RESEARCH REPORT
PORK QUALITY

**Title:** The Development of Equations to Predict the Iodine Value of Various Swine Carcass Fat Depots – NPB# 13-077

**Investigator:** John Michael Gonzalez

**Institution:** Kansas State University

**Date Submitted:** 6/30/2014

**Industry Summary.**

The objectives of this study were two fold. The first objective was to analyze existing data to develop predictive equations to determine the iodine value of three economically relevant adipose depots in finishing pigs. These equations would be developed using parameters such as dietary iodine value product, withdrawal period, carcass characteristics, etc. The second objective was to validate these equations in a live-animal finishing trial. In addition to examining the direct effect of these diets on iodine value in these depots, molecular analyses were conducted to investigate the biological mechanisms that govern or explain the observed phenotypic responses.

Overall, adding fat to swine diets throughout the finishing period increased ADG and improved feed efficiency compared to pigs fed a diet without fat for a portion of the finishing phase. Additional fat also increased backfat which consequently tended to reduce the carcass percent fat free lean. As previous data suggests, as soybean oil was added to diets, dietary C18:2 increased which caused an increase in PUFA. As dietary PUFA's increased, IV increased within each fat depot. Conversely, as soy bean oil was added to diets dietary C18:1 was driven down, which lowered MUFA's for all individual fat depots. Blended diets were similarly affected, however, not to the extent of the pigs fed soy bean oil. Jowl fat, unlike the other two depots, did not show a period affect for IV when additional fat was provided in the diet. Interestingly, tallow did not affect SFA levels in fat depots. Because neither MUFA nor PUFA were significantly impacted by tallow compared to a control diet, IV values were not significantly altered by tallow. Therefore feeding tallow can improve rate of gain as well as feed efficiency while not impacting IV. Feeding soy bean oil can also improve both ADG and feed efficiency, but it

negatively impacts fatty acid composition and IV. This negative impact can be improved by utilizing a withdrawal strategy, but IV levels remain above controls even after long term withdrawal of 42 d.

The jowl depot appeared to be least responsive to withdrawal periods indicating a differential response between adipose depots. This is supported by previous studies that indicate that the jowl depot is weakly correlated to other economically relevant depots. This should be taken into consideration as a standard location and procedure for assessing IV in pig carcasses are developed.

**Producer bottom line:**

- Essential fatty acids (C 18:2 and C 18:3) content of diets can be used to predict iodine value in back, belly, and jowl fat depots in finishing swine using the equations generated herein.
- Equations incorporating the appropriate factors to estimate carcass fat IV will allow producers to feed their pigs appropriately to avoid monetary discounts associated with IV that are higher than acceptable at harvest.
- While a number of different factors were evaluated, dietary EFA, NE content, and backfat thickness exhibited the greatest influence on predicting IV of 3 distinct fat depots.
- Duration of feeding and composition of dietary fat affects the effectiveness of withdrawal time:
    - Adding fat to swine diets throughout the finishing period increased ADG and improved feed efficiency compared to pigs fed a diet without fat for a portion of the finishing phase.
    - Feeding tallow can improve rate of gain as well as feed efficiency while not negatively impacting IV.
    - Feeding soy bean oil can improve both ADG and feed efficiency, but it negatively impacts fatty acid composition and IV. This negative impact can be improved by utilizing a withdrawal strategy, but IV levels remain above controls even after long term withdrawal of 42 d.
- Specific diets fed during different periods and for different durations induce depot specific changes in the individual genes involved in the lipid assimilation and metabolism.

**Keywords.**

Adipose tissue, belly, jowl, iodine value, withdrawal period, finishing pig

**Scientific Abstract:**

**Meta-Analysis:** Meta-analyses used data from existing literature to generate equations to predict finishing pig back, belly, and jowl fat IV and an experiment was conducted to validate these equations. The final database included 24, 21, and 29 papers for back, belly, and jowl fat IV, respectively. For Exp. that changed dietary fatty acid composition, initial diets (**INT**) were defined as those fed before the change in diet composition and final diets (**FIN**) were those fed after. The predictor variables tested were divided into 5 groups: 1) diet fat composition (dietary % C16:1, C18:1, C18:2, C18:3, EFA, unsaturated fatty acids, and iodine value product) for both INT and FIN diets; 2) d feeding the INT and FIN diets; 3) ME or NE of the INT and FIN diet; 4) performance criteria (initial BW, final BW, ADG, ADFI, and G:F); 5) carcass criteria (HCW and backfat thickness). The PROC MIXED procedure of SAS (SAS Institute, Inc., Cary, NC) was used to develop regression equations. Evaluation of models with significant terms was then conducted based on the Bayesian Information Criterion (BIC). The optimum equations to predict back, belly, and jowl fat IV were: backfat IV =84.83+(6.87*INT EFA)-(3.90*FIN EFA)-(0.12*INT d)-(1.30*FIN d)-(0.11*INT EFA*FIN d)+(0.048*FIN EFA*INT d)+(0.12*FIN EFA*FIN d)-(0.0060*FIN NE, kcal/lb)+(0.0005*FIN NE*FIN d)-(0.26*backfat depth, in.); belly fat IV = 106.16+(6.21*INT EFA)-(1.50*FIN d)-(0.11*INT EFA*FIN d)-(0.012*INT NE, kcal/lb)+(0.00069*INT NE, kcal/lb*FIN d)-(0.18*HCW, lb)-(0.25*backfat depth, in.); and jowl fat IV =85.50+(1.08*INT EFA)+(0.87*FIN EFA)-(0.014*INT d)-(0.050*FIN d)+(0.038*INT EFA*INT d)+(0.054*FIN EFA*FIN d)-(0.0066*INT NE, kcal/lb)+(0.071*INT BW, lb)-(2.19*ADFI, lb)-(0.29*backfat depth, in.). Dietary treatments from the validation experiment are described below. The back, belly, and jowl fat IV equations tended to overestimate IV when actual IV were less than approximately 65 g/100g and underestimate belly fat IV when actual IV are greater than approximately 74 g/100g or when the fat blend was fed from d 0 to 84 or d 42 to 84. Overall, with the exceptions noted, the regression equations were an accurate tool for predicting carcass fat quality based on dietary and pig performance factors.

**Validation Study:** A total of 160 finishing pigs (PIC 327 × 1050; initially 100.5 lb.) were used in an 84-d experiment to evaluate the effects of dietary fat source and feeding duration on growth performance, carcass characteristics, lipogenic gene expression, and carcass fat quality in swine. Dietary treatments were a corn-soybean meal control diet with no added fat or a 3 × 3 factorial arrangement of treatments with main effects of fat source (4% tallow, 4% soybean oil, or a blend of 2% tallow and 2% soybean oil (**blend**)) and feeding duration (d 0 to 42, 42 to 84, or 0 to 84). On d 0, 41, and 81, one pig from each pen was selected for backfat, belly, and jowl biopsy collection. Added fat increased ($P < 0.05$) iodine value (**IV**) compared to control diets. Across all three depots a duration × fat source interaction ($P < 0.05$) showed increased poly unsaturated fatty acids (**PUFA**) and decreased mono unsaturated fatty acids (**MUFA**). For backfat there was a feeding period × fat source interaction ($P = 0.05$) for blend and soy bean oil where feeding soy bean oil in period 2 increased sterol regulatory element binding protein-1c expression. In belly samples, fatty acid synthase and acetyl-CoA carboxylase (**ACC**) were increased ($P < 0.05$) in control versus added fat diets. In jowl samples, added fat in period 1 increased ($P < 0.05$) ACC and peroxisome proliferator activated receptor gamma expression compared to period 2. Control diets resulted in decreased ($P < 0.05$) d 42 acyl-CoA oxidase expression compared to diets with added fat. In conclusion feeding soybean oil negatively impacts the fatty acid composition in terms of IV in finishing pigs. Lipogenic gene expression patterns were altered with duration and source of supplemental fat. These changes represent metabolic adjustments to the type and availability of fat in the diet.

**Introduction.**

Iodine value (**IV**), a measure of fatty acid (**FA**) unsaturation, is currently the industry standard for assessing pork fat quality. However, variation exists between the anatomical locations of the fat depots with respect to IV. Additionally, variation exists in the response of these depots to the iodine value product (IVP; IV of feed x percentage of fat in feed) of dietary feedstuffs (Benz et al., 2011, 2010; Weigand et al., 2011). Currently, at least one major processor samples jowl fat IV to determine the quality of the fat of an entire pork carcass. However, the IV of one fat depot may not be a good indicator of IV across other fat depots due to a weak correlation and differential dietary response between depots (Weigand et al. 2011). For example, jowl fat generally has a higher IV than that of other fat depots (Weigand et al., 2011; Benz et al., 2010). This variation must be considered to facilitate the widespread adoption of a standard measurement of IV for pig carcasses.

Generally, pork fat quality (IV) is amenable to dietary changes in the weeks or months prior to harvest. One approach to decreasing the negative impact of high dietary IVP in the initial diet carcass IV is to feed diets with reduced IVP for an appropriate amount of time prior to slaughter (IVP reduction). The theoretical capacity for changing IV is about 60-70% within the first two weeks of withdrawal or diet change, and 100% can be achieved in 6 to 8 weeks (Xu et al., 2010b; Warnants et al., 1999). However, the optimal timing or duration of the withdrawal period has not been established and individual depots respond differentially to dietary changes. This makes the most effective withdrawal strategies difficult to pinpoint.

In addition to their direct impact, the composition of dietary fats can affect endogenous FA synthesis which contributes to the ultimate IV of AT depots (Bee et al., 2002; Smith et al., 1996). Diets with high PUFA (IVP) content, affect lipid metabolism related genes including those involved in de novo lipogenesis, FA desaturation, and FA oxidation (Desvergne et al., 2006). These mechanisms in turn, have an impact on final carcass IV (Smith et al., 1996). These processes have been scarcely investigated with respect to their impact on IV and response to IVP of feedstuffs in pigs.

Ideally, predictive equations and IV reduction strategies will account for depot-specific variation, however this requires an understanding of the biological and physiological basis for variation between depots in order to adjust for, and/or explain differential IV across depots. The objective of the current research was to

validate a previously conducted meta-analysis (Objective 1) by determining the influence of dietary fat source and duration of supplementation on growth performance and carcass composition, and lipogenic gene expression and fat quality in three adipose depots in finishing pigs.

**Objectives.**

1. Update preexisting and unpublished meta-analyses data describing the variables that influence the Iodine Value of pork carcass backfat, belly fat, and jowl fat.
2. Develop equations that will predict the fatty acid composition of the three economically important fat depots based on the fatty acid composition of analyzed feedstuffs.
3. Validate the predictive equations yielded by the meta-analysis.
4. Determine the effects of dietary fatty acid profiles on lipogenic gene expression.

**Materials & Methods.**

**Meta-analysis:**

The term, meta-analysis, is defined as the quantitative summarization of past research (Sauvant et al., 2008). A literature review was conducted to compile literature that examined the effects of dietary FAs and dietary energy on variables associated with growth and carcass characteristics and back, belly, and jowl fat IV. The literature search was conducted via the Kansas State University Libraries, utilizing the CABI search engine, and using the keywords "iodine value and pig" or "iodine value and swine." Data was derived from both refereed and non-refereed publications including theses, technical memos, and university publications. The final database included publication dates from 2002 to 2013.

In order to be included in the final database, experiments had to meet the following criteria: 1) pigs used in experiments had ad libitum access to feed and water; 2) gender of the pigs was classified as either barrows, gilts, mix gender or immunocastrate barrows; 3) the percentage of dietary ingredients fed throughout the experiment was adequately defined; 4) the pigs were fed diets without added conjugated linoleic acid; 5) the experiments provided information including duration of the feeding period, initial BW, final BW, ADG, ADFI, G:F, HCW, and backfat depth. The initial screen yielded 46 publications. Papers were eliminated from the

analysis because pigs were not allowed ad libitum access to food and water (1 paper), dietary conjugated linoleic acid was fed (2 papers and 3 treatments from 1 paper), carcass parameters were not included (4 papers), and growth parameters were not reported (5 papers). The final database resulted in 24 papers with 169 observations for backfat IV, 21 papers with 124 observations for belly fat IV, and 29 papers with 197 observations for jowl fat IV (Appendix). In all papers, back, belly, or jowl fat IV was determined by either FA analysis (NRC 2012) or near-infrared analysis (Zamora-Rojas et al., 2013).

The dietary composition of experimental diets was used to calculate percent dietary C16:1, C18:1, C18:2, and C18:3 FA, EFA (sum of C18:2 and C18:3), total unsaturated FA (**USFA**), dietary iodine value product (**IVP**), and dietary ME (kcal/lb) and NE (kcal/lb) concentrations. Reported individual FA percentages from analyzed ingredients or complete diets were calculated as a percent of total FA. When analyzed values were not reported, FA, as a percentage of total FA, were obtained from Sauvant et al. (2004) or from the U.S. Department of Agriculture (2010). The FA profile of corn oil from Sauvant et al. (2004) was used for DDGS. Dietary FA concentrations were calculated by multiplying the percent of each FA by the reported analyzed ether extract of the ingredient or diet. If ether extract was not reported, it was derived from the NRC (2012). Iodine value was calculated using the following equation (NRC, 2012): Total IV = % C16:1 (0.9502) + % C18:1 (0.8598) + % C18:2 (1.7315) + % C18:3 (2.6152) + % C20:4 (3.2008) + % C20:5 (4.0265) + % C22:1 (0.7225) + % C22:5 (3.6974) + % C22:6 (4.4632). In the equation, % is the percentage that each FA methyl ester represents of the sum total of all FA methyl esters in the gas chromatographic analysis. The dietary IVP was calculated for all dietary treatments using the following equation (NRC, 2012): IVP = (IV of ingredient fat) × (% fat in the ingredient) × (0.1). The ME and NE content of every diet was determined by using the ingredient ME and NE values provided in the NRC (2012). The ME and NE values for glycerol was obtained from Lammers et al. (2008) and Hinson (2009), respectively.

Some observations (back [n=36], belly [n=37], and jowl [n=45]) changed diet composition during the experiment resulting in changes in dietary FA composition. Therefore, dietary variables were determined for initial (**INT**) and final (**FIN**) diets. Initial diets are defined as diets fed prior to the change in ingredient composition and final diets are defined as diets fed after the change in diet composition. Feeding duration of

both the INT and FIN diets was considered for use in the meta-analyses. In the database, observations that did not change dietary FA composition had equal INT and FIN dietary variables and the initial duration was defined as the total duration of the experiment and final duration equaled 0 days. For INT or FIN diets applied over more than one dietary phase, a weighted average of each variable, based on feeding duration within the INT or FIN period, was calculated to describe the treatment applied within that period.

**Statistical analysis**

Descriptive statistics of candidate variables were evaluated using the PROC UNIVARIATE procedure of SAS. All candidate variables were then evaluated for correlation using the PROC CORR procedure of SAS. This was used to determine relationships between variables and prevent multicolinearity. Based on descriptive statistics and correlations the predictor variables tested were divided into the following groups: 1) diet fat composition (C16:1, C18:1, C18:2, C18:3, EFA, USFA, and IVP); 2) duration of feeding for initial and final diets; 3) energy content of the diet (ME or NE); 4) performance criteria (initial BW, final BW, ADG, ADFI, and G:F); 5) carcass criteria (HCW and backfat thickness). The PROC MIXED procedure of SAS (SAS institute, Inc., Cary, NC) was then used to develop regression equations to separately predict back, belly, and jowl fat IV. The method of maximum likelihood (ML) was used in the model selection. The treatment applied within each experiment was the experimental unit for modeling of the equations, and experiment within paper was included as a random effect. The statistical significance for inclusion of terms in the models was determined at $P < 0.10$. Further evaluation of models with significant terms was then conducted based on the Bayesian Information Criterion (BIC). A model comparison with a reduction in BIC of more than 2 was considered improved (Kass and Raftery, 1995). Throughout the selection process, studentized residual plots were observed to determine if quadratic terms or interaction terms needed to be tested in the model. The model was determined using a manual forward selection procedure while progressing through the groups of the predictor variables. First, the best single predictor for back, belly, or jowl fat IV was determined. Variables from the dietary fat composition group had the lowest BIC value. Next, the chosen initial and final dietary fat composition variables and the initial and final duration and their interactions were added to the model. Once the best dietary fat composition × duration model was determined, dietary energy content (ME or NE) was added to the model to determine if

either were significant and improved the precision of the model. The model was then evaluated for improvement by adding the significant growth performance and carcass criteria parameters.

The method of residual maximum likelihood (REML) was then used to obtain the estimate of the parameters for the candidate models. The adequacies of candidate models were also examined by evaluating a histogram of residuals for evidence of normality and plotting residuals against predicted values of Y (back, belly, or jowl IV; Kuehl, 2000 and St-Pierre, 2003). Actual IV was plotted against predicted IV and was evaluated using the line of equality to determine if there was bias in estimation (Altman and Bland, 1983). Residual plots were also used to investigate outliers. Any residual greater or less than 3 standard deviations from the mean were deemed outliers under review. Outliers were reviewed to determine if they were biologically significant. As a result, one observation for back and belly fat IV was removed.

An experiment was conducted in order to validate the regression equations developed to estimate back, belly, and jowl fat IV. Data from this experiment was not included in the meta-analysis dataset. Back, belly, and jowl fat IV means and the 95% confidence interval determined in the experiment were used to validate the estimated means derived from the equations. The procedures of the validation experiment are described in the study below.

**Validation Trial**

The K-State Institutional Animal Care and Use Committee approved the protocols used in these experiments. The validation trial was conducted at the Kansas State University Swine Teaching and Research Center in Manhattan, KS.

*Animals*

A total of 160 finishing pigs (PIC 327 × 1050) with an average initial BW of 100.5 lb. were housed at the Kansas State University Swine Teaching and Research Center finishing barn. The finishing barn was an environmentally controlled facility with 16.15 $ft^2$ slatted-floor pens. Each pen was equipped with a dry self-feeder and a nipple waterer to provide ad libitum access to feed and water. Upon placement in the barn, pigs were fed a corn-soybean meal based diet without added fat for 1 week prior to the start of the experiment.

Pens of pigs were blocked by sex and BW and allotted to 1 of 10 dietary treatments, with 2 barrows or 2 gilts housed in each pen with a total of 8 pens per treatment. Dietary treatments consisted of a corn-soybean meal control diet with no added fat or a 3 × 3 factorial arrangement with main effects of fat source (4% tallow, 4% soybean oil (**soy bean oil**), or a blend of 2% tallow and 2% soybean oil (**blend**)) and feeding duration (d 0 to 42 was defined as period 1, 42 to 84 was defined as period 2, or 0 to 84). Pigs were fed the control corn-soybean meal diet when not fed the added fat diets. Soy oil, Tallow, and a blend of the two were added to create treatments of high levels of dietary unsaturated FA, high levels of saturated FA, and a blend of the two, respectively. The analyzed FA profiles of T, soy bean oil, and complete diets used in the study are shown in Table 9. Diets were formulated to be fed in 3 phases with approximate BW ranges of 41 to 68, 68 to 95, and 95 to 123 kg (Table 10). Diets were analyzed for fat composition (Table 11). A constant concentration of standardized ileal digestible lysine: ME ratio within each phase was maintained by increasing soybean meal in the basal diet when adding the fat sources. Dietary treatments were prepared at the Kansas State Animal Science Feed Mill. Pigs and feeders were weighed on d 0, 14, 28, 42, 56, 60, and 84 to calculate ADG, ADFI, and F/G. Prior to marketing the pigs were individually tattooed so that carcass measurements could be recorded. On d 84, final pig weights were taken, and pigs were transported to Sioux-Preme Packing Co. (Sioux Center, IA) for harvest. Carcass measurements taken at the plant included HCW, loin depth, and back fat thickness.

*Adipose tissue Biopsy Collection*

Adipose tissue (**AT**) biopsy samples were collected at 3 sampling points (day 0, 42 and 84 of the study) from 8 pigs per treatment. Samples were collected on day 0 in order to determine a baseline measurement. Biopsies were collected from 3 discreet AT depots (backfat, jowl, and belly). For subcutaneous backfat (**BF**) collection, the location of the first biopsy location was approximately at the first lumbar vertebra. The location for the BF was determined by following the curvature of the last rib of the animal to where it met the vertebral column. The point was then moved 1.27 cm towards the posterior and 1.27 cm lateral from midline of the animal to collect the samples. Subsequent samples were collected 2.54 cm towards the posterior of the animal in a straight line from the previous biopsy site. For jowl fat collection, the landmark for the first biopsy was

approximately at the angle of the mandible. For subsequent jowl fat collections on day 42 and 84, the collection point was moved in a straight line 2.54 cm towards the posterior of the animal from the previous biopsy site. For belly fat biopsy collection, the location of the first biopsy was on the belly at a location directly ventral relative to the backfat biopsy. This location was determined by following the curvature of the last rib towards where it terminates on the underbelly. The point was then moved 1.27 cm towards the posterior of the animal and 1.27 cm lateral from midline of the animal to collect the sample. For subsequent collections on days 42 and 84, sample locations were moved in a straight line 2.54 cm towards the posterior of the animal from the previous biopsy site.

For all biopsies, the area was shaved and cleaned with 95% betadine followed by 70% ethanol. Next, 0.5-1 mL of 2% Lidocaine HCl with (1%) epinephrine was injected subcutaneously into each biopsy site followed by a wait of 5 minutes to minimize pain associated with the biopsy procedure. For each depot, the area that the analgesic was administered was marked with a circle with a paint stick. After achieving analgesia, a sterile 8-gauge x 5.08 cm long sterile piercing needle was inserted through the skin at a depth sufficient to penetrate entirely through the skin. A 10-gauge × 5 cm long QuickCore™ Biopsy Instrument (Cook Medical, Bloomington, IN) was then inserted through the punctured skin and oriented nearly parallel to the skin to obtain lean-free adipose biopsies. Additional biopsies were collected by inserting the needle through the same skin puncture and adjusting the angle of insertion to the AT by approximately 2-3 degrees. The biopsy site was then cleaned with dilute betadine (5 parts water: 1 part betadine) and direct digital pressure is applied to achieve hemostasis. The site was then sprayed with an aerosol bandage spray to minimize infection. Samples were placed in labeled cryotubes and snap frozen in liquid nitrogen and then placed on dry ice until they could be stored at minus 80°C pending further processing and analysis.

*Fatty Acid Analysis*

A subsample of each AT biopsy was used to determine the FA profiles using the procedures of Sukhija and Palmquist (1988). Briefly, 0.025 g of dry sample was mixed with 2 mL of benzene containing methyl tridecanoate as internal standard (2 mg/mL of benzene, Fluka 91558) and 3 mL methanolic-HCl before being

flushed with nitrogen. Tubes were then capped, vortexed, heated for 2 h at 70°C, and vortexed every 30 min during heating. Tubes were cooled to room temperature, mixed with 5 mL 6% $K_2CO_3$ and 2 mL benzene, vortexed, centrifuged at 500 × g for 5 min. The organic solvent layer was then analysed by gas chromatography. An Agilent gas chromatograph (model 7890A, Santa Clara, CA) equipped with a HP-88 J&W Agilent GC capillary column (30 m × 0.25 mm × 0.20μm film) was used for the analysis. The injection temperature was 250°C, the split ratio of was 1:100, the flame-ionization detector was set at 280°C and using hydrogen (35 mL/min), air (400 mL/min), makeup helium (25 mL/min), and helium carrier gas at constant flow (0.91 mL/min). The oven temperature program was set as follows: initial temperature of 80°C, hold 1 min, increase 14°C/min to 240°C, and hold 3 min. Supelco 37 Component FAME Mix (47885-U Supelco, Sigma-Aldrich) was used as standard.

*RNA Isolation*

For RNA extraction, the methods of Gonzalez et al. (2008) were followed with minor alterations. Approximately 100 mg of muscle was homogenized in 3 mL of Trizol (Life Technologies, Grand Island, NY) utilizing a PowerGen Model 1000 (Fisher Scientific, Waltham, MA) mechanical tissue disruptor. Six hundred microliters of chloroform was added and the upper aqueous layer containing the nucleic acids was collected by centrifugation at 3,220 × g for 56 min at room temperature. This step was repeated two additional times and RNA was precipitated by the addition of isopropanol and centrifugation at 3,220 × g for 56 min. The nucleic acid pellet was washed with the addition of 70% ethanol solution and centrifugation at 3,220 × g for 56 min. Nucleic acid pellets were resuspended in proprietary lysis buffer containing 1% beta-mercaptoethanol and subjected to the protocol utilized by Invitrogen's PureLink™ RNA Mini Kit (Life Technologies, Carlsbad, CA). Spin cartridge membranes were subjected to a DNase step using Invitrogen's On-Column PureLink™ DNase Treatment kit (Life Technologies, Carlsbad, CA) and RNA was eluted by incubating 30 μl of RNase-Free water on the membrane for 1 min, and centrifuging the column at 12,000 × g for 2 min. Total RNA concentration and quality (260nm/280nm ratio) was quantified using a Nanodrop (Thermo Scientific, Waltham, MA). Acceptable

extractions yielded RNA with 260nm/280nm ratios greater than 1.9. Samples were stored at -80°C until PCR analysis.

*cDNA Synthesis and Quantitative Real Time PCR*

In two separate reactions for each sample, fifty nanograms of total RNA was subjected to RNase-free DNase (Promega, Madison, WI) treatment to remove trace genomic DNA contamination and then reverse transcribed using a High-Capacity cDNA Reverse Transcription Kit (Life Technologies, Carlsbad, CA) at 37°C for 120 min. For each target gene, specific primers were designed and validated for quantitative real time PCR (**qPCR**). Primer efficiencies for each primer set were determined by plotting the threshold cycle versus input concentrations for 8, 2-fold serial dilutions of pooled AT cDNA. Primers with efficiencies between 0.9 and 1.1 were considered acceptable for qPCR (Table 16). For further validation, end-point PCR was conducted with each primer set to verify the presence of a single amplicon which was then purified and sequenced to ensure that all primers amplified specifically the gene of interest.

For qPCR, cDNA was amplified in duplicate for each sample using PerfeCTa SYBR Green FastMix (Quanta Biosciences, Gaithersburg, MD) and the appropriate gene specific forward and reverse primers (20 pM) in an Eppendorff Mastercycler realplex$^2$ S PCR System (Eppendorf North America, Hauppauge, NY). Thermal cycling parameters include an initial heating step of 50°C for 2 min, a denaturing step of 95°C for 10 min, 50 cycles of 15s at 95.0ºC, an annealing step for 30 s at 60.5 ºC, and an extension step of 20 s at 68.0ºC. A final dissociation step was included at 95°C for 15 s, 60°C for 30 s, and 95°C for 15 s. Samples were balanced across plates so that equal number of treatments and biopsy days were represented on each plate. Additionally, a pooled sample representing all treatment groups and sample times was run on each plate as an internal standard. Expression was normalized to ribosomal protein L-4 (RPL4; $\Delta$Ct, where Ct refers to the threshold cycle), standardized and compared to each individual pig's d 0 expression for each gene ($\Delta\Delta$Ct). Gene fold change expression levels were calculated as $2^{-\Delta\Delta Ct}$ as previously described by Livak and Schmitgen, (2001).

**Statistical Analysis**

All data was analyzed as a randomized complete block design using the MIXED procedure of SAS (SAS Institute Inc., Cary, NC) with pen as the experimental unit. Pens were blocked by BW within sex. Block was included as a random effect and sex, fat source, feeding duration, and all their interactions as fixed effects. Hot carcass weight was used as a covariate for backfat, loin depth, and lean percentage. Statistical significance was determined at $P < 0.05$ and $P$-values falling within $P > 0.05$ and $P \leq 0.10$ were considered tendencies.

**Results.**

**Meta-Analysis**

The backfat IV database included INT diets that were fed from 21 to 125 days and were analyzed to contain an IVP range of 21.3 to 107.2 g/100g, an EFA range of 0.80 to 4.88 %, and a NE range of 1,026 to 1,264 kcal/lb (Table 1). The FIN diets were fed up to 66 d prior to market and were analyzed to consist of an IVP range of 21.3 to 107.2 g/100g, an EFA range of 0.80 to 4.90%, and NE range of 1,026 to 1,264 kcal/lb. Before beginning the INT period diet, pigs had an average BW range of 48.3 to 207.9 lb. These pigs' ADFI intake ranged from 3.44 to 8.02 lb/d, and they produced carcasses with HCW ranging from 61.9 to 221.6 lb and backfat thicknesses ranging from 0.41 to 1.16 in. The backfat IV values ranged from 58.3 to 86.1 g/100g.

The belly fat IV database included INT diets that were fed from 21 to 125 days and were analyzed to contain an IVP range of 33.8 to 96.2 g/100g, an EFA range of 1.51 to 4.09 %, and a NE range of 1,026 to 1,264 kcal/lb. The FIN diets were fed up to 66 d prior to market and were analyzed to consist of an IVP range of 33.8 to 88.1 g/100g, an EFA range of 1.50 to 3.60 %, and a NE range of 1,026 to 1,264 kcal/lb. These pigs' ADFI ranged from 4.50 to 7.30 lb/d, and they produced carcasses with HCW ranging from 175.3 to 221.6 lb and backfat thickness ranging from 0.55 to 1.15 in. The belly fat IV values ranged from 58.9 to 87.3 g/100g.

The jowl fat IV database included INT diets that were fed from 21 to 125 days and were analyzed to contain an IVP range of 22.1 to 101.1 g/100g, an EFA range of 1.08 to 4.63 %, and a NE range of 1,026 to 1,264 kcal/lb. The FIN diets were fed up to 66 d prior to market and were analyzed to contain an IVP range of

22.1 to 101.1 g/100g, an EFA range of 1.10 to 4.60 %, and a NE range of 1,026 to 1,264 kcal/lb. These pigs' ADFI ranged from 4.48 to 7.39 lb/d, and they produced carcasses with HCW ranging from 162.0 to 221.6 lb and backfat thickness ranging from 0.41 to 1.02 in. The jowl fat IV ranged from 61.4 to 86.2 g/100g.

Correlations between predictor variables were determined and as expected some of the variables within each category were highly correlated. For variables determining dietary fat composition in all 3 datasets, IVP was positively correlated ($R2 > 0.83$; $P < 0.001$) with C18:2, EFA, and USFA for both INT and FIN diets (Table 2). It was also determined that C18:2 was positively correlated ($R2 = 1.00$; $P < 0.001$) with EFA for INT and FIN diet in all 3 datasets. The ME content of the diet was positively correlated ($R2 > 0.86$; $P < 0.001$) with the NE content. For growth and carcass characteristics in all 3 datasets, FIN BW was positively correlated ($R2 > 0.64$; $P < 0.001$) with HCW (Table 3).

Significant single variable models used to predict back, belly, and jowl fat IV for the dietary fat composition category included the INT and FIN diet IVP, C18:1, C18:2, C18:3, EFA, and USFA ($P < 0.01$; Table 4). Also, INT C16:1 ($P < 0.07$) was a significant predictor of backfat IV. For the dietary energy content category, the INT and FIN ME were significant predictors for back fat IV ($P < 0.001$). For belly and jowl fat IV, the INT and FIN dietary NE were significant predictors ($P < 0.01$). Common significant single variable models used to predict back, belly, and jowl fat IV for the growth and carcass characteristic category included ADG, ADFI, HCW, and BF ($P < 0.05$; Table 5). In addition, FIN BW and G:F were significant predictors of backfat IV ($P < 0.07$), FIN BW for belly fat IV ($P < 0.04$), and INT BW for jowl fat IV ($P < 0.06$). Predictors C18:2 and EFA had the lowest BIC values within INT (back BIC = 870.6 and 871.6, belly BIC = 624.5 and 622.6, jowl BIC = 853.7 and 962.1, respectively) and FIN (back BIC = 886.6 and 888.1, belly = 629.1 and 627.3, jowl BIC = 961.4 and 962.1, respectively) diets.

For backfat IV, using variables from the dietary fat composition and duration of feeding categories, INT EFA, FIN EFA, INT d, FIN d, INT EFA*FIN d, FIN EFA*INT d, and FIN EFA*FIN d had the lowest BIC (755.2) for all models tested (Table 6). Next variables from the dietary energy category were tested and the prediction equation developed was improved (BIC = 744.9) by adding FIN NE and FIN NE*FIN d to the

model. Lastly, pig growth and carcass characteristics were investigated for inclusion in the model. Adding backfat depth resulted in the best final model (BIC = 734.5).

Utilizing variables from the dietary fat composition and duration of feeding categories for belly fat IV, INT EFA, FIN d, and INT EFA*FIN d resulted in the lowest BIC (586.0) compared to all models tested. Next dietary energy was tested with the addition of INT NE and INT NE*FIN d improving the model (BIC = 566.9). Lastly, pig growth and carcass characteristics were tested, and the model was further improved by adding HCW and backfat thickness (BIC = 557.9).

For jowl fat IV, dietary fat composition and duration of feeding variables including INT EFA, FIN EFA, INT d, FIN d, INT EFA*INT d, and FIN EFA*FIN d were determined to be components of the best model (BIC = 814.6). Next the inclusion of diet energy content was tested, with the model being further improved by adding INT NE (BIC = 792.6). The final step determined the growth and carcass characteristics that should be included. Adding INT BW, ADFI, and backfat thickness improved (BIC =756.2) the final model.

For back, belly, and jowl fat IV, the residual plots showed no evidence of any prediction bias (Figure 1). The residual plots portray the improved precision for the estimation of back and jowl fat IV compared to the precision when predicting belly fat IV. When evaluating bias for all 3 fat depots, the final equations tended to overestimate carcass fat IV when the actual fat IVs were at the lower end of the range (Figure 2). The final equation for belly fat IV tended to underestimate IV when the actual IV values were at the upper end of the range.

**Equation Validation**

Regression equation input variables derived from the validation experiment are presented in Table 7. Back, belly, and jowl fat IV means determined in the experiment and estimated IV are presented in Table 8. For backfat IV, the means estimated using the regression equations fell within 3.77 g/100g of the actual IV for all dietary treatments except when tallow was fed during period 2, which was 7.47 g/100g greater than the actual value. For belly fat IV, the means estimated using the regression equations fell within 9.22 g/100g of the actual IV for all dietary treatments. However, estimated IV for the following treatments were within 4.00 g/100g of the

actual IV: control; tallow both periods; tallow period 1; tallow period 2; blend period 1; soy bean oil period 1. For jowl fat IV, the means estimated using the regression equations fell within 3.43 g/100g of the actual IV for all dietary treatments.

**Validation Trial**

***Growth and Carcass Characteristics***

Results for growth and carcass characteristics are reported in Table 12. From d 0 to 42 pigs fed added fat had increased (P = 0.005) ADG and improved (P = 0.000) F/G compared to pigs fed diets not containing added fat. Pigs fed diets with added tallow had improved (P= 0.002) F/G versus pigs fed a diet containing a blend of soy oil and tallow. Likewise pigs fed a diet containing diets with added soy oil tended to have improved (P = 0.008) F/G compared with pigs fed a diet containing a blend of soy oil and tallow. During period 2 (d 42 to 84) pigs trended (P = 0.052) to have increased average daily gain and had improved (P < 0.001) F/G when fed additional fat. No differences were found between sources during period 2. Overall (d 0 to 84), pigs fed additional fat in both periods had increased (P = 0.018) ADG and improved (P = 0.042) F/G as well as greater final BW (P = 0.006) compared to pigs fed additional fat only during a single period. Additionally, pigs fed fat in both periods had improved (P = 0.036) F/G compared to pigs fed diets not containing added fat. Pigs fed diets with soy oil tended to have improved (P = 0.092) F/G versus those fed a diet containing a blend of soy oil and tallow. For carcass characteristics, adding fat in both periods increased (P = 0.032) BF and tended to reduce (P = 0.083) FFLI of pigs compared to those fed diets with no additional fat. There were no differences in HCW, percent yield, or LEA amongst treatments.

***Fatty Acid Composition***

*Backfat*

Results for BF fatty acid composition are reported in Table 13. A feeding duration × fat source interaction (P < 0.03) was found for C18:1, C18:2, C18:3, SFA, MUFA, and PUFA for tallow vs. soy bean oil and for C18:2, C18:3, C20:1, MUFA, and PUFA for blend vs. soy bean oil. In both these interactions, MUFA

was decreased while PUFA was increased by the addition of soy bean oil. A feeding duration × fat source (tallow vs. blend) interaction ($P < 0.009$) was also found for C18:2, C18:3, and PUFA as the unsaturated FA were increased to a greater extent by blend than tallow. Feeding period × fat source interactions ($P < 0.01$) were found for C18:2, C18:3, MUFA, and PUFA for blend vs. soy bean oil and tallow vs. soy bean oil. For tallow vs. soy bean oil, the interaction ($P < 0.004$) also occurred for C18:1 and C20:1. These interactions were a result of pigs fed soy bean oil from d 42 to 84 having a greater increase in PUFA and reduction in MUFA on d 84 than when fed soy bean oil from d 0 to 42, whereas feeding tallow or blend had a relatively similar impact on MUFA and PUFA regardless of period fed. Adding 4% fat increased ($P < 0.05$) C18:2, C18:3, C20:1, C22:5n3 and PUFA while decreasing ($P < 0.05$) C16:1, C18:1, SFA and MUFA compared to pigs fed a control diet over both periods. Feeding blend decreased ($P < 0.05$) C16:1, C18:1, SFA and MUFA for both d 42 and 84 and C18:3 on d 84 compared to tallow. Feeding blend also increased ($P < 0.05$) concentrations of C18:2, C18:3, and PUFA for both d 42 and 84 compared to pigs fed tallow. Feeding soy bean oil decreased ($P < 0.05$) C18:1, SFA, and MUFA for both d 42 and 84 while only decreasing ($P < 0.05$) C16:1 and C20:1 for d 84 compared to those fed B. Increases ($P < 0.05$) in C18:2, C18:3, and PUFA concentrations were observed for both d 42 and 84 for pigs fed soy bean oil vs. B. Pigs soy bean oil had lower ($P < 0.05$) concentrations of C16:1, C18:1, C20:1, SFA, and MUFA for both d 42 and 84 vs. those fed tallow. Similarly to other comparisons C18:2, C18:3, and PUFA were increased ($P < 0.05$) both d 42 and 84 for pigs fed soy bean oil vs. tallow. Also C22:5n3 was increased ($P < 0.05$) on d 84 when pigs were fed soy bean oil vs. tallow.

*Belly Fat*

Results for belly FA composition are reported in Table 14. There were feeding duration × fat source interactions ($P < 0.05$) for tallow vs. blend and vs. soy bean oil for C18:2, C18:3 and PUFA and for tallow vs. soy bean oil for C18:1, C18:2, C18:3, SFA, MUFA, and PUFA. These interactions were caused by elevated levels of PUFA and reduced levels of SFA and MUFA with increasing feeding levels of soy bean oil relative to other fat sources. A feeding period × fat source (tallow vs. soy bean oil) interaction ($P < 0.05$) was found for C18:1, C18:2, C18:3, C20:1, MUFA and PUFA. These were driven by the lowering of MUFA levels and the

increased PUFA levels in pigs fed soy bean oil relative to pigs fed tallow. There was a feeding period × fat source (blend vs. soy bean oil) interaction ($P < 0.05$) found for C18:2, C18:3 and PUFA which again was found by the increased concentrations in pigs fed soy bean oil. Pigs fed blend had a greater increase in C18:3 than those T, (feeding period × fat source, $P = 0.001$). Adding 4% fat increased ($P < 0.05$) C18:2, C18:3, MUFA, and PUFA while decreasing ($P < 0.05$) C16:1, C18:1, and SFA for both periods. Additionally, C20:1 decreased ($P < 0.05$) when 4% fat was added compared to a control diet. Feeding blend increased ($P < 0.05$) C18:2, C18:3 and PUFA for both d 42 and 84 and C22:5n3 on d 42 compared to pigs fed tallow. Feeding blend decreased ($P < 0.05$) C16:1, C18:1 and MUFA for both d 42 and 84 and C20:1 on d 42 compared to those fed tallow. Feeding soy bean oil decreased ($P < 0.05$) C 18:1 and MUFA for both d 42 and 84 and C20:1 and SFA on d 84 when compared to pigs fed B. Feeding soy bean oil increased ($P < 0.05$) C18:2, C18:3 and PUFA for both d 42 and 84 compared to feeding B. Feeding soy bean oil also decreased ($P < 0.05$) C16:1, C18:1, C20:1, and MUFA and increased ($P < 0.05$) C18:2, C18:3, C22:5n3, and PUFA for both d 42 and 84 and decreased SFA on d 84 compared with feeding tallow.

*Jowl Fat*

Results for jowl FA composition are reported in Table 15. There was a feeding duration × fat source interaction ($P < 0.05$) tallow vs. soy bean oil for C18:2, C18:3, C22:5n3, SFA, MUFA, and PUFA and for blend vs. soy bean oil for C18:2, C18:3, C20:1, and PUFA. These interactions were driven by the elevated levels of PUFA and reduced levels of MUFA and SFA with increasing feeding duration for soy bean oil relative to other fat sources. For C18:3, there were feeding duration × fat source interactions ($P = 0.001$) for tallow vs. B, and feeding period × fat source interactions for blend vs. soy bean oil and tallow vs. soy bean oil caused by the greater increase in C18:3 concentration in pigs fed soy bean oil relative to blend or tallow. Pigs fed tallow had a greater increase in C20:1 than pigs fed soy bean oil, (feeding period × fat source, $P = 0.017$). Adding 4% fat increased ($P < 0.05$) C16:1, C 18:2, C 18:3, C22:5n3, and PUFA while decreasing ($P < 0.05$) SFA and MUFA on both d 42 and 84 and decreased ($P < 0.05$) total C18:1 on d 42compared to pigs fed a control diet. Feeding blend increased ($P < 0.05$) C18:2, C18:3 C22:5n3, and PUFA while decreasing C18:1 and MUFA for both d 42

and 84 and decreased (P < 0.05) C20:1on d 84 when compared to tallow. Feeding soy bean oil decreased (P < 0.05) C18:1 and MUFA for both d 42 and 84, while only decreasing C20:1 for d 84 when compared to pigs fed B. Conversely, feeding soy bean oil increased C18:2, C18:3, C22:5n3, and PUFA concentrations compared to pigs fed B. Feeding soy bean oil decreased (P < 0.05) C16:1, C18:1, C20:1, and MUFA on both d 42 and 84 and SFA on d 84 and increased (P < 0.05) C18:2, C18:3, C22:5n3 and PUFA compared with pigs fed tallow.

***Iodine Value***

*Backfat*

Pigs fed diets containing 4% added fat had increased (P < 0.05) backfat IV compared to those fed the control diet (Table 13). However, the increase in backfat IV was dependent on dietary fat source, duration of feeding the added fat (84-d vs. 42-d), and the period that the fat was fed (d 0 to 42 vs. d 42 to 84). There were fat source × feeding duration interactions for tallow vs. blend (P = 0.038), tallow vs. soy bean oil (P = 0.001) and blend vs. soy bean oil (P = 0.003). When feeding fat for 84 d compared to 42 d, IV increased 8.5 g/100 g in pigs fed soy bean oil, 4 g/100 g in pigs fed B, and duration of feeding tallow did not affect IV. The more unsaturated the diet fed to pigs, the greater the increase in IV when increasing feeding duration from 42 to 84 d. The fat source × feeding period interactions (P < 0.007) occurred for tallow vs. soy bean oil and blend vs. soy bean oil. Pigs fed tallow from d 0 to 42 had similar backfat IV compared to those fed tallow from d 42 to 84. Similarly, pigs fed blend from d 0 to 42 had similar backfat IV compared to those fed blend from d 42 to 84. However, pigs fed soy bean oil from d 0 to 42 had 6 g/100 g lower backfat IV compared to those fed soy bean oil from d 42 to 84. Therefore, the period in which the fat was fed (d 0 to 42 vs. d 42 to 84) only influenced IV when feeding soy bean oil. For pigs fed fat from d 0 to 84, blend and soy bean oil increased backfat IV by 7.2 and 15.4 g/100g, respectively, compared to those fed tallow. For pigs fed fat from d 0 to 42 and the control diet from d 42 to 84, blend and soy bean oil increased backfat IV by 3 and 4 g/100g, respectively, compared to those fed tallow. For pigs fed the control from d 0 to 42 and added fat from d 42 to 84, blend and soy bean oil increased backfat IV by 3.9 and 8.9 g/100g, respectively, compared to those fed tallow.

*Belly Fat*

Pigs fed diets containing 4% added fat had increased ($P < 0.05$) belly fat IV compared to those fed a control diet (Table 14). Similar to backfat, belly fat IV was dependent on dietary fat source, duration of feeding fat (84 d vs. 42 d), and the period that the fat was fed (d 0 to 42 vs. d 42 to 84). There was a fat source × feeding duration interaction for blend vs. soy bean oil ($P = 0.004$) and (tallow vs. soy bean oil) ($P = 0.001$). There was also a tendency ($P = 0.081$) for a tallow vs. blend × feeding duration interaction. When fed fat for 84 vs. 42 d, IV increased 6.15 g/100 g in pigs fed soy bean oil, 2.54 g/100 g in pigs fed B, while duration of feeding did not affect IV in pigs fed tallow. There was a fat source × feeding period interaction ($P < 0.022$) for both tallow vs. soy bean oil and blend vs. soy bean oil. Pigs fed tallow or blend from d 0 to 42 had similar belly fat IV compared to pigs fed a similar diet from d 42 to 84. However, pigs fed soy bean oil from d 0 to 42 had a 3.62 g/100 g lower belly fat IV compared to pigs fed soy bean oil from d 42 to 84. Therefore, similar to backfat, period only influenced IV when pigs were fed soy bean oil. Feeding blend or soy bean oil from d 0 to 84 increased IV by 5.28 and 12.2 g/100 g respectively, compared to pigs fed tallow. For pigs fed fat from d 0 to 42 and the control diet from d 42 to 84, blend and soy bean oil increased belly fat IV by 2.39 and 3.98 g/100 g, respectively, compared to those fed tallow. Conversely, for pigs fed the control diet from d 0 to 42 and then fed added fat from d 42 to 84, blend and soy bean oil increased belly fat IV by 3.86 and 8.89 g/100 g, respectively, compared to those fed tallow.

*Jowl Fat*

Similar to both belly fat and backfat, pigs fed 4% added fat had increased ($P < 0.05$) jowl fat IV compared to pigs fed a control diet (Table 15). There were fat source × feeding duration interactions for blend vs. soy bean oil ($P = 0.005$) and for tallow vs. soy bean oil ($P = 0.001$). There was also a trend ($P = 0.067$) for a fat source × feeding duration interaction for tallow vs. B. When pigs were fed added fat for 84 vs. 42 d, IV increased 5.54 g/100 g in pigs fed soy bean oil, 2.25 g/100 g in pigs fed B, while duration of feeding did not affect IV in pigs fed tallow. There was no interaction found for fat source × feeding period between any treatments for jowl fat IV. Feeding blend or soy bean oil from d 0 to 84 increased jowl fat IV by 4.7 and 10.8

g/100g, respectively, compared to pigs fed tallow. For pigs fed fat from d 0 to 42 and the control diet from d 42 and 84, blend and soy bean oil increased jowl fat IV by 2.21 and 4.53, respectively, compared to those fed tallow. For pigs fed the control diet from d 0 to 42 then fed added fat from d 42 to 84, blend and soy bean oil increased jowl fat IV by 2.94 and 6.16 g/100 g, respectively, when compared to those fed tallow.

***Gene Expression***

*Backfat*

The results for backfat gene expression are reported in Table 17. There was a feeding period × fat source interaction ( $P = 0.05$) for blend and soy bean oil where feeding soy bean oil in period 1 did not differ from feeding tallow, while feeding soy bean oil in period 2 increased SREBP expression. There was no feeding period, feeding duration, or fat source interactions ($P > 0.05$) for ACC, ACO, FAS, SCD, and PPARg. Feeding tallow during period 1 *or* period 2 decreased ($P < 0.05$) ACC expression compared to soy bean oil. Adding fat during period 2 increased ($P < 0.01$) ACC expression compared to added fat during period 1. Feeding soy bean oil during period 1 increased ($P < 0.05$) expression of ACO compared to tallow. Feeding fat during period 1 decreased ($P = 0.02$) ACO expression compared to supplemental fat during period 2. Feeding added fat in period 2 increased ($P < 0.05$) FAS expression compared to supplementing fat in period 1.

*Belly*

The results for belly gene expression are reported in Table 18. There was a feeding period × fat source (tallow vs. soy bean oil) interaction ($P = 0.05$) for ACO expression where feeding tallow or soy bean oil in period 1 did not differ while feeding tallow in period 2 increased ACO expression compared to soy bean oil. There was a feeding period × fat source (tallow vs. blend) interaction ($P = 0.03$) for PPARg expression as feeding tallow in period 1 or 2 or feeding blend in period 2 did not differ; however feeding blend in period 1 resulted in increased PPARg expression. There were no interactions ($P > 0.05$) for fat source, feeding period, or feeding duration for ACC, FAS, SCD, and SREBP gene expression in belly adipose samples. Day 84 FAS was increased ($P < 0.05$) in control versus added fat diets. ACC expression was increased ($P < 0.05$) in animals

receiving control diets compared to those with added fat and those receiving added fat in period 1 had increased ($P < 0.05$) ACC expression compared to those receiving added fat in period 2.

*Jowl*

The results for jowl gene expression are reported in Table 19. There was a feeding period × fat source (tallow vs. soy bean oil) interaction ($P = 0.05$) for FAS expression where there were no differences when tallow or soy bean oil were fed in period 1, while feeding soy bean oil in period 2 only, resulted in increased FAS expression compared to tallow fed in period 2. There was also a feeding period × fat source (tallow vs. B) interaction ($P = 0.04$) for SCD expression. This was driven by the observation that feeding tallow in period 2 did not differ from period 1; however, feeding blend in only period 2 increased SCD relative expression compared to only period 1. There were no interactions ($P > 0.05$) for fat source, feeding duration, or feeding period for ACC, ACO, PPARg, or SREBP expression. There was a feeding period effect ($P < 0.05$) for added fat in period 1 with respect to ACC and PPARg expression which were both increased ($P < 0.05$) compared to period 2. Feeding control diets resulted in decreased ($P < 0.05$) d 42 ACO expression compared to diets with added fat.

**DISCUSSION**

Fatty acid composition of pig AT is highly influenced by amounts and proportions of FA in the diet (Wood et al. 2008). The meta-analysis would support this concept. The equations generated utilizing single predictors demonstrate that the IV of pork fat is primary influenced by dietary unsaturated FA concentration. Similarly, Boyd et al. (1997) and Madsen et al. (1992) developed equations to predict backfat IV using IVP as the predictor variable; however, in contrast to these equations, our regression analyses determined that dietary EFA was a better predictor for back, belly, and jowl fat IV than IVP. In pork fat, EFA (sum of C18:2 and C18:3) are derived directly from the diet, whereas C16 and C18 saturated and monounsaturated FA are mainly the products of de novo synthesis. As a result, the dietary concentrations of EFA have a direct effect on pork fat IV, while dietary C16 and C18 based FA have only minimal direct incorporation into the adipose (Wood et al., 2008). Calculated IVP was shown to be correlated with dietary levels of PUFA and MUFA. Therefore, it may be less accurate in predicting pork fat IV because of the association with dietary FA that are not directly

deposited. Our model overcame this situation by using only the unsaturated fatty acids (EFA) that are directly deposited into the pork fat and as a result, our model was improved compared to using an IVP-based model. Our findings are in agreement with Benz et al. (2011c) who reported that dietary C18:2 is a better predictor of backfat and jowl fat IV than the IVP of the diet.

Some experiments had observations that changed dietary FA composition during the experiment (i.e. switching diets from a high to low or low to high unsaturated or IVP). To account for the changes, both INT and FIN dietary EFA were included in the model to predict back and jowl fat IV. Benz et al. (2011a) demonstrated the influence of initial dietary EFA on back and jowl fat IV. When increasing the time pigs were initially fed a diet with 2.2% EFA from 26 to 82 d, or decreasing the final diet (EFA=1.6%) from 56 to 0 d, the authors reported a 4.0 and 2.7 g/100g increase in back and jowl fat IV, respectively. Furthermore in pigs fed a 4.6% INT EFA diet, there was a 16.7 and 8.7 g/100g increase in back and jowl fat IV, respectively. In addition, Asmus et al. (2014) demonstrated the importance of accounting for FIN EFA and FIN d when estimating jowl fat IV by feeding an initial diet containing 3.4% EFA followed by a FIN diet containing 1 of 2 levels of EFA. For pigs fed FIN diets for 47 d immediately prior to harvest with 2.6 or 1.7% FIN EFA, the authors reported a 2.7 and 7.9 g/100g decrease in jowl fat IV, respectively, when compared to pigs fed a diet containing 3.4% EFA the entire experiment. However, when FIN diets with a 2.6 and 1.7% FIN EFA were only fed for the final 23 d, there was only a 1.9 and 2.7 g/100g decrease in jowl fat IV, respectively. These studies are in agreement with our models used to estimate back and jowl fat IV which included INT EFA, FIN EFA, INT d, and FIN d as well as the interactions of these variables.

The importance of diet EFA and duration of feeding on estimating carcass fat IV can further be explained by the mechanisms of AT deposition and turnover. Pig AT maintains a certain level of C18:2 derived from the diet, but when extra C18:2 is provided by the diet, the amount in AT is increased at the expense of other FA (Koch et al., 1968; Warnants et al., 1999). If dietary levels are reduced, AT begins eliminating excess levels of C18:2. It appears that the theoretical capacity for changing carcass fat IV is about 60-70% within the first two weeks of dietary change, while the full capacity for change is only reached in 6 to 8 weeks (Warnants et al., 1999; Xu et al., 2010b). However, the elimination rates of C18:2 from backfat is variable and is

dependent on the initial C18:2 content in backfat (Camoes et al., 1995, and Wiseman and Agunbiade, 1998). This would support our model's improvement for predicting carcass fat IV when the diet × duration interaction is also included. The rate of change in jowl fat IV resulting from either reducing the duration of feeding or the level of unsaturated FA is less than that of back and belly fat IV. For instance, when the FIN d is increased from 0 to 60 d and the INT d is reduced from 120 to 60 d, while all other variables are kept constant, the estimated jowl fat IV is reduced from 81.7 to 71.6 while the backfat is reduced from 80.0 to 66.7g/100g. These differences in fat depot specific IV change can be explained by the fact that finishing pigs would likely deposit fat earlier in the jowl before depositing it in the back and belly (Wiegand et al., 2011). Therefore, the fat that is initially deposited in the jowl is less likely to change.

For predicting belly fat IV, INT EFA, FIN d, and INT EFA*FIN d provided the best model. Previous research has demonstrated considerable intra-belly variation in belly fat IV (Trusell et al., 2011). Therefore, we speculate that variation between sites of collection of the belly fat and fewer total observations is the reason the model is not more complex and robust. As a result, the belly fat IV prediction equation is less precise compared to the prediction equations for back and jowl fat IV.

The equations generated utilizing single predictors demonstrate the influence of dietary energy content on the IV of pork fat. Bee et al. (2002) previously reported an increase in PUFA and a decrease in SFA and MUFA in carcass backfat inner and outer layers and omental fat of pigs fed low energy diets (953 kcal DE/lb) compared to those fed high energy diets (1,516 kcal DE/lb). This was explained by reductions in the activity of lipogenic enzymes resulting from restricted energy intake. Reductions in the activity of these enzymes represent less de novo FA synthesis which leads to a greater proportion of unsaturated FA being deposited. Bee et al. (2002) investigated the effects of DE on pork fat IV, while the current analysis tested ME and NE as predictors of carcass fat IV. In addition, including dietary EFA and NE content improved the precision of the model to predict back, belly, and jowl fat IV more than dietary ME. The models clearly demonstrated the negative correlation between NE and carcass fat IV.

Other variables are also known to influence the amount, composition, and quality of pork fat. Wood et al. (2008) described these various factors (such as backfat thickness, gender, age, BW, and maturity) affecting

fat composition of pigs. Younger, lighter, and leaner pigs were found to have lower concentrations of C18:0 and C18:1 and greater concentrations of C18:2 in their subcutaneous AT. This is also the case when intact males and gilts are compared to castrates. Genetic line influence on the FA composition of AT in swine has been described by several authors (Wood et al., 2003; Kloareg et al., 2007; Monziols et al., 2007), but the differences observed between genotypes are likely attributable to their differences in leanness and subcutaneous fat depth (Hugo & Roodt, 2007). Gender differences in fat composition are also a function of the differences in subcutaneous fat depth and leanness, and differences found between intact males and females with the same backfat thickness indicate that the AT of intact males may be less mature than that of castrates and females (Wood et al., 2008). The observations collected for the meta-analyses were from a variety of genetic lines and not distributed evenly across individual genders; therefore, the equations created from our meta-analyses did not include genetic line or gender. The current analyses support the conclusion that the backfat depth account for much of the differences observed between carcass fat IV, and that backfat depth is negatively correlated with the IV of carcass fat.

Prediction equations are tools that can become an integral part of a pork enterprise; however, it is essential that they are used correctly to prevent the generation of inaccurate information. It is important to realize that the equations are only valid as long as the input variables consist of values within the ranges used to generate the predictive equation. For example, backfat IV is estimated to be reduced from 73.4 to 68.7 g/100g by lowering the INT EFA from 4 to 2.7% when the INT diet is fed for 90 d followed by a final diet containing 2.7% EFA fed for 30 d (FIN NE of 2,580, backfat depth of 20 mm). However, if FIN d is increased to a value outside of the range used in generating the equations (d 0 to 66), the equation does not behave appropriately and will generate predictions that are not accurate. For example, when INT d equals 30 and FIN d equals 90, while all other variables were kept constant, the estimated backfat IV is increased from 60.0 to 64.0 g/100g. Previous research has documented that reducing the INT EFA will result in decreased carcass backfat IV (Xu et al., 2010b and Benz et al., 2011a). Therefore, in the example, the increase in backfat IV results from using values outside of the range of the predictor variables.

Other factors have been shown to affect the FA content of pork fat, but were not included in these analyses because the data are limited. When 10 ppm of ractopamine-HCl was fed for 28 d (Carr et al., 2005) and 35 d (Apple et al., 2008) prior to slaughter, the backfat depth was reduced and the backfat IV was increased by approximately 0.07 and 0.08 g/100g per day, respectively. Weber et al. (2006) also reported that when pigs were fed diets with 10 ppm ractopamine HCl for 28 d, the IV of the inner and outer backfat increased about 0.08 g/100g per day, but the IV of belly fat increased only 0.04 g/100g per day. However, Duttlinger et al. (2008) did not observe differences in backfat, belly fat, or jowl fat IV when 7.5 ppm of ractopamine HCl was fed for 28 d. Weber et al. (2006) also reported a reduction in fat IV from feeding 0.6% conjugated linoleic acid (CLA) for 56 d. White et al. (2009) reported a reduction in the IV of the outer and middle backfat layers and belly fat when 0.6% CLA was added to diets containing up to 40% DDGS. They reported that feeding 0.6% CLA during the last 10 d prior to slaughter successfully minimized the effects of feeding 20% DDGS for the last 30 d. Lastly, pelleting finishing pig diets has also been shown to increase belly fat IV (Nemechek et al., 2013). The authors reported that pelleting diets with 1.7 and 2.6% EFA increased belly fat IV 1.3 and 3.7 g/100g, respectively, compared to un-pelleted diets fed to pigs for 81 d.

The final prediction equations developed herein were compared to data generated from an additional experiment which was not included in the meta-analysis. For backfat IV, the means estimated using the regression equations fell within 3.77 g/100g of the actual IV for all dietary treatments except when tallow was fed during period 2. It was determined by the line of equality that when the actual IV values are below approximately 65 g/100g the equation will overestimate backfat IV. Therefore, the overestimation of IV when the control, tallow both periods, tallow period 1, and tallow period 2 diets were fed was expected based on the line of equality. For belly fat IV, the means estimated using the regression equations fell within 9.22 g/100g of the actual IV for all dietary treatments. It was determined by the line of equality that when the actual IV values are less than approximately 65 g/100g and greater than approximately 70 g/100g the equation will over and under estimate IV, respectively. Therefore, the overestimation of IV when the blend both periods, blend period 2, soy bean oil both periods, and soy bean oil period 2 diets were fed is expected based on the line of equality. The equation also underestimated the IV for the tallow both periods treatment. For jowl fat IV, the means

estimated using the regression equations fell within 3.43 g/100g of the actual IV for all dietary treatments. It was determined by the line of equality that when the actual IV values are less than approximately 65 g/100g the equation will overestimate backfat IV. Therefore, the overestimation of the IV for the control, tallow both periods, and tallow period 2 diets is expected based on the line of equality. However, the equation tended to overestimate the IV for the soy bean oil period 2 treatment by 2.06 g/100g. Overall, with the exceptions noted, the regression equations were an accurate tool for predicting carcass fat quality based on dietary and pig performance factors.

**Validation Trial**

Overall, adding fat to swine diets through finishing provided increased ADG and improved feed efficiency; compared to pigs fed a diet without fat or only fed fat a portion of the finishing phase. Additional fat also increased backfat which consequently tended to reduce the carcass percent fat free lean, however, this did not impact hot carcass weight.

As previous data suggests, within this trial as soy bean oil was added to diets C18:2 increased which caused an increase in PUFA. AS PUFA's increased IV increased within each fat depot. Conversely, as soy bean oil was added to diets C18:1 was driven down which lowered MUFA's for all individual fat depots. Blended diets were similarly affected, however, not to the extent of the soy bean oil levels. Jowl fat, unlike the other two depots, did not show a period affect for IV when additional fat was provided in the diet. Interestingly enough tallow did not affect SFA levels in fat depots. Because neither MUFA nor PUFA were significantly impacted by tallow compared to a control diet IV values were not significantly different between the two. Therefore feeding tallow can improve rate of gain as well as feed efficiency while not impacting IV. Feeding soy bean oil likewise can improve both ADG and feed efficiency, but as previously shown it negatively impacts FA composition and IV. However, this negative impact can be improved by utilizing a withdrawal strategy.

In addition to their direct impact, the composition of dietary fats can affect endogenous FA synthesis which ultimately determines the IV of AT depots (Bee et al., 2002; Smith et al., 1996). Overall, the changes in lipogenic gene expression observed in the current study were variable dependent on the source and duration of

fat supplementation. Diets with high PUFA (IVP) content have been reported to affect lipid metabolism related genes including those involved in de novo lipogenesis, FA desaturation, and FA oxidation (Clarke 2004; Price et al., 2000). These mechanisms in turn, have an impact on final IV in pig carcasses (Smith et al., 1996). The expression of these genes is governed by regulatory factors that respond to dietary changes and thus are an important contributor to lipid deposition in economically valuable adipose tissue depots (Bergen and Burnett 2011). These mechanisms are at the core of adipose tissue metabolism, nutrient partitioning, and response to diet, and as such are essential for successful understanding and manipulation of pork fat quality. To date these processes have been studied extensively in cell culture and rodent studies, however they have been scarcely investigated with respect to their impact on IV and response to IVP of feedstuffs in pigs. In pigs, the primary site for de novo FA synthesis is the AT as opposed to the liver, which occurs commonly in rodents and humans (Bergen and Mersmann, 2005) therefore conclusions from rodent and *in vivo* studies must be extrapolated with caution. As reported herein, dietary FA are well represented in AT depots and given their effect on endogenous synthesis, dietary fat IVP can be important in determining the final carcass IV.

To further our understanding of the details of depot specific lipid metabolism, the FA profile and the relative expression of 6 lipogenic regulatory factors was determined in 3 economically relevant AT depots. This approach utilized serial AT biopsies to garner a longitudinal perspective of lipid metabolism over the course of the finishing phase. While it is laborious, the minimal invasiveness of the biopsy approach allows for repeated measures in the same animal each of which, representing an informative snapshot of lipid metabolism over time in response to swine management strategies and nutritional regimens.

Sterol regulatory element binding proteins are a family of nuclear receptor transcription factors involved in regulation of lipid metabolism (Brown and Goldstein, 1997). The increase in BF SREBP expression was unexpected as unsaturated FA have been shown to accelerate SREBP mRNA turnover in HEK-293 cells (Hanna et al., 2001). SREBPs are synthesized as membrane bound precursors which must be cleaved for activation. The mechanism by which unsaturated fats decrease SREBP activity include both a reduction in mRNA levels and decreased proteolytic processing to liberate the active form of the nuclear receptor. Additionally, the presence of sterols and other affects the effectiveness of these FA on reducing SREBP levels (Thewke et al., 1998).These

processes have not been thoroughly studied in a porcine model and it should be noted that these studies were conducted in rodents or cell lines which are not directly comparable to the porcine fat metabolism.

Feeding tallow decreased BF expression of ACC which is the rate-limiting step in de novo lipogenesis, while feeding soy bean oil increased ACO which is involved in oxidation of FA. It is purported that feeding unsaturated fats in place of saturated fats induces a metabolic shift in the rodent liver towards lipid oxidation and away from storage (Jump and Clarke, 1999) which is consistent with the gene expression profile observed in the BF depot in the current study. Fatty acid synthase is an important regulator in long chain FA synthesis and the expression of this gene increased when added fat was supplemented in the later portion of the finishing phase. Additional fat during this phase would be expected to provide additional energy for metabolic processes; any excess would be converted to fat via FAS dependent pathways. This may indicate that during earlier phases, nutrients are being portioned towards growth of lean and bone and away from storage in the form of fat. As the animal progresses on its growth curve and lean deposition wanes, induction of energy storage paradigms may then ensue. Overall the source and duration of supplemental fat induced changes in regulation lipid metabolism in the BF depot to accommodate the timing and composition of nutrient provision.

In the belly, feeding tallow in period 2 increased ACO expression compared to soy bean oil which is opposite of the BF depot. Belly FAS and ACC expression increased in control versus added fat diets which may be due to obligatory lipogenesis necessary for the proper function of this depot. Again this is opposite of the expression pattern observed in the BF depot. This shift highlights the depot-specificity of metabolic regulation which has not been thoroughly investigated in pigs but is becoming more appreciated in livestock and biomedical research (Dodson et al., 2014). One limitation for assessing the expression profile in the belly depot is the heterogeneity of the tissue in this location with diffuse patches of lean and fat making it difficult to obtain consistent samples. In future studies a more systematic approach must be employed to increase the homogeneity and consistency of sample collection.

In the jowl depot, feeding soy bean oil in period 2 only resulted in increased FAS expression compared to tallow fed in period 2. This is consistent with the belly depot but opposite of the BF depot. Added fat during period 1 increased the expression of PPARg which is considered a master regulator of lipid metabolism, as well

as ACC. This indicates that early supplementation of fat may induce the expansion of the jowl depot while the jowl may be refractory to later withdrawal or supplementation relative to other depots as indicated by the changes in IV reported above. Sterol CoA desaturase is the rate-limiting enzyme in the cellular synthesis of monounsaturated FA from saturated FA in mammalian species (Ntambi, 1999). Feeding blend diets in period 2 increased jowl SCD relative expression compared to period 1 indicating that the timing of supplementation affects desaturase activity however it is not clear how this change affected the IV profile in the jowl depot.

Together these data underline the depot specific nature of lipid metabolism in porcine adipose tissue and provide credence to notion that depots show differential responses to diet composition and withdrawal strategies. This must be taken in to account when utilizing regression equations to predict the response to IVP and inclusion/withdrawal strategies.

Further research of this nature using a combination of applied and molecular approaches is warranted. The composition of dietary lipids directly affects the composition of adipose depots in pigs over time as reported in the current study. Given the differential and often irreconcilable variations in fat depot IV, the industry will be well-served pursing molecular approaches to understanding and manipulating adipose tissue in a depot-specific manner. Moreover, if predictive equations can be validated via molecular profiling (or vice versa) it provides a very strong scaffold for developing and tailoring management strategies and nutritional regimens toward the optimal (most profitable) pig phenotype. The current study demonstrates that specific diets fed during different periods and for different durations did induce depot specific changes in the individual genes involved in the lipogenic paradigm. It will be important to further understand upstream and downstream factors involved in these pathways to fully understand the nature and impact of these responses.

**CONCLUSION**

There are many factors, both dietary and biological, that affect the FA composition of AT in pigs. Iodine value is a measure of FA unsaturation and is commonly used for assessing pork fat quality. Equations incorporating the appropriate factors to estimate carcass fat IV will allow producers to feed their pigs appropriately to avoid monetary discounts associated with IV that are higher than acceptable at harvest. While a number of different factors were evaluated, we found that dietary EFA, NE content, and backfat thickness

exhibited the greatest influence on predicting IV of 3 distinct fat depots. Regression equations from this paper can be used to predict back, belly, and jowl fat IV. Additionally, we observed longitudinal changes in depot specific FA profiles in response to diet composition and withdrawal strategies, and gained some perspective of the molecular regulation of these changes. Together these data validate the accuracy and usefulness of the regression equations and provide biological insight on depot specific lipid metabolism and composition in finishing swine.

**Table 1.** Descriptive statistics for data included in the evaluation.

| | Initial period[1] | | | | Final period[2] | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Item | IVP,[3] g/100 g | EFA,% | NE, kcal/lb | Days | IVP,[3]g/ 100g | EFA,% | NE, kcal/lb | Days | INT-BW,[4]lb | FIN-BW,[5]lb | AD G, lb | ADFI, lb | HCW, lb | Backfat depth, in | Fat IV, g/100 g |
| Backfat IV[6] | | | | | | | | | | | | | | | |
| Mean | 60.9 | 2.48 | 1170 | 69 | 55.3 | 2.23 | 1,171 | 8 | 106.3 | 261.7 | 2.07 | 5.80 | 194.0 | 0.79 | 70.5 |
| SD | 21.0 | 0.99 | 58 | 27 | 18.7 | 0.82 | 52 | 17 | 44.5 | 37.0 | 0.18 | 0.84 | 29.3 | 0.15 | 6.0 |
| Minimum | 21.3 | 0.80 | 1026 | 21 | 21.3 | 0.80 | 1,026 | 0 | 48.3 | 100.3 | 1.61 | 3.44 | 61.9 | 0.41 | 58.3 |
| Maximum | 107.2 | 4.88 | 1264 | 125 | 107.2 | 4.90 | 1,264 | 66 | 207.9 | 305.6 | 2.43 | 8.02 | 221.6 | 1.16 | 86.1 |
| Belly fat IV[7] | | | | | | | | | | | | | | | |
| Mean | 57.3 | 2.33 | 1145 | 76 | 51.9 | 2.10 | 1156 | 9 | 101.6 | 273.1 | 2.09 | 5.75 | 203.0 | 0.81 | 69.3 |
| SD | 13.7 | 0.56 | 50 | 27 | 13.5 | 0.49 | 44 | 17 | 52.9 | 13.7 | 0.15 | 0.62 | 9.3 | 0.15 | 5.4 |
| Minimum | 33.8 | 1.51 | 1026 | 21 | 33.8 | 1.50 | 1026 | 0 | 48.3 | 233.7 | 1.83 | 4.50 | 175.3 | 0.55 | 58.9 |
| Maximum | 96.2 | 4.09 | 1257 | 125 | 88.1 | 3.60 | 1257 | 66 | 221.8 | 305.6 | 2.71 | 7.30 | 221.6 | 1.15 | 87.3 |
| Jowl fat IV[8] | | | | | | | | | | | | | | | |
| Mean | 59.1 | 2.49 | 1134 | 75 | 54.0 | 2.25 | 1143 | 7 | 109.6 | 274.7 | 2.07 | 5.95 | 201.5 | 0.74 | 72.1 |
| SD | 16.8 | 0.75 | 49 | 21 | 16.0 | 0.65 | 42 | 14 | 41.2 | 14.6 | 0.18 | 0.66 | 9.9 | 0.10 | 4.3 |
| Minimum | 22.1 | 1.08 | 1026 | 21 | 22.1 | 1.10 | 1026 | 0 | 52.9 | 214.7 | 1.70 | 4.48 | 162.0 | 0.41 | 61.4 |
| Maximum | 101.1 | 4.63 | 1264 | 125 | 101.1 | 4.60 | 1264 | 66 | 221.8 | 305.6 | 2.71 | 7.39 | 221.6 | 1.02 | 86.2 |

[1]Characteristics of initial diets fed during the experiment.
[2]Characteristics of final diets fed during the experiment.
[3]Iodine value product (IVP = [iodine value of the dietary lipids] × [percentage dietary lipid] × 0.10); and IV = iodine value (IV = [C16:1] × 0.95 + [C18:1] × 0.86 + [C18:2] × 1.732 + [C18:3] × 2.616 + [C20:1] × 0.785 + [C20:4] × 3.2008 + [C20:5] × 4.0265 + [C22:1] × 0.7225 + [C22:5] × 3.6974 + [C22:6] × 4.4632; NRC, 2012).
[4]Refers to BW of pigs at the beginning of the experiment.
[5]Refers to BW of pigs at the end of the experiment.
[6]The final database resulted in 24 papers with 169 observations for backfat IV.
[7]The final database resulted in 21 papers with 124 observations for belly fat IV.
[8]The final database resulted in 29 papers with 197 observations for jowl fat IV.

**Table 2.** Pearson's correlation coefficients between dependent dietary variables used to predict back, belly, and jowl fat iodine value (IV)[1]

| | Initial period[2] | | | | | | | | Final Period[3] | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Fatty acids, % | | | | | | Energy, kcal/lb | | Fatty acids, % | | | | | | Energy, kcal/lb | |
| Item | C16:1 | C18:1 | C18:2 | C18:3 | EFA | USFA[5] | ME | NE | C16:1 | C18:1 | C18:2 | C18:3 | EFA | USFA[5] | ME | NE |
| IVP, [4] g/100g | 0.13 | 0.57 | 0.93 | 0.82 | 0.94 | 0.97 | 0.68 | 0.58 | 0.33 | 0.68 | 0.91 | 0.71 | 0.92 | 0.97 | 0.65 | 0.55 |
| | 0.48 | 0.73 | 0.83 | 0.47 | 0.83 | 0.97 | 0.47 | 0.17 | 0.59 | 0.81 | 0.82 | 0.28 | 0.83 | 0.97 | 0.54 | 0.34 |
| | 0.30 | 0.71 | 0.90 | 0.59 | 0.91 | 0.98 | 0.40 | 0.12 | 0.43 | 0.79 | 0.89 | 0.43 | 0.90 | 0.98 | 0.46 | 0.14 |
| C16:1, % | 1.00 | 0.71 | -0.17 | -0.12 | -0.17 | 0.33 | 0.43 | 0.36 | 1.00 | 0.71 | 0.01 | -0.08 | 0.01 | 0.49 | 0.43 | 0.38 |
| | 1.00 | 0.83 | -0.02 | 0.33 | -0.01 | 0.64 | 0.70 | 0.57 | 1.00 | 0.79 | 0.12 | 0.09 | 0.14 | 0.69 | 0.57 | 0.49 |
| | 1.00 | 0.86 | -0.12 | 0.11 | -0.11 | 0.50 | 0.73 | 0.70 | 1.00 | 0.84 | 0.01 | 0.13 | 0.02 | 0.58 | 0.65 | 0.67 |
| C18:1, % | | 1.00 | 0.25 | 0.17 | 0.24 | 0.76 | 0.79 | 0.70 | | 1.00 | 0.34 | 0.16 | 0.34 | 0.84 | 0.71 | 0.65 |
| | | 1.00 | 0.24 | 0.26 | 0.24 | 0.88 | 0.84 | 0.66 | | 1.00 | 0.34 | 0.14 | 0.36 | 0.92 | 0.78 | 0.67 |
| | | 1.00 | 0.35 | 0.31 | 0.35 | 0.85 | 0.75 | 0.59 | | 1.00 | 0.44 | 0.28 | 0.46 | 0.90 | 0.72 | 0.56 |
| C18:2, % | | | 1.00 | 0.84 | 1.00 | 0.82 | 0.45 | 0.36 | | | 1.00 | 0.78 | 1.00 | 0.80 | 0.42 | 0.32 |
| | | | 1.00 | 0.38 | 1.00 | 0.67 | -0.01 | -0.29 | | | 1.00 | 0.24 | 1.00 | 0.68 | 0.11 | -0.11 |
| | | | 1.00 | 0.53 | 1.00 | 0.79 | 0.06 | -0.23 | | | 1.00 | 0.40 | 1.00 | 0.79 | 0.14 | -0.22 |
| C18:3, % | | | | 1.00 | 0.88 | 0.69 | 0.53 | 0.51 | | | | 1.00 | 0.81 | 0.57 | 0.46 | 0.44 |
| | | | | 1.00 | 0.41 | 0.42 | 0.29 | 0.10 | | | | 1.00 | 0.28 | 0.22 | 0.23 | 0.10 |
| | | | | 1.00 | 0.58 | 0.53 | 0.41 | 0.32 | | | | 1.00 | 0.42 | 0.39 | 0.27 | 0.18 |
| EFA, % | | | | | 1.00 | 0.82 | 0.46 | 0.38 | | | | | 1.00 | 0.80 | 0.44 | 0.35 |
| | | | | | 1.00 | 0.67 | -0.01 | -0.28 | | | | | 1.00 | 0.69 | 0.14 | -0.09 |
| | | | | | 1.00 | 0.80 | 0.09 | -0.20 | | | | | 1.00 | 0.80 | 0.16 | -0.19 |
| USFA, [5] % | | | | | | 1.00 | 0.78 | 0.67 | | | | | | 1.00 | 0.71 | 0.61 |
| | | | | | | 1.00 | 0.63 | 0.36 | | | | | | 1.00 | 0.65 | 0.47 |
| | | | | | | 1.00 | 0.53 | 0.26 | | | | | | 1.00 | 0.56 | 0.28 |
| ME, kcal/lb | | | | | | | 1.00 | 0.94 | | | | | | | 1.00 | 0.94 |
| | | | | | | | 1.00 | 0.91 | | | | | | | 1.00 | 0.93 |
| | | | | | | | 1.00 | 0.89 | | | | | | | 1.00 | 0.86 |

[1]The 1st, 2nd, and 3rd row within each variable represents Pearson's correlation coefficients for back, belly, and jowl fat IV datasets, respectively.
[2]Correlations between characteristics of initial diets fed during the experiment.
[3]Correlations between characteristics of final diets fed during the experiment.
[4]Iodine value product (IVP = [iodine value of the dietary lipids] × [percentage dietary lipid] × 0.10); and IV = iodine value (IV = [C16:1] × 0.95 + [C18:1] × 0.86 + [C18:2] × 1.732 + [C18:3] × 2.616 + [C20:1] × 0.785 + [C20:4] × 3.2008 + [C20:5] × 4.0265 + [C22:1] × 0.7225 + [C22:5] × 3.6974 + [C22:6] × 4.4632; NRC, 2012).
[5]Refers to total dietary unsaturated fatty acids.

**Table 3.** Pearson's correlation coefficients between dependent growth performance and carcass characteristic variables used to predict back, belly, and jowl fat iodine value (IV)[1]

| | FIN-BW, [7] lb | ADG, lb | ADFI, lb | GF | HCW, lb | Backfat depth, in |
|---|---|---|---|---|---|---|
| INT BW, [2] lb | 0.25 | 0.27 | 0.57 | -0.62 | 0.21 | 0.05 |
| | 0.14 | 0.49 | 0.62 | -0.43 | 0.01 | -0.05 |
| | 0.03 | 0.03 | 0.47 | -0.57 | -0.03 | -0.02 |
| FIN BW, [3] lb | 1.00 | 0.70 | 0.63 | -0.44 | 0.96 | 0.41 |
| | 1.00 | 0.53 | 0.32 | 0.08 | 0.64 | 0.24 |
| | 1.00 | 0.47 | 0.45 | -0.13 | 0.89 | 0.36 |
| ADG, lb | | 1.00 | 0.72 | -0.24 | 0.64 | 0.25 |
| | | 1.00 | 0.66 | 0.02 | 0.45 | 0.15 |
| | | 1.00 | 0.54 | 0.29 | 0.50 | 0.39 |
| ADFI, lb | | | 1.00 | -0.79 | 0.59 | 0.35 |
| | | | 1.00 | -0.70 | 0.19 | 0.31 |
| | | | 1.00 | -0.59 | 0.30 | 0.19 |
| G:F | | | | 1.00 | -0.46 | -0.38 |
| | | | | 1.00 | 0.20 | -0.26 |
| | | | | 1.00 | 0.04 | 0.04 |
| HCW, lb | | | | | 1.00 | 0.47 |
| | | | | | 1.00 | 0.47 |
| | | | | | 1.00 | 0.40 |

[1]The 1st, 2nd, and 3rd row within each variable represents Pearson's correlation coefficients for back, belly, and jowl fat IV datasets, respectively.
[2]Refers to BW of pigs at the beginning of the experiment.
[3]Refers to BW of pigs at the end of the experiment.

**Table 4.** Dietary characteristic single variable models used to predict back, belly, and jowl fat iodine value (IV)

| Item | IVP, [1] g/100g | C16:1, % | C18:1, % | C18:2, % | C18:3, % | EFA, % | USFA, [2] % | ME, kcal/lb | NE, kcal/lb |
|---|---|---|---|---|---|---|---|---|---|
| Initial period[3] | | | | | | | | | |
| Backfat IV | | | | | | | | | |
| Probability, *P* < | 0.001 | 0.07 | 0.01 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.16 |
| BIC[4] | 897.9 | 1,040.9 | 1,034.6 | 870.6 | 959.6 | 871.7 | 942.1 | 1,032.7 | 1,042.3 |
| Belly fat IV | | | | | | | | | |
| Probability, *P* < | 0.001 | 0.29 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.34 | 0.01 |
| BIC[4] | 632.5 | 716.1 | 695.5 | 624.5 | 695.9 | 622.6 | 648.4 | 716.3 | 705.2 |
| Jowl fat IV | | | | | | | | | |
| Probability, *P* < | 0.001 | 0.92 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.83 | 0.001 |
| BIC[4] | 896.8 | 1,104.5 | 1,065.4 | 853.7 | 1,066.7 | 858.9 | 940.7 | 1,104.4 | 1,078.8 |
| Final period[5] | | | | | | | | | |
| Backfat IV | | | | | | | | | |
| Probability, *P* < | 0.001 | 0.17 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.12 |
| BIC[4] | 918.2 | 1,042.3 | 1031 | 886.6 | 986.7 | 888.1 | 951.1 | 1,031.3 | 1,041.8 |
| Belly fat IV | | | | | | | | | |
| Probability, *P* < | 0.001 | 0.67 | 0.001 | 0.001 | 0.46 | 0.001 | 0.001 | 0.42 | 0.001 |
| BIC[4] | 644.2 | 717 | 702 | 629.1 | 716.7 | 627.3 | 659.4 | 716.6 | 707 |
| Jowl fat IV | | | | | | | | | |
| Probability, *P* < | 0.001 | 0.77 | 0.001 | 0.001 | 0.2 | 0.001 | 0.001 | 0.56 | 0.01 |
| BIC[4] | 992 | 1,104.4 | 1,075.1 | 961.4 | 1,102.8 | 962.1 | 1,013.1 | 1,104.2 | 1,090.5 |

[1]IVP = iodine value product (IVP = [iodine value of the dietary lipids] × [percentage dietary lipid] × 0.10); and IV = iodine value (IV = [C16:1] × 0.95 + [C18:1] × 0.86 + [C18:2] × 1.732 + [C18:3] × 2.616 + [C20:1] × 0.785 + [C20:4] × 3.2008 + [C20:5] × 4.0265 + [C22:1] × 0.7225 + [C22:5] × 3.6974 + [C22:6] × 4.4632; NRC, 2012).

[2]Dietary unsaturated fatty acids.

[3]Characteristics of initial diets fed during the experiment.

[4] Bayesian Information Criterion (BIC) values were used to compare the precision of the model. Models that minimized Bayesian Information Criterion (BIC) Variables within fat depot were used to select variables for initial model building.[5]Characteristics of final diets fed during the experiment.

**Table 5.** Pig growth and carcass characteristic single variable models used to predict back, belly, and jowl fat iodine value (IV)

| Item | INT BW,[1] lb | FIN BW,[2] lb | ADG, lb | ADFI, lb | G:F | HCW, lb | Backfat depth, in |
|---|---|---|---|---|---|---|---|
| Backfat IV | | | | | | | |
| Probability, *P* < | 0.19 | 0.02 | 0.05 | 0.03 | 0.07 | 0.02 | 0.01 |
| BIC[3] | 1,042.5 | 1,038.3 | 1,040.4 | 1,039.5 | 1,041.1 | 1,038.3 | 1,036.5 |
| Belly fat IV | | | | | | | |
| Probability, *P* < | 0.97 | 0.04 | 0.01 | 0.01 | 0.77 | 0.001 | 0.001 |
| BIC[3] | 717.2 | 713.2 | 710.1 | 709.8 | 717.1 | 704.8 | 705.5 |
| Jowl fat IV | | | | | | | |
| Probability, *P* < | 0.06 | 0.15 | 0.01 | 0.05 | 0.76 | 0.01 | 0.001 |
| BIC[3] | 1,101.1 | 1,102.4 | 1,097.8 | 1,100.5 | 1,104.4 | 1,094.7 | 1,082.0 |

[1]Refers to BW of pigs at the beginning of the experiment.
[2]Refers to BW of pigs at the end of the experiment.
[3]Bayesian Information Criterion (BIC) values were used to compare the precision of the model. Models that minimized Bayesian Information Criterion (BIC) Variables within fat depot were used to select variables for initial model building.

**Table 6.** Regression equations generated from meta-analyses of existing data for prediction of back, belly, and jowl fat iodine value (IV)[1]

| Dependent Variable | Models | BIC[2] |
|---|---|---|
| Backfat IV | = 60.30 + (3.70*INT EFA) + (2.37*FIN EFA) - (0.051*INT d) - (0.086*FIN d) | 817.0 |
| | = 69.40 + (0.55*INT EFA) + (2.06*FIN EFA) - (0.18*INT d) - (0.088*FIN d) + (0.053*INT EFA*INT d) | 782.4 |
| | = 70.66 + (1.22*INT EFA) + (0.86*FIN EFA) - (0.20*INT d) - (0.20*FIN d) + (0.058*INT EFA*INT d) + (0.047*FIN EFA*FIN d) | 775.8 |
| | = 69.00 + (6.66*INT EFA) - (4.31*FIN EFA) - (0.18*INT d) - (0.13*FIN d) - (0.095*INT EFA*FIN d) + (0.055*FIN EFA*INT d) + (0.13*FIN EFA*FIN d) | 755.2 |
| | = 86.93 + (6.67*INT EFA) - (3.91*FIN EFA) - (0.17*INT d) - (0.14*FIN d) - (0.90*INT EFA*FIN d) + (0.051*FIN EFA*INT d) + (0.13*FIN EFA*FIN d) - (0.0161*INT NE) | 746.9 |
| | =87.76 + (7.03*INT EFA) - (3.96*FIN EFA) - (0.17*INT d) - (1.34*FIN d) - (0.11*INT EFA*FIN d) + (0.047*FIN EFA*INT d) + (0.12*FIN EFA*FIN d) - (0.0174*FIN NE) + (0.0011*FIN NE*FIN d) | 744.9 |
| | =84.83 + (6.87*INT EFA) - (3.90*FIN EFA) - (0.12*INT d) - (1.30*FIN d) - (0.11*INT EFA*FIN d) + (0.048*FIN EFA*INT d) + (0.12*FIN EFA*FIN d) - (0.0132*FIN NE) + (0.0011*FIN NE*FIN d) - (6.604*BF) | 734.5 |
| Belly fat IV | = 54.59 + (6.73*INT EFA) + (0.31*FIN d) - (0.14*INT EFA*FIN d) | 586.0 |
| | = 82.77 + (6.37*INT EFA) + (0.28*FIN d) - (0.13*INT EFA*FIN d) - (0.022*INT NE) | 580.1 |
| | = 93.05 + (6.45*INT EFA) - (1.43*FIN d) - (0.12*INT EFA*FIN d) - (0.033*INT NE) + (0.00148*INT NE*FIN d) | 566.9 |
| | = 111.08 + (6.20*INT EFA) - (1.42*FIN d) - (0.11*INT EFA*FIN d) - (0.032*INT NE) + (0.00146*INT NE*FIN d) - (0.0953*HCW) | 561.3 |
| | =90.53 + (6.41*INT EFA) - (1.53*FIN d) - (0.12*INT EFA*FIN d) - (0.0265*INT NE) + (0.00157*INT NE*FIN d) - (6.35*BF) | 560.7 |
| | = 106.16 + (6.21*INT EFA) - (1.50*FIN d) - (0.11*INT EFA*FIN d) - (0.0265*INT NE) + (0.00152*INT NE*FIN d) - (0.0816*HCW) - (6.35*BF) | 557.9 |
| Jowl fat IV | = 58.11 + (3.86*INT EFA) + (1.54*FIN EFA) + (0.013*INT d) | 831.1 |
| | = 65.14 + (0.87*INT EFA) + (0.85*FIN EFA) - (0.073*INT d) - (0.078*FIN d) + (0.045*INT EFA*INT d) + (0.051*FIN EFA*FIN d) | 814.6 |
| | = 85.28 + (1.18*INT EFA) + (0.95*FIN EFA) - (0.058*INT d) - (0.087*FIN d) + (0.038*INT EFA*INT d) + (0.051*FIN EFA*FIN d) - (0.0183*INT NE) | 792.6 |
| | = 86.17 + (0.64*INT EFA) + (0.91*FIN EFA) - (0.065*INT d) - (0.080*FIN d) + (0.043*INT EFA*INT d) + (0.053*FIN EFA*FIN d) - (0.0126*INT NE) - (8.89*BF) | 767.7 |
| | = 77.88 + (1.04*INT EFA) + (1.01*FIN EFA) - (0.0063*INT d) - (0.041*FIN d) + (0.038*INT EFA*INT d) + (0.053*FIN EFA*FIN d) - (0.0123*INT NE) + (0.0299*INT BW) - (9.144*BF) | 759.3 |

| | | |
|---|---|---|
| | = 85.50 + (1.08*INT EFA) + (0.87*FIN EFA) - (0.014*INT d) - (0.050*FIN d) + (0.038*INT EFA*INT d) + (0.054*FIN EFA*FIN d) - (0.0146*INT NE) + (0.0322*INT BW) - (0.993*ADFI) - (7.366*BF) | 756.2 |

[1]INT EFA = initial period dietary essential fatty acids, %; FIN EFA = final period dietary essential fatty acids, %; INT d = initial period days; FIN d=final period days; INT NE= initial period dietary net energy, kcal/lb; FIN NE= final period dietary net energy, kcal/lb; BF= backfat depth, in; INT BW = BW at the beginning of the experiment, lb.

[2]Bayesian Information Criterion (BIC) values were used to compare the precision of the model. Models that minimized BIC were preferred candidate models, with a reduction of more than 2 considered improved (Kass and Raftery, 1995).

**Table 7.** Inputs from validation experiment used in the regression equations to predict back, belly, and jowl fat iodine value (IV)[1]

| Treatment[2]: | A | B | C | D | E | F | G | H | I | J |
|---|---|---|---|---|---|---|---|---|---|---|
| d 0 to 42: | Control | Tallow | Tallow | Control | Blend | Blend | Control | Soy | Soy | Control |
| d 42 to 84: | Control | Tallow | Control | Tallow | Blend | Control | Blend | Soy | Control | Soy |
| Initial diet EFA, % | 1.50 | 1.91 | 1.87 | 1.47 | 2.53 | 2.65 | 1.47 | 3.44 | 3.44 | 1.47 |
| Initial diet NE, kcal/lb | 1,142 | 1,212 | 1,204 | 1,134 | 1,218 | 1,210 | 1,134 | 1,224 | 1,216 | 1,134 |
| Initial diet days | 84 | 84 | 42 | 42 | 84 | 42 | 42 | 84 | 42 | 42 |
| Final diet EFA, % | 1.50 | 1.91 | 1.52 | 1.94 | 2.53 | 1.52 | 2.41 | 3.45 | 1.52 | 3.45 |
| Final diet NE, kcal/lb | 1,142 | 1,212 | 1,150 | 1,221 | 1,218 | 1,150 | 1,227 | 1,224 | 1,150 | 1,232 |
| Final diet days | 0 | 0 | 42 | 42 | 0 | 42 | 42 | 0 | 42 | 42 |
| Backfat, in | 0.67 | 0.76 | 0.77 | 0.73 | 0.88 | 0.82 | 0.77 | 0.86 | 0.71 | 0.76 |
| HCW, lb | 214.40 | 218.60 | 217.20 | 212.80 | 213.00 | 212.90 | 216.10 | 216.40 | 215.50 | 213.10 |
| ADFI, lb | 6.08 | 5.97 | 6.15 | 6.15 | 6.13 | 5.95 | 5.84 | 6.09 | 5.97 | 5.78 |
| Initial BW, lb | 100.60 | 100.70 | 100.50 | 100.50 | 101.10 | 100.00 | 100.90 | 100.50 | 100.30 | 100.20 |

[1]Inputs were obtained from the experiment conducted for validation of regression equations (Stephenson et al., 2014).

[2] Control= no added fat; Tallow= 4% beef tallow; Soy= 4% soybean oil; Blend= 2% tallow and 2% soybean oil

**Table 8.** Validation of regression equations used to predict back, belly, and jowl fat iodine value (IV)

| Treatment[1]: | A | B | C | D | E | F | G | H | I | J | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| d 0 to 42: | Control | Tallow | Tallow | Control | Blend | Blend | Control | Soy | Soy | Control | |
| d 42 to 84: | Control | Tallow | Control | Tallow | Blend | Control | Blend | Soy | Control | Soy | SEM |
| Backfat IV | | | | | | | | | | | |
| Actual[2] | 63.29 | 64.03 | 63.83 | 62.72 | 71.17 | 66.92 | 67.83 | 79.43 | 67.87 | 73.86 | 1.16 |
| Predicted[3] | 65.71 | 67.04 | 67.16 | 70.19 | 70.54 | 68.59 | 71.60 | 77.04 | 71.09 | 75.13 | |
| Belly fat IV | | | | | | | | | | | |
| Actual[2] | 66.23 | 67.25 | 67.50 | 66.15 | 72.42 | 69.91 | 70.39 | 79.45 | 72.44 | 74.96 | 0.94 |
| Predicted [4] | 63.49 | 63.25 | 68.57 | 65.95 | 66.66 | 70.07 | 65.43 | 72.07 | 72.03 | 65.74 | |
| Jowl fat IV | | | | | | | | | | | |
| Actual[2] | 64.68 | 65.10 | 65.43 | 64.66 | 69.96 | 67.56 | 67.84 | 75.94 | 71.07 | 70.90 | 0.96 |
| Predicted[5] | 67.68 | 68.20 | 66.54 | 68.09 | 70.29 | 68.36 | 69.59 | 75.11 | 71.18 | 72.96 | |

[1] Control= no added fat; Tallow= 4% beef tallow; Soy= 4% soybean oil; Blend= 2% tallow and 2% soybean oil

[2]Means were obtained from the experiment conducted for validation of regression equations (Validation Trial).

[3]Backfat IV=84.83 + (6.87*INT EFA) - (3.90*FIN EFA) - (0.12*INT d) - (1.30*FIN d) - (0.11*INT EFA*FIN d) + (0.048*FIN EFA*INT d) + (0.12*FIN EFA*FIN d) - (0.0132*FIN NE) + (0.0011*FIN NE*FIN d) - (6.604*BF) where INT EFA = initial period dietary essential fatty acids, %; FIN EFA = final period dietary essential fatty acids, %; INT d = initial period days; FIN d=final period days; FIN NE= final period dietary net energy, kcal/lb; BF= backfat depth, in.

[4]Belly fat IV= 106.16 + (6.21*INT EFA) - (1.50*FIN d) - (0.11*INT EFA*FIN d) - (0.0265*INT NE) + (0.00152*INT NE*FIN d) - (0.0816*HCW) - (6.35*BF) where INT NE = initial period dietary NE, kcal/lb.

[5]Jowl fat IV= 85.50 + (1.08*INT EFA) + (0.87*FIN EFA) - (0.014*INT d) - (0.050*FIN d) + (0.038*INT EFA*INT d) + (0.054*FIN EFA*FIN d) - (0.0146*INT NE) + (0.0322*INT BW) - (0.993*ADFI) - (7.366*BF) where INT BW = BW at the beginning of the experiment, lb.

**Figure 1**. Plot of residuals against predicted A) back, B) belly, and C) jowl fat iodine value (IV) from each mixed model analysis. The following equations were used: A) backfat IV =84.83 + (6.87*INT EFA) - (3.90*FIN EFA) - (0.12*INT d) - (1.30*FIN d) - (0.11*INT EFA*FIN d) + (0.048*FIN EFA*INT d) + (0.12*FIN EFA*FIN d) - (0.0132*FIN NE) + (0.0011*FIN NE*FIN d) - (6.604*BF); B) belly fat IV = 106.16 + (6.21*INT EFA) - (1.50*FIN d) - (0.11*INT EFA*FIN d) - (0.0265*INT NE) + (0.00152*INT NE*FIN d) - (0.0816*HCW) - (6.35*BF); C) jowl fat IV = 85.50 + (1.08*INT EFA) + (0.87*FIN EFA) - (0.014*INT d) - (0.050*FIN d) + (0.038*INT EFA*INT d) + (0.054*FIN EFA*FIN d) - (0.0146*INT NE) + (0.0322*INT BW) - (0.993*ADFI) - (7.366*BF) where INT EFA = initial period dietary essential fatty acids, %; FIN EFA = final period dietary essential fatty acids, %; INT d = initial period days; FIN d=final period days; INT NE= initial period dietary net energy, kcal/lb; FIN NE= final period dietary net energy, kcal/lb; BF= backfat depth, in; ADFI = average daily feed intake, lb; INT BW = BW at the beginning of the experiment, lb.

**Figure 2.** Plot of actual iodine value (IV) vs predicted IV relative to the line of equality for A) back, B) belly, and C) jowl fat IV from each mixed model analysis. The following equations were used: A) backfat IV =84.83 + (6.87*INT EFA) - (3.90*FIN EFA) - (0.12*INT d) - (1.30*FIN d) - (0.11*INT EFA*FIN d) + (0.048*FIN EFA*INT d) + (0.12*FIN EFA*FIN d) - (0.0132*FIN NE) + (0.0011*FIN NE*FIN d) - (6.604*BF); B) belly fat IV = 106.16 + (6.21*INT EFA) - (1.50*FIN d) - (0.11*INT EFA*FIN d) - (0.0265*INT NE) + (0.00152*INT NE*FIN d) - (0.0816*HCW) - (6.35*BF); C) jowl fat IV = 85.50 + (1.08*INT EFA) + (0.87*FIN EFA) - (0.014*INT d) - (0.050*FIN d) + (0.038*INT EFA*INT d) + (0.054*FIN EFA*FIN d) - (0.0146*INT NE) + (0.0322*INT BW) - (0.993*ADFI) - (7.366*BF) where INT EFA = initial period dietary essential fatty acids, %; FIN EFA = final period dietary essential fatty acids, %; INT d = initial period days; FIN d=final period days; INT NE= initial period dietary net energy, kcal/lb; FIN NE= final period dietary net energy, kcal/lb; BF= backfat depth, in; ADFI = average daily feed intake, lb; INT BW = BW at the beginning of the experiment, lb.

**Figure 1**

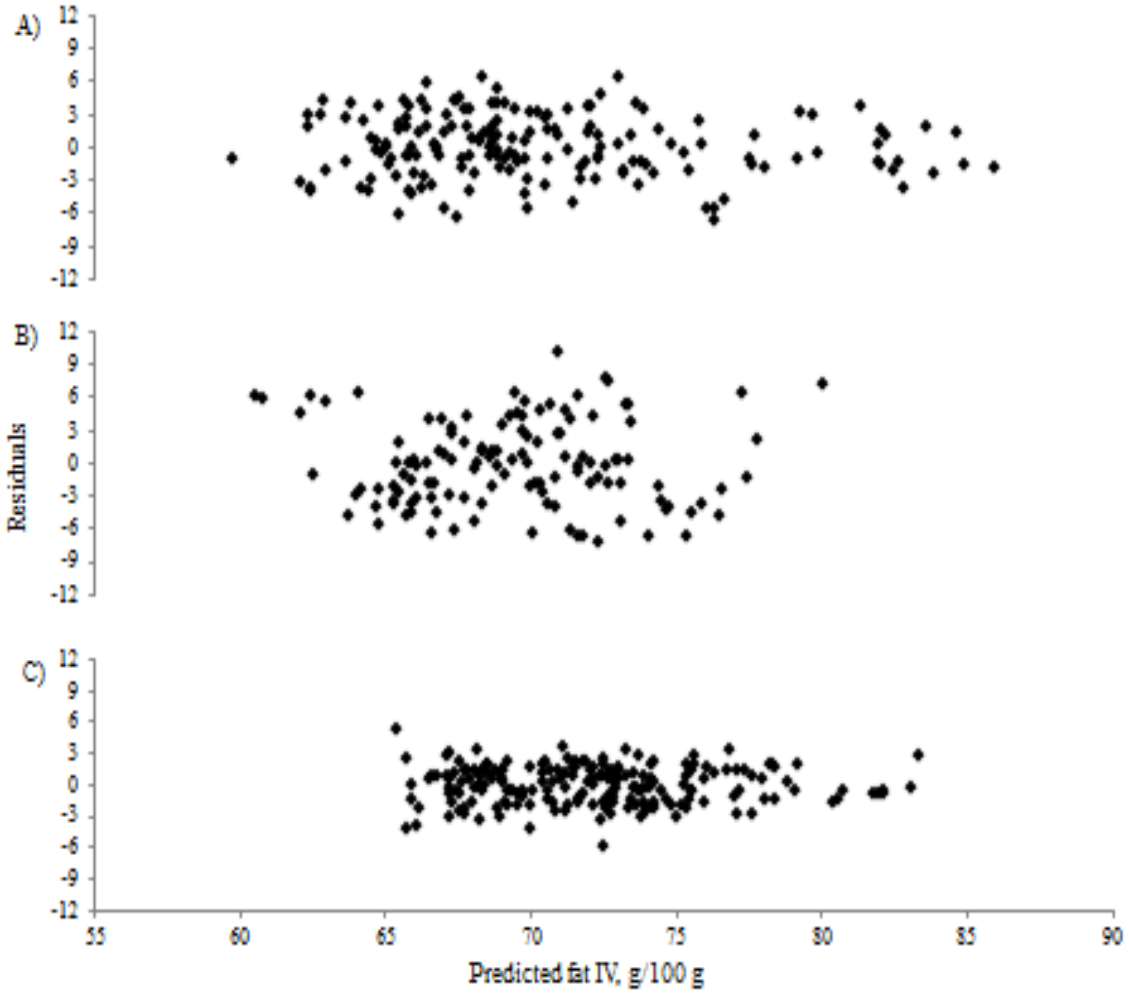
A)
B)
C)
Residuals
12
9
6
3
0
-3
-6
-9
-12
55
60
65
70
75
80
85
90
Predicted fat IV, g/100 g

**Figure 2**

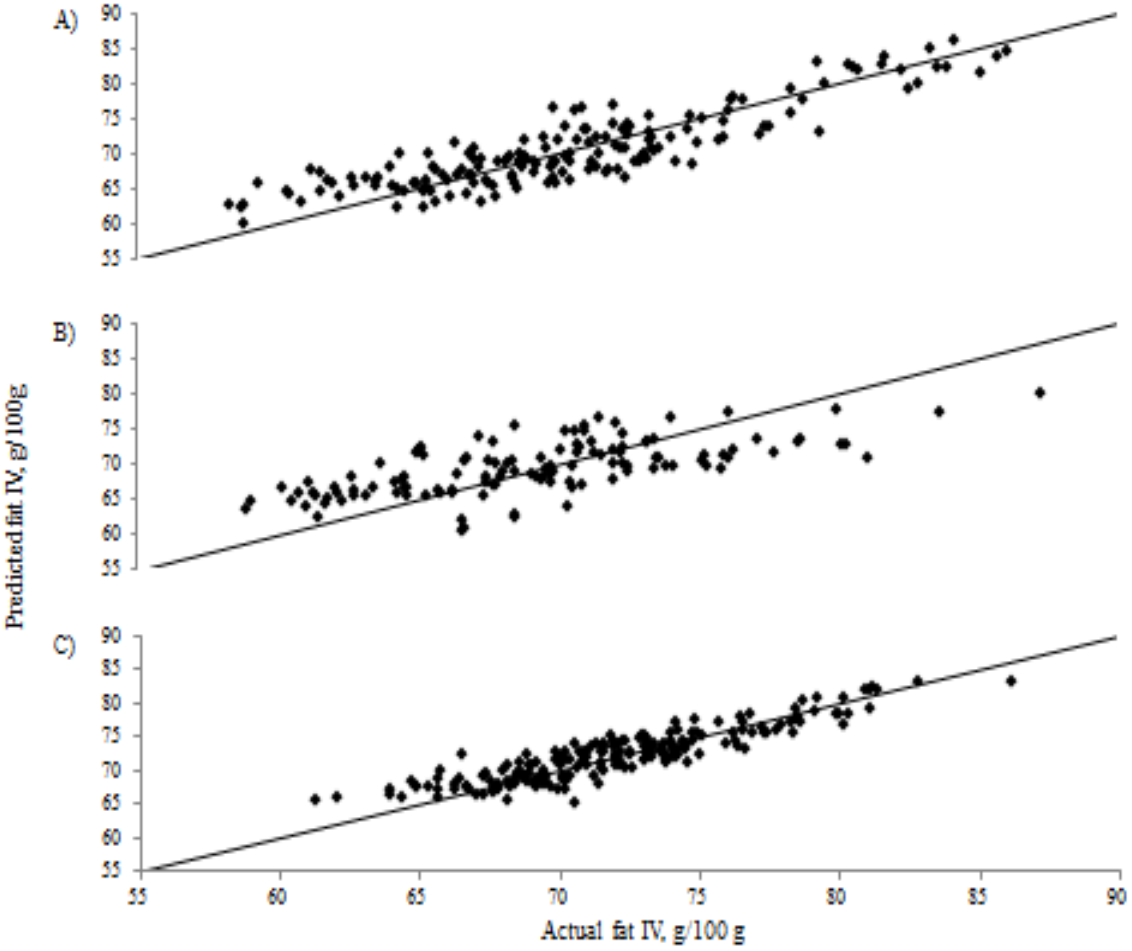
A)
B)
C)
90
85
80
75
70
65
60
55
Predicted fat IV, g/100g
Actual fat IV, g/100 g

**Table 9.** Phase 1, 2 and 3 diet composition (as-fed basis)[1]

| | Phase 1 | | Phase 2 | | Phase 3 | |
|---|---|---|---|---|---|---|
| Item | Control | Added Fat | Control | Added Fat | Control | Added Fat |
| Ingredient, % | | | | | | |
| Corn | 76.40 | 69.40 | 80.70 | 74.10 | 84.00 | 77.70 |
| Soybean meal, 46.5% CP | 20.95 | 23.90 | 17.00 | 19.60 | 14.00 | 16.25 |
| Fat source[2] | --- | 4.00 | --- | 4.00 | --- | 4.00 |
| Monocalcium, 21% P | 0.49 | 0.48 | 0.38 | 0.38 | 0.31 | 0.31 |
| Limestone | 1.05 | 1.05 | 1.00 | 1.00 | 0.90 | 0.90 |
| Salt | 0.35 | 0.35 | 0.35 | 0.35 | 0.35 | 0.35 |
| Vitamin premix | 0.15 | 0.15 | 1.00 | 1.00 | 0.08 | 0.08 |
| Trace mineral premix | 0.15 | 0.15 | 0.35 | 0.35 | 0.08 | 0.08 |
| L-Lys HCl | 0.28 | 0.28 | 0.23 | 0.23 | 0.20 | 0.20 |
| DL-Meth | 0.05 | 0.07 | 0.01 | 0.03 | --- | --- |
| L-Thr | 0.08 | 0.09 | 0.05 | 0.65 | --- | --- |
| Phytase[3] | 0.08 | 0.08 | 0.08 | 0.08 | 0.08 | 0.08 |
| Total | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| | | | | | | |
| Calculated analysis | | | | | | |
| Standard ileal digestible (SID) amino acids, % | | | | | | |
| Lysine | 0.91 | 0.98 | 0.78 | 0.83 | 0.68 | 0.73 |
| Isoleucine:lysine | 63 | 63 | 66 | 65 | 67 | 67 |
| Leucine:lysine | 143 | 138 | 157 | 150 | 168 | 160 |
| Methionine:lysine | 32 | 32 | 29 | 30 | 31 | 31 |
| Met & Cys:lysine | 58 | 58 | 58 | 58 | 61 | 60 |
| Threonine:lysine | 63 | 63 | 64 | 64 | 65 | 65 |
| Tryptophan:lysine | 18 | 18 | 18 | 18 | 18 | 18 |
| Valine:lysine | 71 | 70 | 75 | 74 | 78 | 76 |
| SID lysine:NE, g/Mcal | 3.65 | 3.68 | 3.07 | 3.10 | 2.67 | 2.70 |
| ME, kcal/lb | 1,497 | 1,577 | 1,502 | 1,582 | 1,507 | 1,587 |
| NE, kcal/lb | 1,130 | 1,199 | 1,143 | 1,213 | 1,154 | 1,225 |
| Total lysine, % | 1.03 | 1.10 | 0.88 | 0.94 | 0.78 | 0.83 |
| CP, % | 16.6 | 17.5 | 15.0 | 15.7 | 13.8 | 14.4 |
| Ca, % | 0.54 | 0.55 | 0.50 | 0.50 | 0.44 | 0.45 |
| Crude fiber, % | 2.3 | 2.3 | 2.3 | 2.2 | 2.2 | 2.2 |
| P, % | 0.45 | 0.45 | 0.41 | 0.41 | 0.38 | 0.38 |
| Available P, % | 0.26 | 0.26 | 0.24 | 0.24 | 0.22 | 0.22 |

[1] Phase 1 diets were fed from approximately 85 to 150 lb; Phase 2 diets were fed from 150 to 210 lb; Phase 3 diets were fed from 210 to 270 lb.

[2] Fat sources were either tallow, soybean oil or a blend of 2% tallow and 2% soybean oil.

[3] Phyzyme 600 (Danisco Animal Nutrition, St. Louis, MO) provided 204.3 phytase units (FTU)/lb, with a release of 0.11% available P.

**Table 10.** Diet Analysis (as-fed basis)[1] Phases 1, 2 and 3

| | Diets[2] | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Phase 1 | | | | Phase 2 | | | | Phase 3 | | | |
| Item, %[3] | Control | Tallow | Blend | Soy | Control | Tallow | Blend | Soy | Control | Tallow | Blend | Soy |
| Moisture | 10.07 | 9.33 | 9.97 | 10.01 | 10.32 | 10.01 | 10.01 | 10.29 | 10.48 | 9.77 | 10.47 | 10.25 |
| DM | 89.93 | 90.67 | 90.03 | 89.99 | 89.68 | 89.99 | 89.99 | 89.71 | 89.52 | 90.23 | 89.53 | 89.75 |
| CP | 17.9 | 18.7 | 17.5 | 18.3 | 16.1 | 16 | 16.3 | 16.7 | 15 | 15.2 | 15.3 | 14.9 |
| ADF | 2.6 | 3.6 | 3.3 | 3.4 | 3.3 | 3.2 | 3 | 3.4 | 1.9 | 2.4 | 2.8 | 2.3 |
| NDF | 6.5 | 8 | 8 | 6.6 | 5.9 | 5.2 | 6 | 5.4 | 7.1 | 8.4 | 8.4 | 6.8 |
| CF | 1.9 | 2.7 | 2.9 | 2.4 | 1.5 | 2.4 | 2.4 | 2.1 | 2 | 2.5 | 2.9 | 2.5 |
| NFE | 63.1 | 58.2 | 59.4 | 58.2 | 65 | 61.5 | 60.9 | 61.4 | 66.3 | 62.1 | 62.3 | 63 |
| Fat | 3.0 | 6.7 | 6.2 | 6.5 | 2.3 | 6.3 | 6.7 | 5.5 | 3.1 | 7.1 | 5.9 | 6.4 |
| Ash | 3.85 | 4.2 | 4.27 | 4.29 | 3.65 | 3.64 | 3.71 | 3.37 | 3.64 | 3.87 | 3.78 | 3.59 |
| Starch | 47.1 | 37.8 | 40.9 | 42.1 | 51.5 | 47.5 | 45.6 | 48.2 | 49.8 | 43.1 | 43.5 | 45.1 |

[1] Phase 1 diets were fed from approximately 85 to 150 lb; Phase 2 diets were fed from 150 to 210 lb; Phase 3 diets were fed from 210 to 270 lb.
[2] Control = no added fat; Tallow = 4% beef tallow; Soy = 4% soybean oil; Blend = 2% tallow and 2% soybean oil
[3] Values represent the mean of one composite sample of each diet.

**Table 11.** Fatty acid analysis of ingredients and treatment diets

| | Ingredients | | Diets[1] | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Phase 1 | | | | Phase 2 | | | | Phase 3 | | | |
| Item | Beef Tallow | Soy Oil | Control | Tallow | Blend | Soy | Control | Tallow | Blend | Soy | Control | Tallow | Blend | Soy |
| Myristic acid (C14:0), % | 2.94 | 0.08 | 0.06 | 1.51 | 0.81 | 0.09 | 0.09 | 1.56 | 0.94 | 0.09 | 0.05 | 1.52 | 1.09 | 0.08 |
| Palmitic acid (C16:0), % | 24.09 | 9.61 | 16.83 | 20.78 | 16.92 | 12.85 | 16.78 | 21.06 | 17.42 | 13.59 | 16.17 | 20.80 | 18.38 | 13.36 |
| Palmitoleic acid (C16:1), % | 3.77 | 0.11 | 0.15 | 1.91 | 1.14 | 0.14 | 0.20 | 1.99 | 1.28 | 0.13 | 0.14 | 1.98 | 1.38 | 0.12 |
| Stearic acid (C18:0), % | 16.91 | 4.34 | 2.48 | 10.49 | 7.00 | 3.68 | 2.56 | 10.50 | 7.87 | 3.89 | 2.01 | 10.40 | 8.85 | 3.86 |
| Oleic acid (C18:1 *cis*-9), % | 38.38 | 24.52 | 20.99 | 28.51 | 25.88 | 23.06 | 21.61 | 29.70 | 25.63 | 21.47 | 22.45 | 28.71 | 26.15 | 21.79 |
| Linoleic acid (C18:2n-6), % | 5.07 | 51.80 | 51.11 | 27.36 | 39.08 | 50.77 | 50.31 | 26.32 | 36.98 | 50.42 | 52.14 | 27.12 | 35.17 | 50.60 |
| α-linoleic acid (C18:3n-3), % | 0.32 | 6.81 | 2.31 | 1.45 | 3.01 | 4.71 | 2.47 | 1.41 | 3.80 | 6.07 | 2.07 | 1.61 | 2.94 | 5.99 |
| Arachidic acid (C20:0), % | 0.16 | 0.33 | 0.43 | 0.27 | 0.33 | 0.38 | 0.39 | 0.25 | 0.29 | 0.36 | 0.37 | 0.26 | 0.29 | 0.37 |
| Gadoleic acid (C20:1), % | 0.26 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Other fatty acids, % | 8.10 | 2.40 | 5.63 | 7.70 | 5.83 | 4.33 | 5.60 | 7.21 | 5.79 | 3.98 | 4.61 | 7.59 | 5.75 | 3.82 |
| Total SFA, %[2] | 45.72 | 15.10 | 24.24 | 36.48 | 28.13 | 19.79 | 24.19 | 36.20 | 29.27 | 20.50 | 22.24 | 36.03 | 31.20 | 20.14 |
| Total MUFA, %[3] | 47.57 | 26.04 | 22.15 | 34.10 | 29.34 | 24.48 | 22.86 | 35.45 | 29.53 | 22.82 | 23.43 | 34.61 | 30.26 | 23.09 |
| Total PUFA, %[4] | 6.71 | 58.86 | 53.61 | 29.43 | 42.52 | 55.73 | 52.96 | 28.35 | 41.20 | 56.68 | 54.33 | 29.36 | 38.54 | 56.77 |
| UFA:SFA ratio[5] | 1.19 | 5.62 | 3.13 | 1.74 | 2.55 | 4.05 | 3.13 | 1.76 | 2.42 | 3.88 | 3.50 | 1.78 | 2.21 | 3.97 |
| PUFA:SFA ratio[6] | 0.15 | 3.90 | 2.21 | 0.81 | 1.51 | 2.82 | 2.19 | 0.78 | 1.41 | 2.76 | 2.44 | 0.81 | 1.24 | 2.82 |
| Iodine value, g/100g[7] | 49.94 | 129.89 | 113.41 | 80.22 | 100.67 | 121.15 | 112.96 | 79.47 | 99.27 | 122.72 | 115.69 | 80.52 | 94.37 | 123.05 |
| Analyzed IVP[8] | 499.44 | 1298.85 | 34.02 | 53.75 | 62.41 | 78.75 | 25.98 | 50.07 | 66.51 | 67.49 | 35.86 | 57.17 | 55.68 | 78.75 |

[1] Control = no added fat; Tallow = 4% beef tallow; Soy = 4% soybean oil; Blend = 2% tallow and 2% soybean oil

[2] Total SFA = ([C6:0] + [C8:0] + [C10:0] + [C11:0] + [C12:0] + [C14:0] + [C15:0] + [C16:0] + [C17:0] + [C18:0] + [C20:0] + [C21:0] + [C22:0] + [C23:0] + [C24:0]); brackets indicate concentration.

[3] Total MUFA = ([C14:1] + [C15:1] + [C16:1] + [C18:1*n*99] + [C18:1n9t] + [C18:1n11t] + [C18:1n11c] + [C20:1] + [C22:1n9] + [C24:1]); brackets indicate concentration.

[4] Total PUFA = ([C18:2n-6] + [C18:3n-3] + [C18:3n-6] + [CLA 9c11t] + [CLA10t,12c] + [CLA9c,11c] + [CLA9t,11t] + [C20:3n6] + [C20:3n3] + [C22:2] +[C20:5n3] +[C22:5n3] + [C22:6n3]; brackets indicate concentration.

[5] UFA:SFA = (total MUFA+PUFA)/ total SFA.

[6] PUFA:SFA = total PUFA/ total SFA.

[7] Calculated as IV value (IV) = [C16:1] × 0.950 + [C18:1] × 0.860 + [C18:2] × 1.732 + [C18:3] × 2.616 + [C20:1] × 0.785 + [C20:4] × 3.201 + [C22:1] × 0.723 + [C22:5] × 3.697 + [C22:6] × 4.463; brackets indicate concentration.

[8] Iodine value of dietary lipids calculated from analyzed fatty acid composition × % analyzed dietary lipids × 0.10.

**Table 12.** Effects of source and duration of added fat on growth performance and carcass characteristics of finishing pigs[1]

| Treatment[2]: | A | B | C | D | E | F | G | H | I | J | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| d 0 to 42: | Control | Tallow | Tallow | Control | Blend | Blend | Control | Soy | Soy | Control | | Contrasts[3,4,5,6] | | | | | |
| d 42 to 84: | Control | Tallow | Control | Tallow | Blend | Control | Blend | Soy | Control | Soy | SEM | 1 | 2 | 3 | 4 | 5 | 6 |
| **BW, lb** | | | | | | | | | | | | | | | | | |
| d 0 | 100.6 | 100.7 | 100.5 | 100.5 | 101.1 | 100.0 | 100.9 | 100.5 | 100.3 | 100.2 | 2.42 | 0.844 | 0.492 | 0.659 | 0.902 | 0.606 | 0.695 |
| d 84 | 286.3 | 292.0 | 291.4 | 287.2 | 295.7 | 283.6 | 283.9 | 295.7 | 287.2 | 286.1 | 5.59 | 0.089 | 0.006 | 0.606 | 0.444 | 0.553 | 0.864 |
| **d 0 to 42** | | | | | | | | | | | | | | | | | |
| ADG, lb | 2.03 | 2.17 | 2.20 | 2.08 | 2.10 | 2.06 | 2.02 | 2.17 | 2.09 | 1.97 | 0.06 | 0.005 | - | - | 0.067 | 0.345 | 0.372 |
| ADFI, lb | 5.06 | 5.11 | 5.18 | 5.38 | 5.24 | 5.09 | 5.06 | 5.16 | 4.97 | 4.89 | 0.14 | 0.752 | - | - | 0.910 | 0.447 | 0.519 |
| F:G | 2.50 | 2.36 | 2.35 | 2.59 | 2.51 | 2.49 | 2.51 | 2.38 | 2.37 | 2.49 | 0.05 | 0.000 | - | - | 0.002 | 0.008 | 0.607 |
| **d 42 to 84** | | | | | | | | | | | | | | | | | |
| ADG, lb | 2.39 | 2.39 | 2.34 | 2.37 | 2.48 | 2.31 | 2.35 | 2.48 | 2.31 | 2.46 | 0.07 | 0.052 | - | - | 0.586 | 0.362 | 0.145 |
| ADFI, lb | 7.09 | 6.82 | 7.11 | 6.92 | 7.15 | 6.82 | 6.61 | 7.01 | 7.07 | 6.68 | 0.19 | 0.177 | - | - | 0.967 | 0.863 | 0.895 |
| F:G | 2.95 | 2.84 | 3.04 | 2.92 | 2.90 | 2.97 | 2.81 | 2.82 | 3.05 | 2.73 | 0.06 | 0.000 | - | - | 0.713 | 0.218 | 0.112 |
| **d 0 to 84** | | | | | | | | | | | | | | | | | |
| ADG, lb | 2.21 | 2.28 | 2.27 | 2.22 | 2.27 | 2.18 | 2.19 | 2.33 | 2.19 | 2.21 | 0.05 | 0.134 | 0.018 | 0.842 | 0.219 | 0.384 | 0.718 |
| ADFI, lb | 6.08 | 5.97 | 6.15 | 6.15 | 6.13 | 5.95 | 5.84 | 6.09 | 5.97 | 5.78 | 0.15 | 0.924 | 0.372 | 0.401 | 0.301 | 0.803 | 0.202 |
| F:G | 2.75 | 2.61 | 2.70 | 2.77 | 2.70 | 2.75 | 2.66 | 2.61 | 2.72 | 2.62 | 0.04 | 0.036 | 0.042 | 0.294 | 0.732 | 0.092 | 0.176 |
| **Carcass Characteristics** | | | | | | | | | | | | | | | | | |
| HCW, lb | 214.4 | 218.6 | 217.2 | 212.8 | 213.0 | 212.9 | 216.1 | 216.4 | 215.5 | 213.1 | 5.5 | 0.801 | 0.717 | 0.787 | 0.631 | 0.822 | 0.798 |
| Yield, % | 74.6 | 74.1 | 74.5 | 73.8 | 74.1 | 74.5 | 74.5 | 74.2 | 74.3 | 74.5 | 0.5 | 0.455 | 0.548 | 0.671 | 0.510 | 0.950 | 0.552 |
| LEA,[7] $in^2$ | 9.27 | 9.28 | 9.70 | 9.30 | 9.50 | 9.32 | 9.43 | 9.21 | 9.61 | 9.39 | 0.37 | 0.859 | 0.550 | 0.493 | 0.971 | 0.957 | 0.928 |
| BF,[7] in | 0.67 | 0.76 | 0.77 | 0.73 | 0.88 | 0.82 | 0.77 | 0.86 | 0.71 | 0.76 | 0.06 | 0.032 | 0.125 | 0.763 | 0.166 | 0.336 | 0.665 |
| FFLI,[8] % | 56.74 | 55.85 | 56.24 | 56.18 | 54.77 | 55.11 | 55.79 | 54.74 | 56.72 | 55.97 | 0.83 | 0.083 | 0.121 | 0.946 | 0.189 | 0.373 | 0.667 |

[1] A total of 160 finishing pigs (PIC 337 × 1050, initial BW of 100.5 lb) were used in an 84-d finishing trial with 2 pigs per pen and 8 pens per treatment.

[2] Control = no added fat; Tallow = 4% beef tallow; Soy = 4% soybean oil; Blend = 2% tallow and 2% soybean oil

[3]There were no fat or fat source interactions $P > 0.05$.

[4] The period 1 (d 0 to 42) contrast statements are as follows 1 = no added fat vs. added fat (treatments A, D, G, and J vs. B, C, E, F, H, and I); 4 = tallow vs. blend (treatments B and C vs. E and F); 5 = blend vs. soy oil (treatments E and F vs. H and I); 6 = tallow vs. soy oil (treatments B and C vs. H and I).

[5] The period 2 (d 42 to 84) contrast statements are as follows 1 = no added fat vs. added fat (treatments A, C, F, and I vs. B, D, E, G, H, and J); 4 = tallow vs. blend (treatments B and D vs. E and G); 5 = blend vs. soy oil (treatments E and G vs. H and J); 6 = tallow vs. soy oil (treatments B and D vs. H and J).

[6] The overall (d 0 to 84) contrast statements are as follows: 1 = no added fat vs. added fat both periods (treatment A vs. B, E, and H); 2 = added fat both periods vs. added fat only during a single period (treatments B, E, H vs. C, D, F, G, I, and J); 3 = added fat only during period 1 vs. added fat only during period 2 (treatments C, F, I vs. D, G, and J); 4 = tallow vs. blend (treatments B,C, D vs. E, F, and G); 5 = blend vs. soy oil (treatments E, F, G, vs. H, I, and J); 6 = tallow vs. soy oil (treatments B, C, D, vs. H, I, and J).

[7] Adjusted using HCW as a covariate.

[8] Fat Free Lean Index was calculated using NPPC (2001) equation.

**Table 13.** Effects of source and duration of feeding fat on backfat quality of finishing pigs[1,2]

| Treatment[3]: | A | B | C | D | E | F | G | H | I | J | | Interactions[4,5] | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| d 0 to 42: | Control | Tallow | Tallow | Control | Blend | Blend | Control | Soy | Soy | Control | | | | | | | |
| d 42 to 84: | Control | Tallow | Control | Tallow | Blend | Control | Blend | Soy | Control | Soy | SEM | 1 | 2 | 3 | 4 | 5 | 6 |
| Palmitoleic acid (C16:1), % | | | | | | | | | | | | | | | | | |
| d 0[a] | 3.51 | 3.81 | 3.40 | 3.89 | 3.27 | 3.43 | 3.99 | 3.35 | 3.50 | 3.46 | 0.13 | | | | | | |
| d 42[a,b,d] | 2.72 | 2.58 | 2.83 | 3.04 | 2.16 | 2.22 | 3.01 | 2.07 | 1.86 | 2.83 | 0.13 | | | | | | |
| d 84[e,f,g,,h] | 2.51 | 2.55 | 2.61 | 2.51 | 2.14 | 2.37 | 2.38 | 1.81 | 2.21 | 1.94 | 0.10 | 0.180 | 0.881 | 0.130 | 0.567 | 0.146 | 0.353 |
| Total C18:1, %[6] | | | | | | | | | | | | | | | | | |
| d 0 | 40.36 | 41.00 | 41.75 | 40.49 | 40.33 | 42.25 | 42.81 | 41.12 | 39.21 | 40.34 | 0.76 | | | | | | |
| d 42[a,b,c,d] | 42.15 | 43.97 | 44.60 | 43.24 | 40.78 | 40.87 | 44.20 | 39.34 | 37.73 | 43.64 | 0.76 | | | | | | |
| d 84[e,f,g,h] | 42.14 | 44.32 | 43.19 | 44.11 | 41.11 | 41.76 | 41.70 | 36.91 | 40.41 | 38.11 | 0.61 | 0.173 | 0.069 | 0.001 | 0.386 | 0.053 | 0.004 |
| Total C18:2, %[7] | | | | | | | | | | | | | | | | | |
| d 0 | 13.07 | 12.24 | 12.24 | 12.84 | 12.78 | 12.13 | 11.94 | 12.79 | 14.07 | 14.08 | 0.65 | | | | | | |
| d 42[a,b,c,d] | 10.61 | 10.05 | 10.88 | 9.32 | 15.13 | 15.58 | 9.25 | 17.83 | 21.15 | 10.52 | 0.65 | | | | | | |
| d 84 [e,f,g,h] | 12.28 | 11.72 | 12.15 | 11.10 | 16.48 | 14.16 | 14.38 | 22.29 | 15.35 | 18.91 | 0.53 | 0.009 | 0.001 | 0.001 | 0.186 | 0.001 | 0.001 |
| Total C18:3, %[8] | | | | | | | | | | | | | | | | | |
| d 0 | 0.62 | 0.65 | 0.63 | 0.65 | 0.67 | 0.63 | 0.61 | 0.66 | 0.81 | 0.70 | 0.07 | | | | | | |
| d 42 [a,b,c,d] | 0.65 | 0.44 | 0.51 | 0.43 | 0.99 | 1.08 | 0.45 | 1.34 | 1.56 | 0.49 | 0.07 | | | | | | |
| d 84 [e,f,g,h] | 0.69 | 0.61 | 0.58 | 0.60 | 1.35 | 0.92 | 1.14 | 2.14 | 1.01 | 1.82 | 0.06 | 0.001 | 0.001 | 0.001 | 0.073 | 0.001 | 0.001 |
| Gadoleic acid (C20:1), % | | | | | | | | | | | | | | | | | |
| d 0 | 0.60 | 0.63 | 0.55 | 0.63 | 0.63 | 0.63 | 0.63 | 0.64 | 0.55 | 0.59 | 0.03 | | | | | | |
| d 42[a,d] | 0.72 | 0.71 | 0.66 | 0.69 | 0.64 | 0.64 | 0.66 | 0.61 | 0.59 | 0.67 | 0.03 | | | | | | |
| d 84[e,f,g,h] | 0.68 | 0.68 | 0.66 | 0.71 | 0.65 | 0.65 | 0.61 | 0.53 | 0.64 | 0.55 | 0.03 | 0.547 | 0.029 | 0.104 | 0.063 | 0.343 | 0.004 |
| Docosapentaenoic acid (C22:5n3), % | | | | | | | | | | | | | | | | | |
| d 0 | 0.21 | 0.16 | 0.12 | 0.12 | 0.19 | 0.12 | 0.12 | 0.12 | 0.11 | 0.12 | 0.03 | | | | | | |
| d 42 | 0.11 | 0.06 | 0.07 | 0.11 | 0.13 | 0.09 | 0.11 | 0.09 | 0.10 | 0.07 | 0.03 | | | | | | |
| d 84[h] | 0.07 | 0.07 | 0.07 | 0.08 | 0.12 | 0.09 | 0.10 | 0.14 | 0.09 | 0.13 | 0.02 | 0.397 | 0.938 | 0.347 | 0.848 | 0.765 | 0.615 |
| Total SFA, %[9] | | | | | | | | | | | | | | | | | |
| d 0 | 38.11 | 38.45 | 38.71 | 38.04 | 38.78 | 38.02 | 37.44 | 38.36 | 38.20 | 38.02 | 0.75 | | | | | | |
| d 42[a,b,c,d] | 40.41 | 40.50 | 38.61 | 41.04 | 38.16 | 37.80 | 40.48 | 37.03 | 35.15 | 40.26 | 0.75 | | | | | | |
| d 84 [e,f,g,h] | 40.01 | 38.27 | 39.06 | 39.04 | 36.17 | 38.24 | 37.85 | 34.33 | 38.52 | 36.67 | 0.63 | 0.219 | 0.121 | 0.005 | 0.722 | 0.180 | 0.081 |
| Total MUFA, % [10] | | | | | | | | | | | | | | | | | |
| d 0 | 46.57 | 47.24 | 47.25 | 46.98 | 46.30 | 47.96 | 48.83 | 46.76 | 45.41 | 46.01 | 0.67 | | | | | | |
| d 42 [a,b,c,d] | 47.16 | 48.01 | 48.93 | 48.26 | 44.44 | 44.32 | 48.87 | 42.65 | 40.84 | 47.95 | 0.67 | | | | | | |
| d 84 [e,f,g,h] | 45.99 | 48.22 | 47.14 | 48.07 | 44.61 | 45.47 | 45.42 | 39.79 | 43.94 | 41.21 | 0.54 | 0.090 | 0.024 | 0.001 | 0.334 | 0.011 | 0.001 |
| Total PUFA, %[11] | | | | | | | | | | | | | | | | | |
| d 0 [d] | 15.28 | 14.31 | 14.00 | 15.01 | 14.89 | 14.00 | 13.72 | 14.89 | 16.36 | 16.05 | 0.75 | | | | | | |
| d 42 [a,b,c,d] | 12.40 | 11.48 | 12.41 | 10.73 | 17.37 | 17.85 | 10.64 | 20.33 | 23.97 | 11.87 | 0.75 | | | | | | |
| d 84 [e,f,g,h] | 13.58 | 13.04 | 13.32 | 12.45 | 18.58 | 15.74 | 16.18 | 25.10 | 16.97 | 21.54 | 0.61 | 0.007 | 0.001 | 0.001 | 0.234 | 0.001 | 0.001 |

| | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Iodine value, g/100g[12] | | | | | | | | | | | | | | | | | |
| d 0 | 67.36 | 65.91 | 64.97 | 66.64 | 66.80 | 65.79 | 65.93 | 66.01 | 68.71 | 67.52 | 1.28 | | | | | | |
| d 42 [a,b,c,d] | 63.03 | 60.48 | 62.85 | 60.63 | 68.29 | 68.86 | 60.58 | 71.98 | 76.75 | 61.60 | 1.28 | | | | | | |
| d 84 [e,f,g,h] | 63.29 | 64.03 | 63.82 | 62.72 | 71.25 | 66.85 | 67.74 | 79.43 | 67.88 | 73.90 | 1.05 | 0.038 | 0.003 | 0.001 | 0.276 | 0.007 | 0.001 |

[1] A total of 160 finishing pigs (PIC 337 × 1050, initial BW of 100.5 lb) were used in an 84-d finishing trial with 2 pigs per pen and 8 pens per treatment.
[2] C22:6n3 not included, all values were equal to or less than 0.003.
[3]Control = corn soybean meal diet with no fat; Tallow = 4% beef tallow; Blend = 2% tallow and 2% soybean oil; Soy= 4% soybean oil.
[4]There was a treatment × day interaction ($P < 0.001$) for all variables except C 22:5n3 (P = 0.3066).
[5] The d 84 contrast statements for interactions are as follows: 1 = feeding duration (84-d vs. 42-d) × fat source (tallow vs. blend); 2 = feeding duration (84-d vs. 42-d) × fat source (blend vs. soy oil); 3 = feeding duration (84-d vs. 42-d) × fat source (tallow vs. soy oil); 4 = feeding period (d 0 to 42 vs. d 42 to 84) × fat source (tallow vs. blend); 5 = feeding period (d 0 to 42 vs. d 42 to 84) × fat source (blend vs. soy oil); 6 = feeding period (d 0 to 42 vs. d 42 to 84) × fat source (tallow vs. soy oil).
[a,b,c,d] Within a row, superscripts represent significant ($P < 0.05$) main effects where a = control vs. fat (treatments A, D, G, and J vs. B, C, E, F, H, and I); b = tallow vs. blend (treatments B and C vs. E and F); c = blend vs. soy oil (treatments E and F vs. H and I); d = tallow vs. soy oil (treatments B and C vs. H and I).
[e,f,g,h] Within a row, superscripts represent significant ($P < 0.05$) main effects where e = control vs. fat (treatments A, C, F, and I vs. B, D, E, G, H, and J); f = tallow vs. blend (treatments B and D vs. E and G); g = blend vs. soy oil (treatments E and G vs. H and J); h = tallow vs. soy oil (treatments B and D vs. H and J).
[6] Total C18:1= ([C18:1n9t] + [C18:1n11t] + [C18:1n9c] + [C18:1n11c]); brackets indicate concentration.
[7] Total C18:2= ([C18:2n6t] + C18:2n6c]); brackets indicate concentration.
[8] Total C18:3= ([C18:3n6] + [C18:3n3]); brackets indicate concentration.
[9] Total SFA= ([C6:0] + [C8:0] + [C10:0] + [C11:0] + [C12:0] + [C14:0] + [C15:0] + [C16:0] + [C17:0] + [C18:0] + [C20:0] + [C21:0] + [C22:0] + [C23:0] + [C24:0]); brackets indicate concentration.
[10]Total MUFA = ([C14:1] + [C16:1] + [C17:1] + [C18:1n9t] + [C18:1n11t] + [C18:1n9c] + [C18:1n11c] + [C20:1] + [C22:1n9] + [C24:1]); brackets indicate concentration.
[11]Total PUFA = ([C18:2n6t] + [C18:2n6c] + [C18:3n6] + [C18:3n3] + [CLA 9c11t] + [CLA 10t12c] + [CLA 9c11c] + [CLA 9t11t] + [C20:2] + [C20:3n6] + [C20:3n3] + [C22:2] + [C20:5n3] + [C22:5n3] + [C22:6n3]); brackets indicate concentration.
[12] Calculated as IV value= [C16:1] × 0.9502 + [C18:1] × 0.8598 + [C18:2] × 1.7315] + [C18:3] × 2.6125 + [C20:1] × 0.7852 + [C22:1n9] × 3.2008 + [C22:5n3] × 3.6974 + [C22:6n3] × 4.4632; brackets indicate concentrations.

**Table 14.** Effects of source and duration of added fat on belly fat quality of finishing pigs[1,2]

| Treatment[3]: | A | B | C | D | E | F | G | H | I | J | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| d 0 to 42: | Control | Tallow | Tallow | Control | Blend | Blend | Control | Soy | Soy | Control | Interactions[4,5] | | | | | |

| d 42 to 84: | Control | Tallow | Control | Tallow | Blend | Control | Blend | Soy | Control | Soy | SEM | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Palmitoleic acid (C16:1), % | | | | | | | | | | | | | | | | | |
| d 0 | 4.58 | 4.86 | 4.78 | 4.81 | 4.38 | 4.71 | 5.14 | 4.64 | 5.01 | 5.03 | 0.16 | | | | | | |
| d 42 [a,b,d] | 3.96 | 3.75 | 3.67 | 4.24 | 3.20 | 3.29 | 4.13 | 2.91 | 3.25 | 3.93 | 0.16 | | | | | | |
| d 84 [e,f,h] | 3.21 | 3.12 | 3.29 | 3.31 | 2.64 | 2.91 | 2.93 | 2.43 | 2.86 | 2.65 | 0.13 | 0.635 | 0.832 | 0.482 | 0.997 | 0.373 | 0.353 |
| Total C18:1, %[6] | | | | | | | | | | | | | | | | | |
| d 0 | 42.51 | 43.63 | 42.70 | 42.86 | 42.31 | 43.28 | 43.45 | 42.65 | 43.34 | 41.21 | 0.81 | | | | | | |
| d 42[a,b,c,d] | 45.27 | 46.97 | 45.56 | 46.29 | 43.22 | 43.43 | 46.21 | 40.74 | 41.00 | 44.88 | 0.81 | | | | | | |
| d 84[e,f,g,h] | 45.60 | 46.50 | 46.13 | 47.09 | 43.77 | 45.01 | 44.46 | 40.77 | 44.06 | 41.88 | 0.65 | 0.407 | 0.227 | 0.038 | 0.213 | 0.189 | 0.008 |
| Total C18:2, %[7] | | | | | | | | | | | | | | | | | |
| d 0 | 11.43 | 10.51 | 11.10 | 10.94 | 10.85 | 10.42 | 10.35 | 11.31 | 10.52 | 11.50 | 0.62 | | | | | | |
| d 42 [a,b,c,d] | 9.52 | 9.42 | 10.89 | 8.06 | 12.48 | 13.37 | 8.62 | 16.16 | 16.10 | 9.30 | 0.62 | | | | | | |
| d 84 [e,f,g,h] | 9.87 | 9.85 | 10.13 | 8.93 | 13.77 | 11.83 | 11.96 | 18.20 | 13.05 | 15.65 | 0.51 | 0.044 | 0.012 | 0.001 | 0.148 | 0.008 | 0.001 |
| Total C18:3, %[8] | | | | | | | | | | | | | | | | | |
| d 0 | 0.54 | 0.49 | 0.55 | 0.51 | 0.64 | 0.52 | 0.49 | 0.53 | 0.50 | 0.54 | 0.05 | | | | | | |
| d 42 [a,b,c,d] | 0.42 | 0.42 | 0.56 | 0.35 | 0.78 | 0.87 | 0.38 | 1.18 | 1.18 | 0.41 | 0.05 | | | | | | |
| d 84 [e,f,g,h] | 0.45 | 0.45 | 0.44 | 0.41 | 1.04 | 0.66 | 0.85 | 1.67 | 0.80 | 1.39 | 0.04 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| Gadoleic acid (C20:1), % | | | | | | | | | | | | | | | | | |
| d 0 | 0.60 | 0.63 | 0.61 | 0.60 | 0.63 | 0.61 | 0.61 | 0.62 | 0.62 | 0.61 | 0.03 | | | | | | |
| d 42 [b,d] | 0.66 | 0.74 | 0.69 | 0.67 | 0.66 | 0.64 | 0.68 | 0.60 | 0.62 | 0.65 | 0.03 | | | | | | |
| d 84 [e.g,h] | 0.67 | 0.66 | 0.64 | 0.68 | 0.64 | 0.65 | 0.61 | 0.54 | 0.63 | 0.57 | 0.03 | 0.579 | 0.057 | 0.169 | 0.134 | 0.516 | 0.026 |
| Docosapentaenoic acid C22:5n3, % | | | | | | | | | | | | | | | | | |
| d 0 | 0.10 | 0.09 | 0.16 | 0.20 | 0.20 | 0.16 | 0.16 | 0.18 | 0.15 | 0.21 | 0.03 | | | | | | |
| d 42 [b,d] | 0.12 | 0.05 | 0.11 | 0.08 | 0.18 | 0.14 | 0.11 | 0.19 | 0.17 | 0.17 | 0.03 | | | | | | |
| d 84 [h] | 0.05 | 0.06 | 0.05 | 0.06 | 0.09 | 0.07 | 0.08 | 0.11 | 0.08 | 0.10 | 0.03 | 0.698 | 0.864 | 0.567 | 0.866 | 0.931 | 0.790 |
| Total SFA, %[9] | | | | | | | | | | | | | | | | | |
| d 0 | 38.01 | 37.65 | 37.37 | 37.22 | 37.66 | 37.74 | 37.15 | 37.18 | 37.36 | 37.75 | 0.64 | | | | | | |
| d 42 [a] | 37.94 | 36.78 | 36.30 | 38.50 | 36.87 | 36.01 | 37.97 | 35.56 | 35.34 | 38.11 | 0.64 | | | | | | |
| d 84 [e,g,h] | 38.81 | 37.75 | 37.83 | 38.01 | 36.41 | 37.35 | 37.62 | 34.68 | 37.09 | 36.22 | 0.53 | 0.258 | 0.263 | 0.022 | 0.926 | 0.234 | 0.252 |
| Total MUFA, %[10] | | | | | | | | | | | | | | | | | |
| d 0 | 48.94 | 50.32 | 49.73 | 50.07 | 49.32 | 50.17 | 50.77 | 49.66 | 50.48 | 48.87 | 0.78 | | | | | | |
| d 42 [a,b,c,d] | 51.04 | 52.29 | 51.03 | 52.17 | 48.44 | 48.46 | 52.07 | 45.62 | 46.00 | 51.01 | 0.78 | | | | | | |
| d 84 [e.f.g,h] | 50.06 | 50.93 | 50.71 | 51.75 | 47.66 | 49.22 | 48.61 | 44.26 | 48.16 | 45.68 | 0.62 | 0.336 | 0.164 | 0.017 | 0.166 | 0.121 | 0.002 |
| Total PUFA, %[11] | | | | | | | | | | | | | | | | | |
| d 0 | 12.60 | 11.58 | 12.46 | 12.27 | 12.51 | 11.69 | 11.66 | 12.67 | 11.76 | 12.93 | 0.70 | | | | | | |
| d 42 [a,b,c,d] | 10.56 | 10.49 | 12.20 | 8.98 | 14.12 | 15.02 | 9.57 | 18.15 | 18.06 | 10.49 | 0.70 | | | | | | |
| d 84 [e,f,g,h] | 11.11 | 11.32 | 11.46 | 10.24 | 15.92 | 13.43 | 13.76 | 21.05 | 14.79 | 18.09 | 0.57 | 0.032 | 0.009 | 0.001 | 0.13 | 0.004 | 0.001 |
| Iodine value, g/100 g[12] | | | | | | | | | | | | | | | | | |
| d 0 | 69.59 | 68.73 | 70.42 | 70.92 | 70.77 | 69.62 | 70.04 | 70.95 | 69.71 | 71.08 | 1.03 | | | | | | |
| d 42 [a,b,c,d] | 67.89 | 67.63 | 70.23 | 65.65 | 72.17 | 73.40 | 66.98 | 77.36 | 77.21 | 68.10 | 1.03 | | | | | | |
| d 84 [e,f,g,h] | 66.53 | 67.25 | 67.51 | 66.22 | 72.53 | 69.90 | 70.08 | 79.45 | 71.49 | 75.11 | 0.86 | 0.081 | 0.004 | 0.001 | 0.316 | 0.022 | 0.001 |

[1] A total of 160 finishing pigs (PIC 337 × 1050, initial BW of 100.5 lb) were used in an 84-d finishing trial with 2 pigs per pen and 8 pens per treatment.

[2] C22:6n3 not included, all values were equal to or less than 0.003.

[3]Contro l= corn soybean meal diet with no fat; Tallow = 4% beef tallow; Blend = 2% tallow and 2% soybean oil; Soy = 4% soybean oil.

[4]There was a treatment × day interaction ($P < 0.001$) for all variables except C 20:1 (P = 0.004) and C 22:5n3 (P = 0.7639).
[5] The d 84 contrast statements for interactions are as follows: 1= feeding duration (84-d vs. 42-d) × fat source (tallow vs. blend); 2 = feeding duration (84-d vs. 42-d) × fat source (blend vs. soy oil); 3 = feeding duration (84-d vs. 42-d) × fat source (tallow vs. soy oil); 4 = feeding period (d 0 to 42 vs. d 42 to 84) × fat source (tallow vs. blend); 5 = feeding period (d 0 to 42 vs. d 42 to 84) × fat source (blend vs. soy oil); 6 = feeding period (d 0 to 42 vs. d 42 to 84) × fat source (tallow vs. soy oil).
[a,b,c,d] Within a row, superscripts represent significant ($P < 0.05$) main effects where a = control vs. fat (treatments A, D, G, and J vs. B, C, E, F, H, and I); b = tallow vs. blend (treatments B and C vs. E and F); c = blend vs. soy oil (treatments E and F vs. H and I); d = tallow vs. soy oil (treatments B and C vs. H and I).
[e,f,g,h] Within a row, superscripts represent significant ($P < 0.05$) main effects where e = control vs. fat (treatments A, C, F, and I vs. B, D, E, G, H, and J); f = tallow vs. blend (treatments B and D vs. E and G); g = blend vs. soy oil (treatments E and G vs. H and J); h = tallow vs. soy oil (treatments B and D vs. H and J).
[6] Total C18:1= ([C18:1n9t] + [C18:1n11t] + [C18:1n9c] + [C18:1n11c]); brackets indicate concentration.
[7] Total C18:2= ([C18:2n6t] + C18:2n6c]); brackets indicate concentration.
[8] Total C18:3= ([C18:3n6] + [C18:3n3]); brackets indicate concentration.
[9] Total SFA= ([C6:0] + [C8:0] + [C10:0] + [C11:0] + [C12:0] + [C14:0] + [C15:0] + [C16:0] + [C17:0] + [C18:0] + [C20:0] + [C21:0] + [C22:0] + [C23:0] + [C24:0]); brackets indicate concentration.
[10]Total MUFA= ([C14:1] + [C16:1] + [C17:1] + [C18:1n9t] + [C18:1n11t] + [C18:1n9c] + [C18:1n11c] + [C20:1] + [C22:1n9] + [C24:1]); brackets indicate concentration.
[11]Total PUFA= ([C18:2n6t] + [C18:2n6c] + [C18:3n6] + [C18:3n3] + [CLA 9c11t] + [CLA 10t12c] + [CLA 9c11c] + [CLA 9t11t] + [C20:2] + [C20:3n6] + [C20:3n3] + [C22:2] + [C20:5n3] + [C22:5n3] + [C22:6n3]); brackets indicate concentration.
[12] Calculated as IV value= [C16:1] × 0.9502 + [C18:1] × 0.8598 + [C18:2] × 1.7315] + [C18:3] × 2.6125 + [C20:1] × 0.7852 + [C22:1n9] × 3.2008 + [C22:5n3] × 3.6974 + [C22:6n3] × 4.4632; brackets indicate concentrations.

**Table 15.** Effects of source and duration of added fat on jowl fat quality of finishing pigs[1,2]

| Treatment[3]: | A | B | C | D | E | F | G | H | I | J | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| d 0 to 42: | Control | Tallow | Tallow | Control | Blend | Blend | Control | Soy | Soy | Control | | Interactions[4,5] | | | | | |
| d 42 to 84: | Control | Tallow | Control | Tallow | Blend | Control | Blend | Soy | Control | Soy | SEM | 1 | 2 | 3 | 4 | 5 | 6 |
| Palmitoleic acid (C16:1), % | | | | | | | | | | | | | | | | | |
| d 0[a] | 4.30 | 4.49 | 4.31 | 4.38 | 4.02 | 4.10 | 4.58 | 4.04 | 4.46 | 4.64 | 0.18 | | | | | | |
| d 42[a,d] | 3.42 | 3.19 | 3.36 | 3.51 | 3.07 | 3.30 | 3.31 | 2.72 | 2.98 | 3.37 | 0.18 | | | | | | |
| d 84[e,h] | 3.35 | 3.12 | 3.41 | 3.27 | 2.78 | 2.98 | 3.09 | 2.59 | 2.86 | 2.79 | 0.14 | 0.885 | 0.934 | 0.951 | 0.337 | 0.503 | 0.774 |
| Total C18:1, %[6] | | | | | | | | | | | | | | | | | |
| d 0 | 43.38 | 43.64 | 44.68 | 44.30 | 44.81 | 44.23 | 44.88 | 44.01 | 44.48 | 43.44 | 0.76 | | | | | | |
| d 42[a,b,c,d] | 47.27 | 49.98 | 48.84 | 49.34 | 47.80 | 47.16 | 50.80 | 43.36 | 42.74 | 48.00 | 0.76 | | | | | | |
| d 84[f,g,h] | 47.82 | 48.54 | 48.36 | 48.82 | 46.52 | 47.02 | 47.11 | 42.97 | 44.90 | 44.52 | 0.62 | 0.590 | 0.196 | 0.063 | 0.739 | 0.667 | 0.424 |
| Total C18:2, %[7] | | | | | | | | | | | | | | | | | |

| | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| d 0 | 13.19 | 12.55 | 11.81 | 12.43 | 12.30 | 12.48 | 12.19 | 12.80 | 12.15 | 13.06 | 0.61 | | | | | | |
| d 42[a,b,c,d] | 11.49 | 10.22 | 10.65 | 9.54 | 12.59 | 13.20 | 9.83 | 17.22 | 17.01 | 10.08 | 0.61 | | | | | | |
| d 84 [e,f,g,h] | 10.32 | 10.20 | 10.30 | 9.72 | 13.31 | 12.11 | 11.89 | 17.83 | 14.23 | 14.60 | 0.53 | 0.095 | 0.002 | 0.001 | 0.66 | 0.466 | 0.222 |
| Total C18:3, %[8] | | | | | | | | | | | | | | | | | |
| d 0 | 0.66 | 0.63 | 0.59 | 0.61 | 0.62 | 0.62 | 0.61 | 0.63 | 0.58 | 0.67 | 0.07 | | | | | | |
| d 42 [a,b,c,d] | 0.53 | 0.46 | 0.49 | 0.43 | 0.79 | 0.84 | 0.44 | 1.28 | 1.24 | 0.46 | 0.07 | | | | | | |
| d 84 [e,f,g,h] | 0.46 | 0.46 | 0.44 | 0.44 | 0.94 | 0.67 | 0.76 | 1.51 | 0.88 | 1.17 | 0.06 | 0.001 | 0.001 | 0.001 | 0.082 | 0.001 | 0.001 |
| Gadoleic acid (C20:1), % | | | | | | | | | | | | | | | | | |
| d 0 | 0.62 | 0.70 | 0.69 | 0.72 | 0.71 | 0.66 | 0.66 | 0.66 | 0.69 | 0.64 | 0.03 | | | | | | |
| d 42[d] | 0.72 | 0.74 | 0.75 | 0.73 | 0.76 | 0.74 | 0.69 | 0.68 | 0.70 | 0.67 | 0.03 | | | | | | |
| d 84[f,g,h] | 0.81 | 0.86 | 0.81 | 0.88 | 0.82 | 0.79 | 0.78 | 0.70 | 0.78 | 0.73 | 0.03 | 0.555 | 0.031 | 0.109 | 0.171 | 0.358 | 0.017 |
| Docosapentaenoic acid C22:5n3, % | | | | | | | | | | | | | | | | | |
| d 0[a,c] | 0.07 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.06 | 0.07 | 0.07 | 0.09 | 0.01 | | | | | | |
| d 42[a,b,c,d] | 0.05 | 0.05 | 0.05 | 0.05 | 0.07 | 0.07 | 0.05 | 0.09 | 0.08 | 0.06 | 0.01 | | | | | | |
| d 84[e.f.g.h] | 0.05 | 0.05 | 0.04 | 0.05 | 0.07 | 0.06 | 0.06 | 0.09 | 0.06 | 0.07 | 0.00 | 0.110 | 0.315 | 0.009 | 0.717 | 0.787 | 0.508 |
| Total SFA, %[9] | | | | | | | | | | | | | | | | | |
| d 0 | 35.76 | 35.97 | 35.98 | 35.57 | 35.65 | 36.00 | 35.20 | 35.72 | 35.45 | 35.05 | 0.71 | | | | | | |
| d 42 [a] | 34.93 | 33.57 | 34.01 | 34.85 | 33.13 | 32.80 | 33.43 | 32.70 | 33.27 | 35.73 | 0.71 | | | | | | |
| d 84 [e,h] | 35.75 | 34.98 | 35.01 | 35.20 | 33.79 | 34.78 | 34.69 | 32.57 | 34.70 | 34.51 | 0.57 | 0.364 | 0.233 | 0.033 | 0.797 | 0.927 | 0.717 |
| Total MUFA, %[10] | | | | | | | | | | | | | | | | | |
| d 0 | 49.46 | 49.90 | 50.71 | 50.37 | 50.54 | 49.96 | 51.10 | 49.80 | 50.77 | 49.99 | 0.80 | | | | | | |
| d 42 [a,b,c,d] | 52.18 | 54.74 | 53.78 | 54.25 | 52.35 | 51.95 | 55.46 | 47.41 | 47.11 | 52.76 | 0.80 | | | | | | |
| d 84 [e,f,g,h] | 52.57 | 53.23 | 53.25 | 53.63 | 50.72 | 51.42 | 51.62 | 46.79 | 49.15 | 48.61 | 0.66 | 0.540 | 0.185 | 0.049 | 0.879 | 0.533 | 0.414 |
| Total PUFA, %[11] | | | | | | | | | | | | | | | | | |
| d 0 | 14.89 | 14.20 | 13.34 | 14.01 | 13.87 | 14.04 | 13.73 | 14.42 | 13.70 | 14.86 | 0.67 | | | | | | |
| d 42 [a,b,c,d] | 13.01 | 11.76 | 12.24 | 10.83 | 14.57 | 15.25 | 11.13 | 19.82 | 19.52 | 11.40 | 0.67 | | | | | | |
| d 84 [e,f,g,h] | 11.68 | 11.79 | 11.73 | 11.17 | 15.46 | 13.85 | 13.70 | 20.64 | 16.19 | 16.87 | 0.58 | 0.069 | 0.001 | 0.001 | 0.63 | 0.361 | 0.144 |
| Iodine value, g/100 g[12] | | | | | | | | | | | | | | | | | |
| d 0 | 68.43 | 67.15 | 66.57 | 67.36 | 67.19 | 67.09 | 67.56 | 67.82 | 67.37 | 68.83 | 0.99 | | | | | | |
| d 42 [a,b,c,d] | 66.96 | 66.50 | 66.59 | 64.97 | 69.55 | 70.48 | 66.51 | 74.93 | 74.08 | 64.80 | 0.99 | | | | | | |
| d 84 [e,f,g,h] | 65.03 | 65.18 | 65.40 | 64.72 | 69.88 | 67.61 | 67.66 | 75.94 | 69.93 | 70.88 | 0.84 | 0.067 | 0.005 | 0.001 | 0.598 | 0.518 | 0.220 |

[1] A total of 160 finishing pigs (PIC 337 × 1050, initial BW of 100.5 lb) were used in an 84-d finishing trial with 2 pigs per pen and 8 pens per treatment.

[2] C22:6n3 not included, all values were equal to or less than 0.01.

[3] Control = no added fat; Tallow = 4% beef tallow; Soy = 4% soybean oil; Blend = 2% tallow and 2% soybean oil

[4]There was a treatment × day interaction ($P < 0.001$) for all variables except C 16:1 (P = 0.1233), C 20:1 (P = 0.0326), and saturated (P = 0.074).

[5] The d 84 contrast statements for interactions are as follows: 1= feeding duration (84-d vs. 42-d) × fat source (tallow vs. blend); 2 = feeding duration (84-d vs. 42-d) × fat source (blend vs. soy oil); 3 = feeding duration (84-d vs. 42-d) × fat source (tallow vs. soy oil); 4 = feeding period (d 0 to 42 vs. d 42 to 84) × fat source (tallow vs. blend); 5 = feeding period (d 0 to 42 vs. d 42 to 84) × fat source (blend vs. soy oil); 6 = feeding period (d 0 to 42 vs. d 42 to 84) × fat source (tallow vs. soy oil).

[a,b,c,d] Within a row, superscripts represent significant ($P < 0.05$) main effects where a = control vs. fat (treatments A, D, G, and J vs. B, C, E, F, H, and I); b = tallow vs. blend (treatments B and C vs. E and F); c = blend vs. soy oil (treatments E and F vs. H and I); d = tallow vs. soy oil (treatments B and C vs. H and I).

[e,f,g,h] Within a row, superscripts represent significant ($P < 0.05$) main effects where e = control vs. fat (treatments A, C, F, and I vs. B, D, E, G, H, and J); f = tallow vs. blend (treatments B and D vs. E and G); g = blend vs. soy oil (treatments E and G vs. H and J); h = tallow vs. soy oil (treatments B and D vs. H and J).

[6] Total C18:1= ([C18:1n9t] + [C18:1n11t] + [C18:1n9c] + [C18:1n11c]); brackets indicate concentration.

[7] Total C18:2= ([C18:2n6t] + C18:2n6c]); brackets indicate concentration.

[8] Total C18:3= ([C18:3n6] + [C18:3n3]); brackets indicate concentration.

[9] Total SFA= ([C6:0] + [C8:0] + [C10:0] + [C11:0] + [C12:0] + [C14:0] + [C15:0] + [C16:0] + [C17:0] + [C18:0] + [C20:0] + [C21:0] + [C22:0] + [C23:0] + [C24:0]); brackets indicate concentration.

[10]Total MUFA= ([C14: 1] + [C16:1] + [C17:1] + [C18:1n9t] + [C18:1n11t] + [C18:1n9c] + [C18:1n11c] + [C20:1] + [C22:1n9] + [C24:1]); brackets indicate concentration.

[11]Total PUFA= ([C18:2n6t] + [C18:2n6c] + [C18:3n6] + [C18:3n3] + [CLA 9c11t] + [CLA 10t12c] + [CLA 9c11c] + [CLA 9t11t] + [C20:2] + [C20:3n6] + [C20:3n3] + [C22:2] + [C20:5n3] + [C22:5n3] + [C22:6n3]); brackets indicate concentration.

[12] Calculated as IV value= [C16:1] × 0.9502 + [C18:1] × 0.8598 + [C18:2] × 1.7315] + [C18:3] × 2.6125 + [C20:1] × 0.7852 + [C22:1n9] × 3.2008 + [C22:5n3] × 3.6974 + [C22:6n3] × 4.4632; brackets indicate concentrations.

**Table 16.** Accession number, primer sequences, amplicon size, reaction efficiency and sequencing results for the selected genes of interest.

| Gene of Interest[1] | Accession No. | Forward Primer | Reverse Primer | Amplicon Size | Efficiency | Sequenced |
|---|---|---|---|---|---|---|
| ACC | NM.001114269.1 | atgtttcggcagtccctgat | tgtggaccagctgaccttga | 133 | 1.03 | Pass |
| SREBP | NM_214157 | cggacggctcacaatgc | gacggcggatttattcagctt | 114 | 1.02 | Pass |
| SCD | NM_213781.1 | gccgagaagctggtgatgtt | cagcaataccagggcacgat | 95 | 1.13 | Pass |
| ACO | NM_001101028.1 | ggattttcttcaggggagcatc | gtcaaccagagcaacggctt | 109 | 0.97 | Pass |
| FAS | NM_001099930.1 | catcgtgttcgcctgcttgg | ctcatcggcggtgtggacat | 150 | 1.01 | Pass |
| PPARg | AF103946.1 | tgttccatgctgttatgggtga | caaaacggcatctcggtgtc | 127 | 1.00 | Pass |

[1]ACC = Acetyl CoA Carboxylase; SREBP = Sterol Regulatory Element Binding Protein 1-C; SCD = Stearoyl-CoA Desaturase; ACO = Acyl-CoA Oxidase; FAS = Fatty Acid Synthase; PPARg = Peroxisome Proliferator Activator Protein-Gamma.

**Table 17.** Effects of source and duration of added fat on relative gene expression of lipid metabolism genes in backfat biopsies collected from finishing pigs[1]

| Treatment[2]: | A | B | C | D | E | F | G | H | I | J |
|---|---|---|---|---|---|---|---|---|---|---|

| d 0 to 42: | Control | Tallow | Tallow | Control | Blend | Blend | Control | Soy | Soy | Control | | Interactions[3,4] | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| d 42 to 84: | Control | Tallow | Control | Tallow | Blend | Control | Blend | Soy | Control | Soy | SEM | 1 | 2 | 3 | 4 | 5 | 6 |
| ACC | | | | | | | | | | | | | | | | | |
| d 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1.29 | | | | | | |
| d 42[d] | 5.81 | 1.35 | 4.18 | 6.47 | 4.45 | 5.32 | 1.78 | 7.72 | 3.58 | 3.27 | 1.29 | | | | | | |
| d 84[h,j] | 1.30 | 1.06 | 1.94 | 2.91 | 1.68 | 1.24 | 3.40 | 2.31 | 1.60 | 7.181 | 1.29 | 0.75 | 0.50 | 0.76 | 0.63 | 0.18 | 0.07 |
| ACO | | | | | | | | | | | | | | | | | |
| d 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0.43 | | | | | | |
| d 42[d] | 2.03 | 1.23 | 1.65 | 2.37 | 2.36 | 1.92 | 1.14 | 3.21 | 1.51 | 1.08 | 0.43 | | | | | | |
| d 84[j] | 1.28 | 0.99 | 1.50 | 1.71 | 1.17 | 1.09 | 1.68 | 1.40 | 1.31 | 2.89 | 0.43 | 0.62 | 0.50 | 0.89 | 0.67 | 0.24 | 0.11 |
| FAS | | | | | | | | | | | | | | | | | |
| d 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1.38 | | | | | | |
| d 42 | 2.73 | 1.11 | 1.72 | 9.06 | 4.50 | 5.36 | 0.79 | 2.51 | 1.70 | 3.24 | 1.38 | | | | | | |
| d 84[j] | 1.08 | 0.81 | 1.23 | 1.19 | 3.67 | 1.17 | 3.34 | 1.51 | 1.23 | 4.30 | 1.38 | 0.44 | 0.21 | 0.68 | 0.30 | 0.62 | 0.13 |
| SCD | | | | | | | | | | | | | | | | | |
| d 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0.78 | | | | | | |
| d 42[b,d] | 3.65 | 1.52 | 1.82 | 4.12 | 4.19 | 3.65 | 1.28 | 6.23 | 2.00 | 1.60 | 0.78 | | | | | | |
| d 84[g] | 1.41 | 0.91 | 1.60 | 2.19 | 1.42 | 1.59 | 1.76 | 1.80 | 1.76 | 4.31 | 0.78 | 0.59 | 0.45 | 0.85 | 0.78 | 0.12 | 0.20 |
| PPARg | | | | | | | | | | | | | | | | | |
| d 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2.07 | | | | | | |
| d 42 | 7.08 | 1.61 | 3.62 | 11.46 | 5.60 | 4.98 | 1.06 | 11.85 | 4.85 | 5.44 | 2.07 | | | | | | |
| d 84[d,e,j] | 2.17 | 1.07 | 3.41 | 6.35 | 6.55 | 3.19 | 6.66 | 2.83 | 2.49 | 8.49 | 2.07 | 0.13 | 0.21 | 0.75 | 0.89 | 0.52 | 0.43 |
| SREBP | | | | | | | | | | | | | | | | | |
| d 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0.29 | | | | | | |
| d 42 | 1.52 | 0.97 | 1.72 | 1.19 | 1.19 | 1.07 | 0.96 | 1.53 | 0.82 | 0.70 | 0.29 | | | | | | |
| d 84[j] | 0.98 | 1.01 | 1.58 | 1.32 | 1.33 | 1.29 | 1.3 | 1.25 | 1.24 | 2.37 | 0.29 | 0.37 | 0.24 | 0.82 | 0.70 | 0.05 | 0.12 |

[1] A total of 160 finishing pigs (PIC 337 × 1050, initial BW of 100.5 lb) were used in an 84-d finishing trial with 2 pigs per pen and 8 pens per treatment.
[2]Contro l= corn soybean meal diet with no fat; Tallow = 4% beef tallow; Blend = 2% tallow and 2% soybean oil; Soy = 4% soybean oil.
[3]There was a day effect ($P < 0.05$) for all variables except for ACO.
[4] The d 84 contrast statements for interactions are as follows: 1= feeding duration (84-d vs. 42-d) × fat source (tallow vs. blend); 2 = feeding duration (84-d vs. 42-d) × fat source (blend vs. soy oil); 3 = feeding duration (84-d vs. 42-d) × fat source (tallow vs. soy oil); 4 = feeding period (d 0 to 42 vs. d 42 to 84) × fat source (tallow vs. blend); 5 = feeding period (d 0 to 42 vs. d 42 to 84) × fat source (blend vs. soy oil); 6 = feeding period (d 0 to 42 vs. d 42 to 84) × fat source (tallow vs. soy oil).
[a,b,c,d] Within a row, superscripts represent significant ($P < 0.05$) main effects where a = control vs. fat (treatments A, D, G, and J vs. B, C, E, F, H, and I); b = tallow vs. blend (treatments B and C vs. E and F); c = blend vs. soy oil (treatments E and F vs. H and I); d = tallow vs. soy oil (treatments B and C vs. H and I).
[e,f,g,h,i,j] Within a row, superscripts represent significant ($P < 0.05$) main effects where e = control vs. fat (treatments A, C, F, and I vs. B, D, E, G, H, and J); f = tallow vs. blend (treatments B and D vs. E and G); g = blend vs. soy oil (treatments E and G vs. H and J); h = tallow vs. soy oil (treatments B and D vs. H and J); i = added fat both periods vs. added fat period 1(treatments B, E, and H vs. C, D, F, G, I and J); j = added fat period 1 vs. added fat period 2 (treatments C, F, and I vs. D, G, and J)
ACC = Acetyl CoA Carboxylase; ACO = Acyl-CoA Oxidase; FAS = Fatty Acid Synthase; SCD = Stearoyl-CoA Desaturase; PPARg = Peroxisome Proliferator Activator Protein-Gamma; SREB*P* = Sterol Regulatory Element Binding Protein 1-C.

**Table 18.** Effects of source and duration of added fat on relative gene expression of lipid metabolism genes in belly fat biopsies collected from finishing pigs[1]

| Treatment[2]: | A | B | C | D | E | F | G | H | I | J | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| d 0 to 42: | Control | Tallow | Tallow | Control | Blend | Blend | Control | Soy | Soy | Control | Interactions[3,4] |

| d 42 to 84: | Control | Tallow | Control | Tallow | Blend | Control | Blend | Soy | Control | Soy | SEM | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ACC | | | | | | | | | | | | | | | | | |
| d 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1.20 | | | | | | |
| d 42 | 4.18 | 2.23 | 3.97 | 5.29 | 1.99 | 1.45 | 5.25 | 2.71 | 4.40 | 4.15 | 1.20 | | | | | | |
| d 84 [e,j] | 1.54 | 1.39 | 1.30 | 0.62 | 0.57 | 4.66 | 0.44 | 2.81 | 3.11 | 0.51 | 1.20 | 0.24 | 0.15 | 0.77 | 0.12 | 0.48 | 0.41 |
| ACO | | | | | | | | | | | | | | | | | |
| d 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0.78 | | | | | | |
| d 42 | 1.34 | 2.07 | 1.48 | 1.72 | 1.38 | 0.93 | 1.61 | 1.77 | 1.55 | 1.69 | 0.78 | | | | | | |
| d 84 [f,h] | 1.80 | 3.20 | 1.43 | 3.58 | 0.58 | 0.72 | 1.02 | 1.44 | 1.62 | 0.61 | 0.78 | 0.39 | 0.56 | 0.79 | 0.14 | 0.52 | 0.03 |
| FAS | | | | | | | | | | | | | | | | | |
| d 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2.34 | | | | | | |
| d 42 | 5.49 | 4.11 | 4.94 | 6.05 | 1.72 | 2.91 | 6.53 | 3.93 | 5.33 | 5.35 | 2.34 | | | | | | |
| d 84 [e] | 13.22 | 1.96 | 1.50 | 0.78 | 0.86 | 6.95 | 1.86 | 4.66 | 5.12 | 0.90 | 2.34 | 0.31 | 0.20 | 0.77 | 0.36 | 0.99 | 0.38 |
| SCD | | | | | | | | | | | | | | | | | |
| d 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0.72 | | | | | | |
| d 42 | 2.92 | 1.80 | 3.81 | 2.75 | 2.10 | 1.16 | 1.63 | 2.18 | 2.96 | 2.90 | 0.72 | | | | | | |
| d 84 | 2.63 | 1.52 | 0.77 | 0.90 | 0.96 | 2.99 | 0.94 | 2.42 | 1.29 | 1.00 | 0.72 | 0.23 | 0.11 | 0.65 | 0.15 | 0.26 | 0.79 |
| PPARg | | | | | | | | | | | | | | | | | |
| d 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3.36 | | | | | | |
| d 42 | 3.45 | 2.69 | 5.30 | 8.40 | 1.52 | 2.66 | 6.22 | 6.51 | 10.23 | 4.35 | 3.36 | | | | | | |
| d 84 [e,j] | 15.50 | 5.17 | 2.04 | 2.37 | 1.59 | 17.51 | 3.27 | 6.71 | 6.98 | 0.57 | 3.36 | 0.06 | 0.06 | 0.99 | 0.03 | 0.26 | 0.33 |
| SREBP | | | | | | | | | | | | | | | | | |
| d 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0.58 | | | | | | |
| d 42 [a] | 2.37 | 1.26 | 1.38 | 4.26 | 1.37 | 1.31 | 1.47 | 1.08 | 1.21 | 1.34 | 0.58 | | | | | | |
| d 84 | 1.00 | 1.44 | 0.58 | 0.51 | 0.54 | 1.06 | 0.69 | 0.87 | 0.65 | 0.45 | 0.58 | 0.20 | 0.49 | 0.55 | 0.79 | 0.88 | 0.91 |

[1] A total of 160 finishing pigs (PIC 337 × 1050, initial BW of 100.5 lb) were used in an 84-d finishing trial with 2 pigs per pen and 8 pens per treatment.
[2]Contro l= corn soybean meal diet with no fat; Tallow = 4% beef tallow; Blend = 2% tallow and 2% soybean oil; Soy = 4% soybean oil.
[3]There was a day effect ($P < 0.05$) for all variables except ACO.
[4] The d 84 contrast statements for interactions are as follows: 1= feeding duration (84-d vs. 42-d) × fat source (tallow vs. blend); 2 = feeding duration (84-d vs. 42-d) × fat source (blend vs. soy oil); 3 = feeding duration (84-d vs. 42-d) × fat source (tallow vs. soy oil); 4 = feeding period (d 0 to 42 vs. d 42 to 84) × fat source (tallow vs. blend); 5 = feeding period (d 0 to 42 vs. d 42 to 84) × fat source (blend vs. soy oil); 6 = feeding period (d 0 to 42 vs. d 42 to 84) × fat source (tallow vs. soy oil).
[a,b,c,d] Within a row, superscripts represent significant ($P < 0.05$) main effects where a = control vs. fat (treatments A, D, G, and J vs. B, C, E, F, H, and I); b = tallow vs. blend (treatments B and C vs. E and F); c = blend vs. soy oil (treatments E and F vs. H and I); d = tallow vs. soy oil (treatments B and C vs. H and I).
[e,f,g,h,i,j] Within a row, superscripts represent significant ($P < 0.05$) main effects where e = control vs. fat (treatments A, C, F, and I vs. B, D, E, G, H, and J); f = tallow vs. blend (treatments B and D vs. E and G); g = blend vs. soy oil (treatments E and G vs. H and J); h = tallow vs. soy oil (treatments B and D vs. H and J); i = added fat both periods vs. added fat period 1(treatments B, E, and H vs. C, D, F, G, I and J); j = added fat period 1 vs. added fat period 2 (treatments C, F, and I vs. D, G, and J)
ACC = Acetyl CoA Carboxylase; ACO = Acyl-CoA Oxidase; FAS = Fatty Acid Synthase; SCD = Stearoyl-CoA Desaturase; PPARg = Peroxisome Proliferator Activator Protein-Gamma; SREB*P* = Sterol Regulatory Element Binding Protein 1-C.

**Table 19.** Effects of source and duration of added fat on relative gene expression of lipid metabolism genes in jowl fat biopsies collected from finishing pigs[1]

| Treatment[2]: | A | B | C | D | E | F | G | H | I | J | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| d 0 to 42: | Control | Tallow | Tallow | Control | Blend | Blend | Control | Soy | Soy | Control | | Interactions[3,4] | | | | | |
| d 42 to 84: | Control | Tallow | Control | Tallow | Blend | Control | Blend | Soy | Control | Soy | SEM | 1 | 2 | 3 | 4 | 5 | 6 |

| | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ACC | | | | | | | | | | | | | | | | | |
| d 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0.76 | | | | | | |
| d 42 | 4.23 | 2.00 | 4.37 | 2.93 | 2.98 | 2.95 | 2.86 | 2.08 | 4.78 | 3.98 | 0.76 | | | | | | |
| d 84 [j] | 1.05 | 0.69 | 1.25 | 0.48 | 0.48 | 0.51 | 2.34 | 1.04 | 0.68 | 2.72 | 0.76 | 0.94 | 0.84 | 0.89 | 0.42 | 0.90 | 0.35 |
| ACO | | | | | | | | | | | | | | | | | |
| d 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0.30 | | | | | | |
| d 42[a] | 1.87 | 1.71 | 2.76 | 1.72 | 2.29 | 2.15 | 1.80 | 2.36 | 2.48 | 2.07 | 0.30 | | | | | | |
| d 84 | 1.20 | 0.59 | 0.75 | 1.03 | 0.47 | 0.43 | 1.03 | 0.62 | 0.53 | 0.97 | 0.30 | 0.94 | 0.80 | 0.75 | 0.59 | 0.78 | 0.79 |
| FAS | | | | | | | | | | | | | | | | | |
| d 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1.41 | | | | | | |
| d 42 | 6.77 | 3.38 | 8.48 | 5.80 | 3.77 | 4.47 | 4.54 | 4.53 | 5.51 | 4.42 | 1.41 | | | | | | |
| d 84[j] | 0.67 | 0.38 | 1.09 | 1.35 | 0.97 | 0.33 | 3.03 | 0.43 | 0.41 | 6.18 | 1.41 | 0.96 | 0.38 | 0.40 | 0.38 | 0.28 | 0.05 |
| SCD | | | | | | | | | | | | | | | | | |
| d 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1.95 | | | | | | |
| d 42 | 3.54 | 1.64 | 4.01 | 3.21 | 1.74 | 2.2 | 1.82 | 2.08 | 3.43 | 2.56 | 1.95 | | | | | | |
| d 84 [e,i,j] | 2.58 | 0.93 | 2.47 | 3.79 | 1.47 | 0.70 | 10.08 | 0.99 | 0.89 | 9.61 | 1.95 | 0.62 | 0.93 | 0.55 | 0.04 | 0.87 | 0.07 |
| PPARg | | | | | | | | | | | | | | | | | |
| d 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0.92 | | | | | | |
| d 42 | 2.89 | 1.91 | 3.88 | 3.80 | 5.12 | 2.70 | 2.23 | 2.61 | 3.56 | 2.71 | 0.92 | | | | | | |
| d 84 [j] | 1.05 | 0.77 | 0.81 | 3.82 | 0.59 | 0.52 | 1.65 | 1.02 | 0.75 | 3.17 | 0.92 | 0.52 | 0.78 | 0.71 | 0.32 | 0.49 | 0.76 |
| SREBP | | | | | | | | | | | | | | | | | |
| d 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0.71 | | | | | | |
| d 42 [c] | 3.21 | 2.89 | 4.14 | 2.8 | 4.71 | 3.86 | 3.21 | 2.51 | 2.89 | 3.37 | 0.71 | | | | | | |
| d 84 | 0.85 | 0.52 | 0.48 | 0.63 | 0.28 | 0.28 | 0.58 | 0.41 | 0.31 | 0.60 | 0.71 | 0.92 | 0.92 | 0.99 | 0.91 | 0.99 | 0.92 |

[1] A total of 160 finishing pigs (PIC 337 × 1050, initial BW of 100.5 lb) were used in an 84-d finishing trial with 2 pigs per pen and 8 pens per treatment.

[2]Contro l= corn soybean meal diet with no fat; Tallow = 4% beef tallow; Blend = 2% tallow and 2% soybean oil; Soy = 4% soybean oil.

[3]There was a day effect ($P < 0.05$) for all variables.

[4] The d 84 contrast statements for interactions are as follows: 1= feeding duration (84-d vs. 42-d) × fat source (tallow vs. blend); 2 = feeding duration (84-d vs. 42-d) × fat source (blend vs. soy oil); 3 = feeding duration (84-d vs. 42-d) × fat source (tallow vs. soy oil); 4 = feeding period (d 0 to 42 vs. d 42 to 84) × fat source (tallow vs. blend); 5 = feeding period (d 0 to 42 vs. d 42 to 84) × fat source (blend vs. soy oil); 6 = feeding period (d 0 to 42 vs. d 42 to 84) × fat source (tallow vs. soy oil).

[a,b,c,d] Within a row, superscripts represent significant ($P < 0.05$) main effects where a = control vs. fat (treatments A, D, G, and J vs. B, C, E, F, H, and I); b = tallow vs. blend (treatments B and C vs. E and F); c = blend vs. soy oil (treatments E and F vs. H and I); d = tallow vs. soy oil (treatments B and C vs. H and I).

[e,f,g,h,i,j] Within a row, superscripts represent significant ($P < 0.05$) main effects where e = control vs. fat (treatments A, C, F, and I vs. B, D, E, G, H, and J); f = tallow vs. blend (treatments B and D vs. E and G); g = blend vs. soy oil (treatments E and G vs. H and J); h = tallow vs. soy oil (treatments B and D vs. H and J); i = added fat both periods vs. added fat in 1 period(treatments B, E, and H vs. C, D, F, G, I and J); j = added fat period 1 vs. added fat period 2 (treatments C, F, and I vs. D, G, and J)

ACC = Acetyl CoA Carboxylase; ACO = Acyl-CoA Oxidase; FAS = Fatty Acid Synthase; SCD = Stearoyl-CoA Desaturase; PPARg = Peroxisome Proliferator Activator Protein-Gamma; SREB*P* = Sterol Regulatory Element Binding Protein 1-C.