Effects of dietary fat source on carcass characteristics and carcass fat quality of grow-finish pigs

T. Tennant[1], M. Knauer[2], and D. Hanson[1]

[1] Department of Food, Bioprocessing, & Nutrition Sciences, North Carolina State University Raleigh 27695, USA

[2] Department of Animal Science, North Carolina State University Raleigh 27695, USA

Abstract – The aim of this study was to evaluate the effects of dietary fat source, growth performance and carcass characteristics on carcass iodine value (IV) from loin backfat and belly fat depots. A total of 480 pigs comprised of 240 barrows and 240 gilts were allocated to a 2X2 factorial with 2 fat sources: corn oil (CO) and beef tallow (TA) fed at an inclusion level of 6% and 2 levels of Ractopamine hydrochloride (RAC) fed at an inclusion level of 0 and 10 ppm. . On Day 56, Day 64, and Day 72, pigs were harvested for each trial replication. Fat samples were collected from loin backfat and belly fat depots and fatty acid composition were determined. Increased unsaturation or decreased saturation of the dietary fat source resulted in greater IV of fat samples from the belly and loin backfat as well as the IV of carcass (P < 0.05). Specifically, CO produced greater IV (P < 0.05) from both sampling sited as well as carcass IV when compared to TA.

Key Words – Iodine value, Fat quality, Diet

I. INTRODUCTION

Pork fat quality has received heightened awareness due in part to a rise in feed cost, resulting in an increased use of alternative feed ingredients that may compromise fat quality by increasing unsaturated fat levels in diets. However, not much is known about the influence of diet on pork fat quality. It is well established that fatty acid composition of pork is influenced by the level of unsaturated fat present in the diet [8]. Thus, feeding strategy is a commonly used management tool to control pork fat quality. Consequently, change in diet may impact meat quality and carcass processing characteristics due to alterations in fatty acid composition of the adipose tissue. In addition to dietary management [1- 3] the composition and quality of fat in pigs can be manipulated through extrinsic and intrinsic factors including: genotype, growth rate, age, body weight, gender, season, etc. [7, 10, 11]. However, existing knowledge relating diet to fatty acid profile is more plentiful in comparison to non-dietary factors. Therefore, our project is designed to quantify the importance of multiple factors in relation to pork fat quality.

The determination of carcass fat quality is indirectly measured by fatty acid composition; the most common method is iodine value (IV) which measures the degree of unsaturation in the fatty acids for a given fat source. Iodine value is described as the number of iodine molecules absorbed by 100 g of fat and can be calculated from fatty acid profile using the following equation IV = C16:1 × 0.9976 + C18:1 × 0.8986 + C18:2 × 1.810 + C18:3 × 2.735 + C20:1 × 0.8175 + C22:1 × 0.7497 [1].

Currently, two regression equations have been developed to allow the prediction of carcass backfat IV from dietary iodine value product (IVP). Madsen et al. [10] was first to create an equation to estimate carcass backfat: Carcass IV = 47.1 + 0.14 x dietary IVP (r2 = 0.86) followed by Boyd (1997): Carcass IV = 52.4 + 0.32 x dietary IVP (r^2 = 0.99). Differences in the prediction equations are attributed to the range in IVP spanned and heavier-weight pigs allowed ad libitum access to feed in the research by Boyd [6]. Recent effort by Benz et al. [5] to validate the dietary IVP with the actual carcass IV when using the Madsen or Boyd equations reported higher predictive values in pigs fed diets with higher levels of unsaturated fats; concluding that dietary C18:2n-6 content was a better predictor of carcass IV than IVP. Collectively, the studies by Madsen et al. [10] and Boyd [6] clearly identified the relationship between carcass IV and IVP. However, a comprehensive evaluation of the multitude of factors that influence fatty acid profiles has not been reported.

II. MATERIALS AND METHODS

A single experiment, was conducted in two sequential replications (winter and summer). A total of (n=480) PIC 337 × C22/C29 (PIC, Inc., Hendersonville, TN) pigs (240 gilts and 240 barrows), were utilized in this study. Pigs (n=240) with an average initial BW of 48.71 ± 6.83 kg were delivered to the North Carolina Swine Evaluation Station and allowed 30 d to acclimate for each replication. After acclimation pigs were allocated five pigs per pen based on sex and initial body weight and randomly assigned to one of 4 treatment diets.

Treatment

Treatment diets were arranged in 2X2 factorial with 2 fat sources: corn oil (CO) and beef tallow (TA) fed at an inclusion level of 6% and 2 levels of Ractopamine hydrochloride (RAC; Paylean, Elanco Animal Health, Greenfield, IN) inclusion: 0 and 10 ppm. At the end of the test (day prior to shipment for harvest), pigs were individually weighed and a transverse ultrasound scan was taken at the 10th rib; backfat depth (over the middle of the Longissimus muscle) and Longissimus muscle depth were measured on the scan. Pens were taken off test in three sequential pulls when d 55 was reached. On d 55 the heaviest pens (n=80 pig) were taken off test, next heaviest pigs were taken off-test sequentially every 7 days. At the end of test pigs were individually weighed and an ultrasound scan was taken at the 10th rib for backfat depth and LM area. On Day 56, Day 64, and Day 72 pigs were harvested and hot carcass weight was measured. Samples of jowl, belly, and 10th rib loin back fat were collected vacuum packaged and stored at -20 C until analyzed.

Fatty Acid Analysis

Fatty acids were extracted from adipose tissue in accordance to Gatlin et al [2]. The fatty acid methyl esters (FAME's) were analyzed by gas chromatograph on a Hewlett Packard 5890 gas chromatograph (Hewlett Packard, Avondale, PA) equipped with a flame ionization detector was used with a 100-m fused silica capillary column with an i.d. of 0.25 mm, a 0.20µm film coating, and a SP-2380 column stationary phase (Supelco, Bellefonte, PA) in accordance to [2]. Iodine value was calculated using the following equation: iodine value = 16:1 (0.95) + 18:1 (0.86) + 18:2 (1.732) + 18:3 (2.616) + 20:1 (0.785) + 22:1 (0.723) [1].

Statistical Analysis

Carcass characteristic and fatty acid data were analyzed with fat source, RAC level, and sex as fixed effects, season was a random effect, and individual animal was used as the experimental unit using PROC MIXED of SAS 9.3 (SAS Institute, Inc., Cary, NC). Least-squares means were compared using the PDIFF option. Regression analysis was carried out using the PROC REG of SAS, with the stepwise selection option used to select prediction equations. Models were developed for IV as the dependent variable.

III. RESULTS AND DISCUSSION

The effects of dietary fat source on carcass iodine value are displayed in Table 1. Increased unsaturation or decreased saturation of the dietary fat source resulted in greater IV of fat samples from the belly and loin backfat as well as the IV of carcass ($P < 0.05$; Table 1). Specifically, CO produced greater IV ($P < 0.05$) from both sampling sited as well as carcass IV when compared to TA. In addition, there were no significant effects for RAC in either treatment group amongst belly and loin sample sites for IV. Kellener et al. [9] reported a similar IV range for belly and loin sample sited for pigs fed CO at 6% and TAL at 6%.

Table 1. Effects of dietary fat source on carcass iodine value (IV)

	Treatment			
	Tallow		Corn Oil	
	No RAC	RAC	No RAC	RAC
Dietary IVP	61.48	60.50	109.95	108.96
Carcass IV[1]	68.79 ^{a}	69.58 ^{a}	85.90 ^{b}	85.04 ^{b}
Loin BF IV	71.57^{a}	68.41^{a}	89.68^{b}	85.62 ^{b}
Belly IV	67.79 ^{a}	69.25 ^{a}	83.94 ^{b}	82.69 ^{b}

^{a,b,}Row means followed by the same letter do not differ ($P > 0.05$).

[1]Carcass fat IV was averaged across the 2 sampling sites: belly fat IV and backfat IV.

Neither of the dietary fat sources had an impact on growth performance nor carcass characteristics (Table 2). However, pigs feed diets containing RAC had heavier final weights ($P < 0.05$) than the diets that received no RAC with the exception to TAL with no RAC. Carcasses from the diets containing RAC weighed more ($P < 0.05$) for HCW than diets with no RAC. RAC fed pigs had an increase in LMA area when compared to pigs of similar dietary fat source that were fed no RAC.

Table 2. Effects of dietary fat source on live growth performance and carcass characteristics

	Treatment			
	Tallow		Corn Oil	
	No RAC	RAC	No RAC	RAC
Initial Wt.	48.98	48.42	48.44	48.91
Final Wt.	121.25 [ab]	124.06 [c]	119.45 [a]	122.55 [b]
HCW, kg	95.66 [a]	98.00 [b]	94.64 [a]	98.14 [b]
LMA, cm^2	40.59 [ab]	42.17 [c]	39.86 [a]	41.69 [bc]
BF, mm	22.26	22.11	22.94	22.33

[a,b,c] Row means followed by the same letter do not differ (P > 0.05).

Regression equations were developed to quantify the association of IV and dietary fat source iodine value product (IVP)(Fig. 1 and Fig. 2) Dietary IVP proved to be the best single indicator for predicting carcass IV for each fat depot (Figure 1and 2). Increased dietary IVP intake presented a reasonable coefficient of determination for both belly (R^2=0.55) and loin backfat IV (R^2=0.66). However, a difference in predicting IV was evident amongst the two fat depots as belly was a less precise predictor of IV when compared to loin backfat.

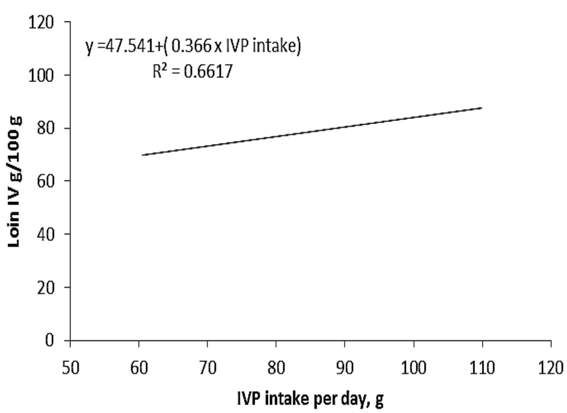

Figure 1. Effect on dietary IVP intake on loin backfat IV

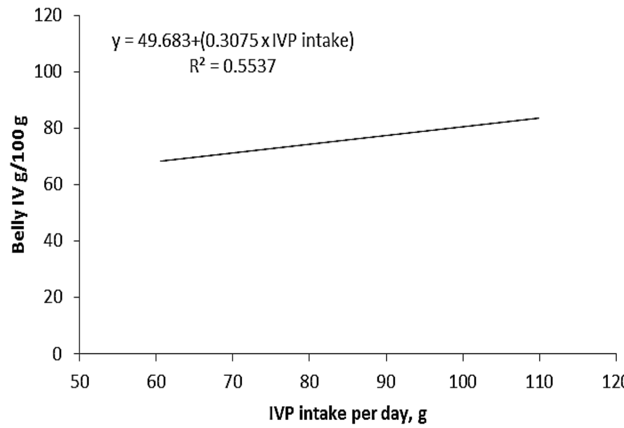

Figure 2. Effect on dietary IVP intake on belly IV

Additional, regression analyses of the dietary IVP, growth by days on feed (DOF), marketing pull, and seasonality data resulted in equations to predict loin backfat and belly fat IV. Prediction equations for loin backfat IV improved with the addition of multiple variables that quantify growth performance and carcass characteristics (R^2=0.66 vs. R^2=0.71). Belly followed similar improvement however still proved to be a less precise predictor of IV.

Table 3. Regression models describing the relationship of growth and diet variables to fat depot IV

Dependent Variable	Model	C. V.	R^2	Adjusted R^2
Loin Backfat, IV	=35.63-0.37*backfat+0.41*DOF+0.37*dietary IVP-2.12*market pull-1.59*season	7.51	0.71	0.70
	=47.54+0.37*dietary IVP	8.0	0.66	0.66
Belly, IV	=45.51+0.11*DOF-0.24*backfat+0.31*dietary IVP+1.83*season	8.42	0.59	0.59
	=49.68+31*dietary IVP	8.79	0.55	0.55

IV. CONCLUSION

Dietary fat source is the single greatest predictor of carcass IV. Increasing the degree of unsaturation in the diet has adverse effect on carcass IV as degree of unsaturation raises carcass IV.

ACKNOWLEDGEMENTS

The authors of this paper would like to thank the National Pork Board for support in funding this project.

REFERENCES

1. AOCS. 1998. Official Methods and Recommended Practices of the AOCS. 5th ed. Am. Oil. Chem. Soc., Champaign, IL.
2. Averette Gatlin, L.A., M.T. See, J. Hansen, D. Sutton and J. Odle. 2002a. The effects of dietary fat sources, levels, and feeding intervals on pork fatty acid composition. J. Anim. Sci. 80:1606 1615.

3. Averette Gatlin, L.A., M.T. See, D.K. Larick, X. Lin, and J. Odle. 2002b. Conjugated linoleic acid in combination with supplemental dietary fat alters pork fat quality. J. Nutr. 132: 3105 3112.

4. Averette Gatlin, L.A., M.T. See, J.A. Hansen and J. Odle. 2003. Hydrogenated dietary fat improves pork quality of pigs from two lean genotypes. J. Anim. Sci. 81:1989-1997.

5. Benz J. M., Tokach M. D., Dritz S. S., Nelssen J. L., DeRouchey J. M., Sulabo R. C., Goodband R. D. 2011. Effects of increasing choice white grease in corn- and sorghum-based diets on growth performance, carcass characteristics, and fat quality characteristics of finishing pigs. J. Anim. Sci. 89:773–782.

6. Boyd, R. D. 1997. Relationship between dietary fatty acid profile and body fat composition in growing pigs.PIC USA T&D Tech. Memo 153. Pig Improve. Co., Franklin, KY.

7. Correa, J. A., C. Gariepy, M. Marcoux, and L. Faucitano. 2008. Effects of growth rate, sex and slaughter weight on fat characteristics of pork bellies. Meat Sci. 80:550–554.

8. Ellis, N.R. and H.S. Isbell. 1926. Soft pork studies. The effect of food fat upon body fat, as shown by the separation of the individual fatty acids of the body fat. J. Biol. Chem. 69:239.

9. Kellner, T. A., K. J. Prusa, and J. F. Patience. "Impact of dietary fat source and concentration and daily fatty acid intake on the composition of carcass fat and iodine value sampled in three regions of the pork carcass." Journal of animal science 92.12 (2014): 5485-5495.

10. Madsen, A., K. Jacobsen, and H. P. Mortensen. 1992. Influence of dietary fat on carcass fat quality in pigs. A review. Acta Agric. Scand., Sect. A. Anim. Sci. 42:220–225.

11. Wood, J.D., Enser, M., Fisher, A.V., Nute, G.R., Sheard, P.R., Richardson, R.I., Hughes, S.I., Whittington, F.M. 2008. Fat deposition, fatty acid composition and meat quality: A review. Meat Sci. 78: 343-358.