Composition and Quality Characteristics of Pigs Selected for Divergent RFI on High or Low Energy Diets

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Summary and Implications

Carcass composition (n= 338) and meat quality (n=151) data were collected on pigs from the eighth generation of the Iowa State University Residual Feed Intake (ISU RFI) selection project fed either high or low energy diets. Both RFI line and diet were found to impact carcass composition, while having minimal effects on pork quality and sensory characteristics. RFI shows promise as a selection tool for improved efficiency without compromising pork quality, even if fed low energy diets.

Introduction

Feed costs account for the single largest cost of pork production. Recent increases in the cost of feedstuffs have led producers to look for ways to select for efficiency, as well as the use of alternative feedstuffs that are lower in energy and starch. RFI is one avenue being studied to select for efficiency and is the focus of the eighth generation of the ISU RFI selection project discussed in this report. RFI can be defined as the difference in observed feed intake of an animal from its expected intake. Expected feed intake is estimated given an animal's growth performance and backfat. Low RFI (LRFI) pigs are those whose actual feed intake is less than expected. LRFI pigs are more efficient that high RFI (HRFI) animals whose feed intake is greater than expected. Work in the fifth generation of the ISU selection project showed that LRFI pigs had greater loin depth and tended to have less backfat when compared to the randomly selected control line. Additionally, LRFI line carcasses had less lipid and greater percent moisture in the loin when compared to the randomly selected control line. No difference in pH at 48 hours, drip loss, or Hunter L* and a* values were detected between lines. In contrast to comparing LRFI to a randomly selected control line, researchers at the Institut National de la Recherche Agronomique (INRA, France) used divergent selection for RFI to demonstrate that, compared to selection for increased RFI, selection for decreased RFI resulted in low loin pH, greater loin lightness scores, and poorer loin water holding capacity after five generations of selection. Therefore, our objective was to examine the impact of divergent selection for RFI on pork quality and composition traits in the eighth generation of the ISU selection project, which included 3 generations of selection for increased RFI in the previously randomly selected control line. Additionally, we wanted to examine if these pigs performed the same on diets low in energy and high in fiber.

Materials and Methods

Three hundred thirty-eight pigs (n=85 LRFI barrows, 83 LRFI gilts, 88 HRFI barrows, 82 HRFI gilts) from the eighth generation of the ISU RFI selection project were randomly assigned within each of two rooms to 20 pens (14-24 pigs per pen). Ten pens were placed on a low energy high fiber (LEHF; 2.91Mcal ME/kg; 24.6% NDF) diet and ten pens on a high energy low fiber diet (HELF; 3.31 Mcal ME/kg; 9.5% NDF). Pigs were harvested (92-140 kg BW) at a commercial abattoir in three groups. Data were collected on hot carcass weight (HCW), fat depth, loin depth, calculated percent lean using a Fat-O-Meater® probe at the 3^{rd} to 4^{th} last rib on the carcass 8 cm off the midline.

Meat quality traits were measured on pigs from one room (n=151 [n=37 LRFI barrows, 35 LRFI gilts, 43 HRFI barrows, 36 HRFI gilts]). At two days post mortem, ultimate pH, drip loss ([(initial weight – final weight)/initial weight] x 100), subjective marbling (scale 1-10; NPPC, 1999), lean and fat color (CIE L* a* b*, D75 light source, 10º observer), and proximate analysis for fat, moisture and protein were collected. Sensory samples were aged for seven days at 0ºC, and then frozen for no longer than 90 days before use. Sensory samples were evaluated for juiciness, tenderness, pork flavor, off-flavor and tenderness by trained panelists (n=8). Instrumental tenderness was determined by star probe (crosshead speed of 3.3 mm/second; average of three punctures).

Data were analyzed using the PROC MIXED procedure of SAS (SAS Inst. Inc., Cary, NC), with fixed effects of line, diet, and sex, random effects of harvest group and room (in the case of composition data), and the covariate of live weight at harvest (in the case of carcass and proximate composition data and subjective marbling data).

Results and Discussion

Carcass Composition

Irrespective of line, the LEHF diet decreased HCW (P<0.01), fat depth (P<0.01), and loin depth (P<0.01) and increased percent lean (P<0.01; **Table 1**). Additionally, the LRFI carcasses had less fat depth and greater loin depth and percent lean than the HRFI carcasses (P<0.01 for all traits).

Gilts had less fat depth (P<0.01) and had greater loin depth (P<0.01) and percent lean than barrows (P<0.01). A line x sex interaction tendency was observed for fat depth, with LRFI gilts having less fat depth and the HRFI pigs on the HELF diet having the greatest fat depth compared to LRFI pigs fed a LEHF diet (P<0.06).

Carcass Quality

No line or diet differences were found in ultimate pH, lean a*and b*, adipose b*, and cook loss (**Table 2**). Carcasses from LRFI had lower marbling (P<0.01) and color (P<0.01) scores than those from the HRFI pigs. This agreed with the proximate composition data, which showed that LRFI carcasses had a significantly lower lipid percentage (P<0.05). HRFI barrows had greater marbling than all other line x sex combinations (P=0.05). Pigs fed the LEHF diet also had lower subjective marbling scores (P=0.01), less percent lipid (P=0.02), and tended to be more tender (P=0.08) than pigs on the HELF diet. Diet also affected adipose color, with HELF carcasses having lower L* values (P=0.05) and a tendency for lower a* values. A sex x diet interaction was found for drip loss (P=0.03), with barrows on the LEHF diet having the greatest drip loss and gilts on the LEHF diet the least drip loss.

These data suggest that, regardless of diet, pigs from the LFRI line are leaner, heavier muscled, and possess less marbling and percent lipid than the HRFI line. Although diet impacts carcass composition and adipose color, it appears that carcasses from HRFI and LRFI lines were generally not differentially impacted by diet. Thus, RFI shows promise as a selection criterion to produce animals that are leaner and more efficient with minimal impacts on pork quality.

Acknowledgments

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Figure 1. Effect of divergent RFI selection and diet on carcass composition traits.[1]

	Line			Diet		
Item	HRFI	LRFI	Sig.[2]	HELF Diet	LEHF Diet	Sig.[2]
HCW	94.43 (1.06)	94.86 (1.07)		97.03 (1.06)	92.26 (1.10)	**
Fat Depth, mm	20.58 (0.67)	18.51 (0.69)	**	21.67 (0.66)	17.43 (0.76)	**
Loin Depth, mm	57.63 (1.26)	60.76 (1.27)	**	60.50 (1.26)	57.88 (1.32)	**
Percent Lean	53.22 (0.50)	54.86 (0.53)	**	52.91 (0.51)	55.17 (0.56)	**

[1] Least square means (SE) shown for each trait

[2] Significance; **P-value <0.05, *0.05< P-value <0.10

Figure 2. Effect of divergent RFI selection and diet on carcass quality traits.[1]

	Line			Diet		
Item	HRFI	LRFI	Sig.[2]	HELF Diet	LEHF Diet	Sig.[2]
pH	5.65 (0.02)	5.65 (0.02)		5.63 (0.02)	5.67 (0.03)	
Drip Loss, %	1.32 (0.16)	1.44 (0.17)		1.37 (0.16)	1.39 (0.17)	
Subjective Color	2.35 (0.21)	1.91 (0.22)	**	2.25 (0.22)	2.01 (0.23)	
Subjective Marbling	1.36 (0.12)	1.13 (0.12)	**	1.40 (0.12)	1.09 (0.13)	**
Lean L*	48.48 (0.27)	50.44 (0.28)	**	50.23 (0.26)	49.70 (0.28)	
Lean a*	3.51 (0.47)	3.08 (0.49)		3.42 (0.47)	3.17 (0.49)	
Lean b*	10.90 (0.41)	10.70 (0.42)		10.97 (0.41)	10.63 (0.43)	
Adipose L*	73.00 (1.15)	72.75 (1.17)		73.65 (1.15)	72.10 (1.21)	**
Adipose a*	-2.28 (0.38)	-2.24 (0.39)		-2.04 (0.38)	-2.49 (0.40)	*
Adipose b*	9.19 (0.55)	8.65 (0.58)		9.21 (0.55)	8.63 (0.62)	
Cook Loss, %	14.55 (0.48)	14.52 (0.52)		14.31 (0.48)	14.76 (0.64)	
Star Probe, kg	5.01 (0.13)	5.20 (0.14)		5.04 (0.13)	5.17 (0.16)	
Proximate Analysis						
Moisture, %	72.32 (0.55)	73.67 (0.58)	*	72.20 (0.56)	73.80 (0.59)	*
Fat, %	1.91 (0.18)	1.38 (0.19)	**	1.95 (0.20)	1.34 (0.22)	**
Protein, %	24.06 (0.15)	24.02 (0.16)		24.12 (0.15)	23.96 (0.17)	
Sensory Traits						
Juiciness	10.15 (0.19)	10.44 (0.22)		10.47 (0.19)	10.12 (0.27)	
Tenderness	9.28 (0.27)	8.97 (0.29)		9.09 (0.27)	9.16 (0.29)	*
Chewiness	4.93 (0.28)	5.49 (0.29)		5.26 (0.29)	5.16 (0.30)	
Pork Flavor	3.92 (0.15)	3.81 (0.16)		3.89 (0.15)	3.84 (0.19)	
Off-Flavor	0.43 (0.06)	0.53 (0.06)		0.52 (0.06)	0.44 (0.06)	

[1] Least square means (SE) shown for each trait

[2] Significance; **P-value <0.05, *0.05< P-value <0.10