area (CLMA), and carcass length (LENGTH). Carcass pH was measured 24 h post-mortem on the 10<sup>th</sup> rib face of the longissimus muscle using a pH star probe (SFK Ltd, Hvidovre, Denmark). Objective color measurements of Hunter L score and Minolta Reflectance (a measure of light reflectance where lower values indicate darker and more desirable color) were obtained on the 10<sup>th</sup> rib face of the loin using a Minolta CR-310 (Minolta Camera Co., Ltd., Osaka, Japan) with a 50-mm-diameter aperture, D65 illuminant, and calibrated to the white calibration plate. A section of bone-in loin containing the 10<sup>th</sup> to 12<sup>th</sup> ribs was excised from the carcass and transported to the Iowa State University Meat Laboratory. A 3.2 mm slice from the 10<sup>th</sup> rib face was removed and utilized for percent lipid content analysis (CIMF) (Bligh and Dyer, 1959). The 11<sup>th</sup> and 12<sup>th</sup> rib sections were cut into 2.54 cm chops and set freshly cut side up for 10 min to allow the sample to bloom. Subjective measures of

color (1 = pale pinkish gray to white; 6 = dark purplish red), marbling (1 = 1.0% IMF; 10 = 10.0% IMF), and firmness (1 = soft; 3 = very firm) were evaluated on the 11th rib face according to NPPC (2000) by personnel trained in meat quality evaluation. Water holding capacity was measured on the 11th rib face using the filter paper method described by Kauffman et al. (1986) and is reported in milligrams of water absorbed by the filter paper (lower values are more desirable).

### ***Sensory Evaluation***

The 11th and 12th rib sections of each loin sample were vacuum packaged and taken to the Iowa State University Food Science Laboratory where they were refrigerated at 0° C for 7 d. A trained sensory panel with 3 members evaluated cooked loin quality attributes (Huff-Lonergan et al., 2002). Weights prior to and immediately after cooking were used to calculate percent cooking loss. Three 1.3 cm<sup>3</sup> cubes were removed from the center of the 11th rib sample and evaluated by the trained sensory panel for juiciness (1 = dry, 10 = juicy), tenderness (1 = tough; 10 = tender), chewiness (1 = not chewy; 10 = very chewy), flavor (1 = little pork flavor, bland; 10 = extremely flavorful, abundant pork flavor), and off-flavor (1 = no off-flavor; 10 = abundant non-pork flavor) using an end-anchored, 10-point scoring system (AMSA, 1995). The 12th rib section was evaluated for tenderness using an Instron Universal Testing Machine (model 1122; Instron Corp., Canton, MA) fitted with a circular, 5-pointed star probe (9 mm diameter with 6 mm between points) (Oltrogge-Hammernick and Prusa, 1987).

### ***Genetic Evaluation and Mating Procedures***

In order to evaluate the most accurate and efficient selection method, carcass and ultrasound information from the first 2 generations was utilized to simulate subsequent generations using 3 different selection models (Newcom et al., 2005). Results of estimated genetic change in IMF illustrated that selection based on IMF EBV using a combination of UIMF and sib measures of CIMF should provide the greatest response to selection.

Breeding values within each generation were estimated for predicted (UIMF) and carcass (CIMF) intramuscular fat by fitting a 2-trait animal model in MATVEC (Wang et al., 2003) using the following model:  $y = Xb + Za + Wc + \beta x + e$ , where  $y$  = vector of observations;  $b$  = vector of fixed effects (contemporary group and sex),  $a$  = vector of random additive genetic effects, which utilizes the numerator relationship matrix among animals;  $c$  = vector of common litter effects, which is assumed to be uncorrelated with the random animal effects,  $\beta$  = linear regression coefficient,  $x$  = vector of appropriate off-test or hot carcass weight, and  $e$  = vector of residuals. The incidence matrices relating observations to fixed, random animal, and common litter effects are  $X$ ,  $Z$ , and  $W$ , respectively. Genetic and environmental (co)variances were updated each generation using UIMF and CIMF values from all pigs in prior generations.

Selection was based on EBV for CIMF. In the select line, the 10 boars and 75 gilts with the highest EBV were selected. Inbreeding coefficients of individuals and all possible matings among selection candidates were calculated with the use of the INBREED procedure of SAS (SAS Inst., Cary, NC). This information was utilized to design matings in both lines in an attempt to minimize inbreeding accumulation.

Average inbreeding coefficients for progeny in generation 6 were 4.8% and 9.5% for the control and select lines, respectively.

### **Statistical Analysis**

Line differences for meat and eating quality traits in generation 6 were assessed using the MIXED procedure of SAS (SAS Inst., Cary, NC). Least squares means and corresponding standard errors were computed with the use of the following base model:

$$y_{ijkmp} = L_i + S_j + CG_k + LS_{ij} + b_1 WT_m + SR(L)_{ni} + DM(L)_{pi} + \varepsilon_{ijkmp}$$

where  $y_{ijkmp}$  = the trait measured on pig  $m$ , in line  $i$ , of sex  $j$ , in contemporary group  $k$ , from sire  $n$  and dam  $p$ ;  $L_i$  = fixed effect of line  $i$ ;  $S_j$  = fixed effect of sex  $j$ ;  $CG_k$  = fixed effect of contemporary group  $k$ ;  $LS_{ij}$  = effect of the interaction of line  $i$  and sex  $j$ ;  $WT_m$  = linear effect of the appropriate carcass or off-test weight of pig  $m$ ;  $SR(L)_{ni}$  = effect of sire  $n$  nested within line  $i$ , assumed random with  $SR(L)_{ni} \sim N(0, \sigma_{SR}^2)$ ;  $DM(L)_{pi}$  = effect of dam  $p$  nested within line  $i$ , assumed random with  $DM(L)_{pi} \sim N(0, \sigma_{DM}^2)$ ;  $\varepsilon_{ijkmp}$  = residual with  $\varepsilon_{ijkmp} \sim N(0, \sigma_\varepsilon^2)$ .

The above model is the result of a stepwise process of fitting all 2-way interactions between fixed effects along with second and third order polynomial effects for the WT covariate and subsequently removing non-significant ( $P > 0.05$ ) fixed effects sequentially. Model effects detailed above were included for the analysis of all performance and carcass composition measures except for average daily gain and lean gain on test, where the covariate of WT at off-test was replaced with a covariate of on-test weight. With the exception of IMF measures, the linear effect of WT was not a significant source of variation for meat and eating quality traits and was removed from the final model for analysis. To evaluate the possible effect of inbreeding depression on performance, dependent variables were adjusted for individual inbreeding level with the inclusion of a linear covariate of individual inbreeding coefficient. However, the linear effect of inbreeding level was not significant ( $P > 0.05$ ) for any of the performance measures evaluated and was excluded from the model for analysis.

## **RESULTS AND DISCUSSION**

### **Response in Traits under Direct Selection Pressure**

Selection candidates were chosen based on genetic merit for IMF. Estimated breeding values used for selection were derived from a 2-trait animal model that included measurements of UIMF from all animals progeny tested and CIMF from a random sample of harvested barrows and gilts. Through 6 generations of selection, an 88% improvement in IMF has been realized (4.53% in SL vs. 2.41% in CL). This result indicates that CIMF responds directly to selection using BLUP methodology and corresponds to what may be expected from moderate heritability values reported for CIMF and UIMF from previous investigations (Newcom et al., 2005). The phenotypic response realized for CIMF coincides with a slightly smaller phenotypic response in UIMF observed after 6 generations of selection. The difference in response between the 2 measures of IMF may be a function of the sex effect that exists for both measures. Boars have significantly less UIMF than gilts or barrows (data not shown), and because no boars were harvested, they are not represented in the mean CIMF levels. Additionally, the ultrasonic prediction method inherently regresses UIMF phenotypes

toward mean levels, resulting in decreased phenotypic variance. Similarly, Newcom et al. (2005) reported lower genetic variance and heritability estimates for ultrasonically measured IMF when compared to the chemical analysis measurement method.

### **Correlated Responses in Growth Performance and Carcass Composition**

Line LS means for measures of growth performance and carcass composition are presented in Table 2. No significant differences ( $P > 0.05$ ) were observed between lines for growth performance, whether measured as the number of days required to reach 114 kg of BW (DAYS), daily accumulation of BW (ADG), or daily accretion of lean tissue (LGOT). These results suggest that breeding programs aimed solely at improvement of IMF, should not expect large correlated changes in growth. These findings are consistent with the reports of an investigation of the correlated responses in muscle quality from 6 generations of selection for lean growth efficiency in Duroc pigs (Lonergan et al., 2001), where significant increases in growth and leanness were not associated with marbling.

Results of this study revealed significant correlated responses in various measures of carcass composition. A difference of 6.17 mm greater backfat measured ultrasonically at the tenth rib ( $P < 0.01$ ) was found in the SL, similar in magnitude to the difference detected on the carcass at the same location ( $P < 0.01$ ) in a random sample of pigs harvested. A smaller line effect was also found for carcass measures at the last thoracic (CLRBF) and last lumbar (CLLBF) vertebrae (Table 2). The SL had less loin muscle area ( $P < 0.01$ ) when compared to the CL, whether measured on the carcass of harvested pigs or predicted ultrasonically on the live animal. Genetic and phenotypic correlations among components of carcass leanness and intramuscular fat have been well documented (Berger et al., 1994; Schwab et al., 2006; Sellier, 1998; Suzuki et al., 2005) and support the correlated responses in carcass composition observed in the population under study.

### **Correlated Responses in Measures of Meat Quality**

Least squares means for measures of meat quality are presented by line in Table 3. The direct response in IMF corresponded to a correlated increase ( $P < 0.01$ ), similar in magnitude, in subjective marbling score. However, subjective measures of firmness and color were not significantly different between lines.

Variation in pH values has been implicated to be associated with various measures of eating quality (Huff-Lonergan et al., 2002); however, its relationship with intramuscular fat has been documented to be small and insignificant (Sellier, 1998). Schwab et al. (2006) found no significant phenotypic relationship between pH and IMF in Duroc swine, regardless of genetic background for carcass leanness. As expected from results of previous investigations, no significant correlated responses were observed in the current study for pH measured at 24 h, 48 h, or 7 d post-mortem.

The significant phenotypic response in IMF after 6 generations of selection has also resulted in an 8% increase ( $P < 0.05$ ) in instrumental tenderness (Table 3). Water holding capacity and percent cooking loss are indicators of physical processing characteristics and were not significantly ( $P > 0.54$ ) affected by selection in the present study. These results confirm previous reports (Lonergan et al., 2007) that intramuscular lipid content is a significant source of variation for objective measures of tenderness at

intermediate levels of pH ( $5.50 \leq \text{pH} \leq 5.80$ ), but is not significantly associated with other objective meat quality characteristics.

Objective measures of loin color were significantly affected by selection for increased IMF. Loin samples from harvested SL pigs were associated with 2.33% more light reflectance and a 2.41 unit increase in Hunter L value at 24 h post-mortem when compared to their unselected CL counterparts. A smaller line difference was detected for the same pork color measurement at 48 h post harvest (Table 3). This difference is larger than expected based on the average published estimate of the genetic correlation between IMF and reflectance ( $r_g = 0.01$ ) reported by Sellier (1998). It is important to note that this correlated response in loin color may be influenced by variation in exposed IMF and may not reflect true differences in the pigmentation of lean tissue. To gain a better understanding of the influence of IMF on objective measures of lean color, a linear covariate of IMF, irrespective of line, as well as a linear covariate of IMF nested within line were included separately in the analysis described earlier. In both cases, the adjustment of objective color to the mean IMF level of the population or line-specific mean IMF did not provide a significantly ( $P > 0.05$ ) better fit of the color data (data not shown). In order to accurately assess the notion that the observed correlated response in loin color may be affected by variation in intramuscular fat, further evaluation of loin color phenotypes that are independent of IMF, such as muscle pigmentation (myoglobin concentration), is warranted.

### **Correlated Responses in Measures of Eating Quality**

General palatability of pork products is typically estimated by objective and subjective meat quality measures evaluated on the carcass. However, the ultimate goal of assessing potential variation in the consumer eating experience may be more accurately estimated utilizing sensory panel evaluations. As illustrated by Thompson (2004), consumer panels are effective when they estimate sensory attributes, but have the disadvantage that correlations between the different attributes are generally high within a given panelist. This complicates the interpretation of relationships among sensory evaluations and carcass traits.

Least squares means for measures of sensory panel scores are presented in Table 4. A general trend for more desirable sensory scores was observed for the SL within the current study; however, statistically significant ( $P < 0.05$ ) differences were only detected for measures of pork flavor intensity and incidence of off-flavor. Elevated levels of juiciness and texture have been implicated to be associated with higher IMF percentages in previous investigations in beef (Thompson, 2004). In pork, elevated levels of IMF have been reported to be associated with higher sensory scores for juiciness, flavor, tenderness, and overall palatability (Murray et al., 2004). However, Van Oeckel et al. (1999) reported a stronger relationship between IMF and flavor as well as tenderness when compared to juiciness. Similarly, in 2 lines of Duroc pigs representing different mean levels of carcass composition, Schwab et al. (2006) reported significant phenotypic correlations between IMF and sensory evaluations of juiciness, flavor, and off-flavor. The results of previous investigations generally support the correlated responses observed after 6 generations of selection for IMF in the current population, while slight deviations

from the present study and those previously reported may be specific to the specie or population evaluated along with the number of observations utilized to assess differences.

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**Table 1.** Distribution of records by generation and line from a selection experiment for increased intramuscular fat in Duroc swine

Trait category	Generation						Total
	1	2	3	4	5	6	
	No. of observations						
<b>Select line<sup>a</sup></b>							
Litters	45	56	54	75	63	60	353
Growth and ultrasound meas.	291	379	373	484	373	344	2,244
Carcass and sensory meas.	64	54	64	77	70	72	401
Boars	75	119	123	182	128	118	745
Gilts	145	192	187	237	188	180	1129
Barrows	71	68	63	65	57	46	370
<b>Control line<sup>b</sup></b>							
Litters	50	36	38	50	58	47	279
Growth and ultrasound meas.	345	235	264	349	410	277	1,880
Carcass and sensory meas.	86	47	81	71	101	77	463
Boars	85	59	63	98	102	72	479
Gilts	181	124	128	168	201	138	940
Barrows	79	52	73	83	107	67	461
<b>Total</b>							
Litters	95	92	92	125	121	107	632
Growth and ultrasound meas.	636	614	637	833	783	621	4,124
Carcass and sensory meas.	150	101	145	148	171	149	864
Boars	160	178	186	280	273	190	1224
Gilts	326	316	315	405	389	318	2,069
Barrows	150	120	136	148	164	113	831

<sup>a</sup>Select line = result of 6 generations of selection for increased intramuscular fat based on a 2-trait animal model that included IMF measured on the carcass and predicted via ultrasound.

<sup>b</sup>Control line = unselected, randomly mated population.

**Table 2.** Growth performance and carcass composition least squares means ( $\pm$ SE) from generation 6 of a selection experiment for increased intramuscular fat in Duroc swine.

Item	Line <sup>a</sup>		
	SL	CL	SL-CL
<b>Growth performance</b>			
Average daily gain, kg/d	0.78 $\pm$ 0.01	0.77 $\pm$ 0.01	0.02 $\pm$ 0.02
Lean gain on test, kg/d	0.22 $\pm$ 0.00	0.22 $\pm$ 0.00	0.00 $\pm$ 0.00
Days to 114 kg, d	189.54 $\pm$ 1.03	187.62 $\pm$ 1.15	1.93 $\pm$ 1.54
<b>Ultrasound measures</b>			
Scan backfat, mm	20.53 $\pm$ 0.58	14.35 $\pm$ 0.58	6.17 $\pm$ 0.80***
Scan loin muscle area, cm <sup>2</sup>	39.15 $\pm$ 0.53	42.73 $\pm$ 0.54	-3.62 $\pm$ 0.72***
Predicted intramuscular fat, %	4.55 $\pm$ 0.10	3.09 $\pm$ 0.10	1.46 $\pm$ 0.14***
<b>In-plant carcass composition</b>			
Length, cm	81.94 $\pm$ 0.34	81.44 $\pm$ 0.33	0.50 $\pm$ 0.47
Tenth rib backfat, mm	24.22 $\pm$ 0.84	16.63 $\pm$ 0.87	7.59 $\pm$ 1.19***
Last rib backfat, mm	24.43 $\pm$ 0.66	18.78 $\pm$ 0.66	5.65 $\pm$ 0.90***
Last lumbar backfat, mm	19.38 $\pm$ 0.76	14.87 $\pm$ 0.75	4.51 $\pm$ 1.06***
Loin muscle area, cm <sup>2</sup>	38.02 $\pm$ 0.77	45.45 $\pm$ 0.75	-7.43 $\pm$ 1.06***

<sup>a</sup>SL = select line, result of 6 generations of selection for increased intramuscular fat based on a 2-trait animal model that included IMF measured on the carcass and predicted via ultrasound; CL = randomly mated, unselected control line.

\*\*\* $P < 0.001$ .

**Table 3.** Meat quality least squares means ( $\pm$ SE) from generation 6 of a selection experiment for increased intramuscular fat in Duroc swine.

Item	Line <sup>a</sup>		
	SL	CL	SL-CL
Intramuscular fat, %	4.53 $\pm$ 0.25	2.41 $\pm$ 0.25	2.12 $\pm$ 0.35***
Subjective color <sup>1</sup>	3.25 $\pm$ 0.07	3.11 $\pm$ 0.08	0.14 $\pm$ 0.10
Subjective marbling <sup>2</sup>	4.89 $\pm$ 0.21	2.50 $\pm$ 0.21	2.39 $\pm$ 0.29***
Subjective firmness <sup>3</sup>	2.16 $\pm$ 0.05	2.05 $\pm$ 0.05	0.11 $\pm$ 0.07
24 h pH	5.65 $\pm$ 0.01	5.65 $\pm$ 0.01	0.00 $\pm$ 0.01
24 h Minolta reflectance, <sup>4</sup> %	24.49 $\pm$ 0.36	22.17 $\pm$ 0.36	2.33 $\pm$ 0.50***
24 h Hunter L value <sup>5</sup>	49.42 $\pm$ 0.37	47.00 $\pm$ 0.37	2.41 $\pm$ 0.52***
48 h pH	5.63 $\pm$ 0.01	5.62 $\pm$ 0.01	0.01 $\pm$ 0.02
48 h Minolta reflectance, <sup>4</sup> %	23.77 $\pm$ 0.36	22.40 $\pm$ 0.36	1.37 $\pm$ 0.50*
48 h Hunter L value <sup>5</sup>	48.78 $\pm$ 0.58	46.89 $\pm$ 0.58	1.89 $\pm$ 0.80*
Water holding capacity, mg	67.43 $\pm$ 2.91	69.81 $\pm$ 2.87	-2.38 $\pm$ 3.99
7 d pH	5.61 $\pm$ 0.01	5.60 $\pm$ 0.01	0.01 $\pm$ 0.02
Percent cooking loss, %	19.22 $\pm$ 0.41	18.87 $\pm$ 0.43	0.35 $\pm$ 0.58
Instron tenderness, kg	5.36 $\pm$ 0.15	5.81 $\pm$ 0.15	-0.45 $\pm$ 0.21*

<sup>a</sup>SL = select line, result of 6 generations of selection for increased intramuscular fat based on a 2-trait animal model that included IMF measured on the carcass and predicted via ultrasound; CL = randomly mated, unselected control line.

\* $P < 0.05$ ; \*\*\* $P < 0.001$ .

<sup>1</sup>Subjective color score (1 = pale pinkish gray to white; 6 = dark purplish red).

<sup>2</sup>Subjective marbling score (1 = 1.0% intramuscular fat; 10 = 10.0% intramuscular fat).

<sup>3</sup>Subjective firmness score (1 = soft; 3 = very firm).

<sup>4</sup>Minolta reflectance are objective measures of light reflectance (0 = 0% reflectance; 100 = 100% reflectance).

<sup>5</sup>Hunter L values are objective measures of exposed lean color (0 = black; 100 = white).

**Table 4.** Sensory panel evaluation least squares means ( $\pm$ SE) from generation 6 of a selection experiment for increased intramuscular fat in Duroc swine.

Item	Line <sup>a</sup>		
	SL	CL	SL-CL
Juiciness score	6.59 $\pm$ 0.13	6.37 $\pm$ 0.13	0.22 $\pm$ 0.18
Chewiness score	2.94 $\pm$ 0.18	3.06 $\pm$ 0.18	-0.12 $\pm$ 0.25
Tenderness score	6.52 $\pm$ 0.21	6.35 $\pm$ 0.21	0.17 $\pm$ 0.29
Flavor score	2.80 $\pm$ 0.13	2.39 $\pm$ 0.13	0.41 $\pm$ 0.18*
Off-flavor score	2.38 $\pm$ 0.14	2.78 $\pm$ 0.15	-0.40 $\pm$ 0.20*

<sup>a</sup>SL = select line, result of 6 generations of selection for increased intramuscular fat based on a 2-trait animal model that included IMF measured on the carcass and predicted via ultrasound; CL = randomly mated, unselected control line.

\* $P < 0.05$ .

<sup>1</sup>Trained sensory panel evaluations of juiciness (1 = dry; 10 = juicy), chewiness (1 = not chewy; 10 = very chewy), tenderness (1 = tough; 10 = tender), flavor (1 = little pork flavor, bland; 10 = extremely flavorful, abundant pork flavor), and off-flavor (1 = no off-flavor; 10 = abundant non-pork flavor).