Diets Differing in Energy and Fiber Content Affected Adipose Tissue Quality of Carcasses from Pigs Divergently Selected for Residual Feed Intake

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Summary and Implications

The goal of this experiment was to determine the impact of high and low energy diets on adipose tissue quality of animals selected for divergent residual feed intake (RFI). Pigs of a low RFI (efficient) line and high RFI (less efficient) line were placed on either a high energy, low fiber (HELF) diet or a low energy, high fiber (LEHF) diet. Line had no impact on adipose tissue color or iodine value. Regardless of line, feeding a diet low in energy resulted in adipose tissue with a darker colored and increased iodine value, when compared to adipose tissue from animals fed a high energy diet.

Introduction

Residual feed intake (RFI) is a measure of feed efficiency being researched. RFI can be defined as the difference in an animal's observed feed intake versus its expected feed intake based on average daily gain and backfat. Low RFI (LRFI) animals are more efficient, consuming less feed than high RFI (HRFI) animals.

It has been found that when an animal is placed on a reduced energy diet it shifts deposition of fatty acids in the adipose tissue from those produced endogenously to those in the diet. While pigs do naturally produce saturated and unsaturated fatty acids, swine diets are high in polyunsaturated (more than one double bond) fatty acids, which will equate to a high iodine value. The objective of this project was to evaluate the impact of line, diet, and sex on the adipose tissue quality of animals divergently selected for RFI.

Materials and Methods

Pigs of generation nine of the ISU RFI selection project were used [n=83 LRFI (42 HELF, 41 LEHF), n=74 HRFI (39 HELF, 35 LEHF)]. LRFI animals have been selected since generation one, and divergent selection for a HRFI line was initiated in generation five. For each generation six pens were placed on the HELF diet (3.32 Mcal/Kg ME; 9.5% NDF) and six pens on the LEHF diet (2.87 Mcal/Kg ME; 24.6% NDF). Pigs were put on-test at 107.2 ± 8.3 days (42.6 ± 7.0 kg). Pigs were slaughtered in a commercial slaughter facility in two groups in June and July. Pigs were off-tested at 227.0 ± 14.5 days (128.4 ± 8.0 kg). Adipose tissue samples were collected as a 2.54 cm diameter core over the clear plate. Samples were placed in re-sealable zipper storage bags, were held at 4° C until day two postmortem, when they were frozen at -20° C. Adipose tissue color were determined by CIE L*(0=black, 100= white), a*(greater values are red, lesser values are green), b* (greater values are yellow, lesser values are blue) using a calibrated Hunter Labscan XE colorimeter (Hunter Association Laboratories Inc., Reston, VA). A D75 light source with a 10º observer was used with a 1.0-cm aperture. Fatty acid methyl esters were extracted and peaks were determined using gas chromatography (flame ionization detector). This sample was a core containing all layers of adipose tissue. Iodine value (IV) was calculated as IV = % C16:1 (0.9976) + % C18:1 (0.8985) + % C18:2 (1.8099) + % C18:3 (2.7345) + % C20:1 (0.8173) + % C20:4 (3.3343) + % C20:5 (4.1956) + % C22:1 (0.7496) + % C22:5 (3.8395) + % C22:6 (4.6358) (AOCS, 1998).

Data sets were analyzed using the MIXED procedure in SAS (v. 9.3, SASA Institute Inc., Cary, NC). The model included fixed effects of line, diet, sex, and line*diet, significant interactions between line*sex, sex*diet, and line*sex*diet were tested and left in the model if $P \leq 0.10$; random effects included slaughter group, pen, litter, and sire. Off-test live weight was fit as a covariate.

Results and Discussion

Results are reported in Table 1. Animals fed the HELF diet had greater adipose tissue L* values ($P<0.01$), meaning adipose tissue was whiter in color. This whiter adipose tissue is more desirable to consumers than the darker fat found in adipose tissue of animals fed the LEHF diet.

Line had little effect on the fatty acid methyl ester profile. Sex did not affect FAME profile and IV in the same manner across diet or line. Adipose tissue samples from barrows fed the HELF diet had a lower IV ($P<0.05$) and tended to have a greater percentage of C18:0 ($P=0.08$). Within the LRFI line, differences in the fatty acid profile of sexes resulted in greater IV in adipose tissue from gilts ($P<0.05$) than in adipose tissue from barrows. Regardless of line or diet, adipose tissue from gilts tended to have a greater IV than adipose tissue from barrows ($P=0.06$).

Due due to their monogastric nature, swine have adipose tissue which is amenable by diet. Consequently, diet greatly impacted the FAME profile of generation nine animals, resulting in a greater IV in the fat of animals fed the LEHF diet (P<0.01). The energy reduction in the LEHF line may be contributing to the higher IV. Due to the greater IV found in adipose tissue of loins from animals fed the LEHF, carcasses from these animals will have softer, poorer quality fat than those fed a HELF diet. Regardless of animal efficiency, feeding pigs diets high in fiber and low in energy results in poorer adipose tissue quality.

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Table 1. Effect of selection of divergent residual feed intake, diets differing in fiber and energy content, and sex on adipose tissue color and iodine value (IV).

Trait	LRFI	HRFI	P-value	HELF	LEHF	P-value	Barrow	Gilt	P-value
Adipose L*	80.79[1]	80.38	0.11	81.18	79.99	**<0.0001**	80.45	80.72	0.31
	(0.17)[2]	(0.18)		(0.18)	(0.18)		(0.18)	(0.18)	
Adipose a*	-0.52	-0.50	0.88	-0.59	-0.43	0.13	-0.46	-0.56	0.34
	(0.08)	(0.09)		(0.08)	(0.08)		(0.08)	(0.08)	
Adipose b*	2.30	2.29	0.69	2.29	2.30	0.92	2.31	2.29	0.55
	(2.36, 2.25)	*(2.35, 2.23)*		*(2.35, 2.24)*	*(2.35, 2.24)*		*(2.36, 2.25)*	*(2.34, 2.24)*	
Iodine Value	77.16	77.04	0.91	75.23	78.97	**<0.0001**	76.42	77.77	*0.06*
	(1.03)	(1.07)		(0.98)	(0.99)		(0.98)	(0.96)	

[1]Least square means shown for each trait.

[2](SE) or (*95% confidence interval*) shown for each trait.