Influence of Dietary Fat Source and Feeding Duration on Pig Growth Performance, Carcass Composition, and Fat Quality[1]

E.W. Stephenson, M.A. Vaughn, D.D. Burnett, C.B. Paulk, M.D. Tokach, S.S. Dritz[2], J.M. DeRouchey, R.D. Goodband, J C. Woodworth, J.M. Gonzalez

Summary

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, and fat quality. Dietary treatments included a corn-soybean meal control diet with no added fat or a 3 × 3 factorial with main effects of fat source (4% tallow, 4% soybean oil, or a blend of 2% tallow and 2% soybean oil) and feeding duration (d 0 to 42, 42 to 84, or 0 to 84). One pig was identified in each pen on d 0, and biopsy samples of the back, belly, and jowl fat were collected on d 0, 41, and 81. At the conclusion of the study, all pigs were harvested, carcass characteristics were measured, and back, belly, and jowl fat samples were collected. Overall (d 0 to 84), there were no differences between fat sources for growth and carcass characteristics; however, pigs fed diets with added fat from d 0 to 84 had improved ($P < 0.036$) F/G compared with pigs fed a control diet without added fat. Pigs fed added fat throughout the entire study also had improved ($P < 0.042$) ADG and F/G and heavier d-84 BW ($P < 0.006$) compared with pigs fed additional fat for only period 1 or 2. Adding fat for the entire study increased ($P < 0.032$) backfat and tended to reduce ($P < 0.083$) fat-free lean index compared with pigs fed the control diet without added fat. Added fat also increased ($P < 0.05$) iodine value (IV) compared with pigs fed the control diet. Increasing the feeding duration of soybean oil or a blend of soybean oil and tallow decreased monounsaturated and increased polyunsaturated fatty acids relative to feeding tallow (duration × fat source interaction, $P < 0.05$), with the greatest changes in C18:1 and C18:2, respectively. In conclusion, feeding added fat improved ADG and F/G; however, feeding soybean oil for increasing duration, either alone or in a blend with tallow, negatively affected the fatty acid composition and IV of finishing pigs.

Key words: finishing pig, iodine value, fat, feeding duration

Introduction

Iodine value (IV) is commonly used by pork processors to evaluate pork fat quality. Measuring IV provides processors with an indication of the amount of unsaturated fatty acids present in fat. Processors that are measuring IV target a value of 73 to 75g/100 g (Benz et al., 2010[3]), and carcasses exceeding these values are generally discounted in price.

---

[1] Funding, wholly or in part, was provided by the National Pork Board.

[2] Department of Diagnostic Medicine/Pathobiology, College of Veterinary Medicine, Kansas State University.

[3] Benz, J.M., S.K. Linneen, M.D. Tokach, S.S. Dritz, J. L. Nelssen, J.M. DeRouchey, R.D. Goodband, R.C. Sulabo, and K.J. Prusa. 2010. Effects of dried distillers grains with solubles on carcass fat quality of finishing pigs. J. Anim. Sci. 88:3666-3682.

Feeding different dietary fat sources as well as ingredients high in unsaturated fat such as dried distillers grains with solubles (DDGS) has been shown to affect IV. When feeding a diet high in unsaturated fat sources, carcass fat quality as measured by IV will decrease (Asmus et al., 2011[4]). It has been shown that removing unsaturated fat sources in late finishing diets can partially alleviate some of the negative effects on pork fat quality. Adding a saturated fat source such as beef tallow in late finishing diets also has been shown to positively affect IV (Browne et al., 2013[5]).

Therefore, this study was conducted to determine the effects of feeding soybean oil, beef tallow, or a blend of the two as well as feeding duration of the dietary fat sources on finishing pig growth performance, carcass characteristics, and IV of belly, jowl, and backfat.

Procedures

The Kansas State University Institutional Animal Care and Use Committee approved the protocol used in this experiment. Pigs were housed at the Kansas State University Swine Teaching and Research Center finishing barn. The building is an environmentally controlled facility with 5 × 5-ft pens with totally slatted flooring. Each pen is 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 wk prior to the start of the experiment.

A total of 160 finishing pigs (PIC 327 × 1050; average initial BW of 100.5 lb) were used in an 84-d study. Pens of pigs were blocked by sex and BW and allotted to 1 of 10 dietary treatments, with 2 barrows or 2 gilts per 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, or a blend of 2% tallow and 2% soybean oil) and feeding duration (d 0 to 42, 42 to 84, or 0 to 84; Table 1). Pigs were fed the control corn-soybean meal diet when not fed diets containing added fat. Soybean oil, tallow, or a blend of the two was added to provide diets with a range of unsaturated and saturated fatty acid concentrations. Samples of the complete diets were analyzed for chemical composition (Table 2), and soybean oil, tallow, and their blend were analyzed for fatty acid profiles (Table 3). Diets were formulated and fed in 3 phases (d 0 to 28, 28 to 56, and 56 to 84. A constant standardized ileal digestible lysine:NE ratio was maintained within each phase by increasing soybean meal in the basal diet when adding fat. Dietary treatments were prepared at the K-State O.H. Kruse Feed Technology Innovation Center.

Pigs and feeders were weighed approximately every 2 wk to calculate ADG, ADFI, and F/G. Pigs were individually tattooed prior to marketing so carcass measurements could be collected. On d 84, pigs were transported to Natural Foods Holdings (Sioux Center, IA) for harvest. Carcass measurements taken at the plant included HCW, loin depth, and backfat thickness.

[4] Asmus et al., Swine Day 2011. Report of Progress 1056, pp. 202-215.

[5] Browne, N.A., J.K. Apple, C.V. Maxwell, J.W. Yancey, T.M. Johnson, D.L. Galloway, and B.E. Bass, 2013. Alternating dietary fat sources for growing-finishing pigs fed dried distillers grains with solubles: II. Fresh belly and bacon quality characteristics. J. Anim. Sci. 91:1509–1521.

One pig from every pen was selected, and fat biopsy samples were collected and analyzed for fatty acid profile and IV on d 0, 41, and 81. For sample collection, pigs were restrained, the hair was clipped in each location (jowl, belly, and loin), and 1 mL of Lidocaine was administered to the sample location. After adequate time was given for the biopsy site to be desensitized, an 8-gauge needle was used to pierce the skin, and a 10-gauge needle biopsy needle was used to collect approximately 250 mg of fat tissue per biopsy site. Fat tissue samples were snap-frozen in liquid nitrogen, then stored in a -80˚F freezer until analysis.

Fatty acid profiles were analyzed by mixing 0.025 g of fat with 2 mL of benzene containing methyl tridecanoate as an internal standard (2 mg/mL of benzene, Fluka 91558) and 3 mL methanolic-HCl, then flushed with nitrogen. Tubes were then capped, vortexed, and heated for 2 h at 70°C. Tubes were vortexed every 30 min during the 2-h period. Tubes were then cooled to room temperature, mixed with 5 mL 6% K_2CO_3 and 2 mL benzene, vortexed, then centrifuged at 500 × g for 5 min. The organic solvent layer was then analyzed 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 × 0.20 μm film) was used for the analysis. The injection temperature was 250°C, the split ratio was 1:100, and the flame-ionization detector was set at 280°C and used 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 a standard.

All data were analyzed as a randomized complete block design using the MIXED procedure in 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 fixed effects included sex, fat source, feeding duration, and all interactions. 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 $P < 0.10$ were defined as a trend or tendency.

Results

Growth and carcass characteristics

From d 0 to 42 (period 1), pigs fed added fat had increased ($P = 0.005$) ADG and improved ($P = 0.001$) F/G compared with pigs fed the control diets without added fat (Table 4). Pigs fed diets with added tallow or soybean oil had improved ($P \leq 0.002$) F/G compared with pigs fed a diet containing a blend of soy oil and tallow.

From d 42 to 84 (period 2), pigs fed added dietary fat tended ($P = 0.052$) to have increased ADG and had improved F/G ($P < 0.001$) compared with those fed diets not containing added fat. No differences were observed among fat sources during period 2.

Overall (d 0 to 84), pigs fed added fat in both period 1 and 2 had increased ($P = 0.018$) ADG and improved ($P = 0.042$) F/G as well as greater final BW ($P = 0.006$) compared with pigs fed added fat only during a single period. In addition, pigs fed fat in both periods had improved ($P = 0.036$) F/G compared with pigs fed the control diet without added fat. Pigs fed diets with soybean oil tended to have improved ($P = 0.092$) F/G vs. those fed the diet containing a blend of soybean oil and tallow.

For carcass characteristics, adding fat in both periods increased ($P = 0.032$) backfat depth and tended to reduce ($P = 0.083$) fat-free lean index (FFLI) compared with pigs fed diets with no added fat. No differences were detected in HCW, percentage yield, or longissimus muscle area among treatments.

Fatty acid composition

Backfat. A feeding duration × fat source interaction ($P < 0.030$) was observed for C18:1, C18:2, C18:3, SFA, MUFA, and PUFA for pigs fed tallow vs. soybean oil and for C18:2, C18:3, C20:1, MUFA, and PUFA for pigs fed soybean oil vs. the blend of soybean oil and tallow (Table 5). In both of these interactions, MUFA was decreased but PUFA was increased by the addition of soybean oil, whereas the opposite effect was observed for those fed beef tallow. A feeding duration × fat source (tallow vs. a blend of soybean oil and tallow) interaction ($P < 0.009$) was also observed for C18:2, C18:3, and PUFA because the unsaturated fatty acids were increased to a greater extent in the blend of soybean oil and tallow than in tallow alone. Feeding period × fat source interactions ($P < 0.010$) were observed for C18:2, C18:3, MUFA, and PUFA for PUFA for the blend vs. soybean oil and tallow vs. soybean oil. For tallow vs. soybean oil, the interaction ($P < 0.004$) also was observed for C18:1 and C20:1. These interactions were a result of pigs fed soybean oil from d 42 to 84 having a greater increase in PUFA and reduction in MUFA on d 84 than when fed soybean oil from d 0 to 42, whereas feeding tallow or a blend of soybean oil and tallow had a 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 and decreased ($P < 0.05$) C16:1, C18:1, SFA and MUFA compared with pigs fed the control diet during both periods. Feeding a blend of soybean oil and tallow decreased ($P < 0.05$) C16:1, C18:1, SFA, and MUFA on both d 42 and 84 and C18:3 on d 84 compared with those fed tallow. Feeding the blend of soybean oil and tallow also increased ($P < 0.05$) concentrations of C18:2, C18:3, and PUFA on both d 42 and 84 compared with pigs fed tallow. Feeding soybean oil decreased ($P < 0.05$) C18:1, SFA, and MUFA on both d 42 and 84 but only decreased ($P < 0.05$) C16:1 and C20:1 when fed for 84 d compared with those fed the blend of soybean oil and tallow. Increases ($P < 0.05$) in C18:2, C18:3, and PUFA concentrations were observed on both d 42 and 84 for pigs fed soybean oil vs. the blend of soybean oil and tallow. In addition, pigs fed soybean oil had decreased ($P < 0.05$) concentrations of C16:1, C18:1, C20:1, SFA, and MUFA on both d 42 and 84 vs. those fed tallow. Similar to other comparisons, C18:2, C18:3, and PUFA increased ($P < 0.05$) on both d 42 and 84 for pigs fed soybean oil vs. tallow. C22:5n3 also increased ($P < 0.05$) on d 84 when pigs were fed soybean oil vs. tallow.

Belly fat. Feeding duration × fat source interactions ($P < 0.05$) occurred for tallow vs. the blend of soybean oil and tallow and the blend vs. soybean oil for C18:2, C18:3, and PUFA (Table 6). An interaction was also observed for tallow vs. soybean oil for C18:1, C18:2, C18:3, SFA, MUFA, and PUFA. These interactions were a result of elevated PUFA and decreased SFA and MUFA, with increasing feeding duration of soybean oil relative to other fat sources. A feeding period × fat source (tallow vs. soybean oil) interaction ($P < 0.05$) was observed for C18:1, C18:2, C18:3, C20:1, MUFA, and

PUFA. These were driven by decreased MUFA and increased PUFA levels in pigs fed soybean oil relative to pigs fed tallow. A feeding period × fat source (blend of soybean oil and tallow vs. soybean oil) interaction ($P < 0.05$) was observed for C18:2, C18:3, and PUFA, which again was due to increased concentrations in pigs fed soybean oil vs. the blend of soybean oil and tallow. Pigs fed the blend of soybean oil and tallow had a greater increase in C18:3 than those fed tallow (feeding period × fat source interaction, $P = 0.001$). Adding 4% fat increased ($P < 0.05$) C18:2, C18:3, MUFA, and PUFA and decreased ($P < 0.05$) C16:1, C18:1, and SFA for both periods compared with those fed the control diet without added fat. In addition, C20:1 decreased ($P < 0.05$) in pigs fed 4% fat compared with the control diet without fat. Feeding the blend of soybean oil and tallow increased ($P < 0.05$) C18:2, C18:3, and PUFA on both d 42 and 84 and C22:5n3 on d 42 compared with pigs fed tallow. Feeding the blend of soybean oil and tallow decreased ($P < 0.05$) C16:1, C18:1, and MUFA on both d 42 and 84 and decreased C20:1 on d 42 compared with those fed tallow. Feeding soybean oil decreased ($P < 0.05$) C18:1 and MUFA but increased ($P < 0.05$) C18:2, C18:3, and PUFA on both d 42 and 84 and increased C20:1 and SFA on d 84 compared with pigs fed the blend of soybean oil and tallow. Feeding soybean 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 on both d 42 and 84 and decreased SFA on d 84 compared with feeding tallow.

Jowl fat. A feeding duration × fat source interaction ($P < 0.05$) was observed among pigs fed tallow vs. soybean oil for C18:2, C18:3, C22:5n3, SFA, MUFA, and PUFA and for the blend of soybean oil and tallow vs. soybean oil for C18:2, C18:3, C20:1, and PUFA (Table 7). These interactions were driven by the elevated concentrations of PUFA and reduced levels of MUFA and SFA with increasing feeding duration for soybean oil relative to other fat sources. For C18:3, feeding duration × fat source interactions ($P = 0.001$) were observed for tallow vs. the blend of soybean oil and tallow. A feeding period × fat source interaction also was observed for the blend of soybean oil and tallow vs. soybean oil as well as tallow vs. soybean oil. This was the result of a greater increase in C18:3 concentration in pigs fed soybean oil relative to tallow or the blend of soybean oil and tallow. Pigs fed tallow had a greater increase in C20:1 than pigs fed soybean oil (feeding period × fat source interaction, $P = 0.017$). Adding 4% fat increased ($P < 0.05$) C16:1, C18:2, C18:3, C22:5n3, and PUFA and decreased ($P < 0.05$) SFA and MUFA on both d 42 and 84 and decreased ($P < 0.05$) total C18:1 on d 42 compared with pigs fed the control diet. Feeding the blend of soybean oil and tallow increased ($P < 0.05$) C18:2, C18:3, C22:5n3, and PUFA and decreased C18:1 and MUFA on both d 42 and 84 and decreased ($P < 0.05$) C20:1 on d 84 compared with tallow. Feeding soybean oil decreased ($P < 0.05$) C18:1 and MUFA for both d 42 and 84 but decreased C20:1 only for d 84 compared with pigs fed the blend of soybean oil and tallow. Conversely, feeding soybean oil increased ($P < 0.05$) C18:2, C18:3, C22:5n3, and PUFA concentrations compared with pigs fed the blend of soybean oil and tallow. Feeding soybean 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 on both d 42 and 84 compared with pigs fed tallow.

Iodine value

Backfat. Pigs fed diets containing 4% added fat had increased ($P < 0.05$) backfat IV compared with those fed the control diet, but the increase in backfat IV was dependent on dietary fat source, duration of feeding (84 d vs. 42 d), and the period that the fat was fed (d 0 to 42 vs. d 42 to 84; Table 5). Fat source × feeding duration interactions occurred for tallow vs. the blend of soybean oil and tallow ($P = 0.038$), tallow vs. soybean oil ($P = 0.001$), and soybean oil vs. the blend of soybean oil and tallow ($P = 0.003$). When feeding fat for 84 d compared with 42 d, pigs fed soybean oil had an IV increase of 8.5 g/100 g, whereas pigs fed the blend of soybean oil and tallow had a 4.0 g/100 g increase. The feeding duration of 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. soybean oil and soybean oil vs. the blend of soybean oil and tallow. Pigs fed tallow from d 0 to 42 had backfat IV similar to those fed tallow from d 42 to 84. Pigs fed the blend of soybean oil and tallow from d 0 to 42 had backfat IV similar to those fed the blend from d 42 to 84; however, pigs fed soybean oil from d 0 to 42 had 6 g/100 g lower backfat IV than those fed soybean oil from d 42 to 84. Therefore, the period in which the fat was fed (d 0 to 42 vs. 42 to 84) influenced IV only when feeding soybean oil. For pigs fed fat from d 0 to 84, the blend of soybean oil and tallow or soybean oil increased backfat IV by 7.2 and 15.4 g/100 g, respectively, compared with those fed tallow. For pigs fed fat from d 0 to 42 and then the control diet from d 42 to 84, soybean oil and the blend of soybean oil and tallow increased backfat IV by 4.1 and 3.0 g/100 g, respectively, compared with those fed tallow. For pigs fed the control diet from d 0 to 42 and then added fat from d 42 to 84, soybean oil and the blend of soybean oil and tallow increased backfat IV by 11.2 and 5.0 g/100 g, respectively, compared with those fed tallow.

Belly fat. Pigs fed diets containing 4% added fat had increased ($P < 0.05$) belly fat IV compared with those fed a control diet (Table 6). Similar to backfat, belly fat IV was dependent on dietary fat source, duration of feeding (84 d vs. 42 d), and the period that the fat was fed (d 0 to 42 vs. d 42 to 84). A fat source × feeding duration interaction was observed for the blend of soybean oil and tallow vs. soybean oil ($P = 0.004$) and tallow vs. soybean oil ($P = 0.001$). There was also a tendency ($P = 0.081$) for a tallow vs. blend of soybean oil and tallow × feeding duration interaction. When fed fat for 84 vs. 42 d, IV pigs fed soybean oil had a 6.2 g/100 g increase and 2.5 g/100 g in pigs fed the blend of soybean oil and tallow. Feeding duration did not affect IV in pigs fed tallow. A fat source × feeding period interaction ($P < 0.022$) occurred for both tallow vs. soybean oil and the blend vs. soybean oil. Pigs fed tallow or the blend from d 0 to 42 had belly fat IV similar to pigs fed a similar diet from d 42 to 84; however, pigs fed soybean oil from d 0 to 42 had a 3.6 g/100 g lower belly fat IV than pigs fed soybean oil from d 42 to 84. Therefore, similar to backfat, period influenced IV only when pigs were fed soybean oil. Feeding the blend of soybean oil and tallow or soybean oil from d 0 to 84 increased IV by 5.3 and 12.2 g/100 g, respectively, compared with pigs fed tallow. For pigs fed fat from d 0 to 42 and the control diet from d 42 to 84, soybean oil and the blend of soybean oil and tallow increased belly fat IV by 4.0 and 2.4 g/100 g, respectively, compared with 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, the blend of soybean oil and tallow and soybean oil increased belly fat IV by 3.9 and 8.9 g/100 g, respectively, compared with 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 with pigs fed the control diet (Table 7). Fat source × feeding duration interactions were observed for the blend of soybean oil and tallow vs. soybean oil ($P = 0.005$) and for tallow vs. soybean oil ($P = 0.001$). There was also a trend ($P = 0.067$) for a fat source × feeding duration interaction for tallow vs. the blend of soybean oil and tallow. When pigs were fed added fat for 84 vs. 42 d, IV increased 5.5 g/100 g in pigs fed soybean oil and 2.3 g/100 g in pigs fed the blend, whereas duration of feeding did not affect IV in pigs fed tallow. No interaction was found for fat source × feeding period between any treatments for jowl fat IV. Feeding the blend of soybean oil and tallow or soybean oil from d 0 to 84 increased jowl fat IV by 4.7 and 10.8 g/100 g, respectively, compared with pigs fed tallow. For pigs fed fat from d 0 to 42 and the control diet from d 42 to 84, the blend of soybean oil and tallow or soybean oil increased jowl fat IV by 2.2 and 4.5, respectively, compared with those fed tallow. For pigs fed the control diet from d 0 to 42 then fed added fat from d 42 to 84, the blend of soybean oil and tallow or soybean oil increased jowl fat IV by 2.9 and 6.2 g/100 g, respectively, compared with those fed tallow.

Discussion

Adding fat from d 0 to 42 or 42 to 84 increased ADG and improved F/G compared with pigs fed no fat from d 0 to 84. Added fat from d 0 to 84 increased backfat depth, which tended to reduce the carcass FFLI. Similar improvements in ADG and F/G were observed among pigs when feeding either soybean oil, tallow, or their blend.

As previous data suggest, C18:2 increased as soybean oil was added to diets, which resulted in an increase in PUFA. As PUFA increased, IV increased within each fat depot. Conversely, as soybean oil was added to diets, C18:1 decreased, which lowered MUFA for all individual fat depots. Pigs fed diets containing the blend of soybean oil and tallow had similar responses, but not to the extent of the pigs fed only soybean oil. Pigs fed tallow had the least change in fatty acids and IV compared with pigs fed the other fat sources.

Jowl fat, unlike the other two depots, did not show a period effect for IV when adding dietary fat. The lack of a period effect for jowl fat is reflective of the slow turnover rate of this fat depot. Interestingly, tallow did not affect SFA levels in fat depots. Because neither MUFA nor PUFA were significantly affected by tallow compared with a control diet, IV values were not significantly altered by tallow. Therefore, feeding tallow can improve rate of gain and feed efficiency without affecting IV. Feeding soybean oil also can improve both ADG and feed efficiency, but it negatively affects fatty acid composition and IV. This negative impact can be improved by utilizing a withdrawal strategy, but IV levels remain above controls even after a long-term withdrawal of 42 d.

Table 1. 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 P, 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-lysine HCl	0.28	0.28	0.23	0.23	0.20	0.20
DL-methionine	0.05	0.07	0.01	0.03	---	---
L-threonine	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	3.65	3.08	3.08	2.68	2.68
ME, kcal/lb	1,497	1,590	1,502	1,595	1,507	1,600
NE, kcal/lb	1,130	1,211	1,143	1,225	1,154	1,236
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
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
Crude fiber, %	2.3	2.3	2.3	2.2	2.2	2.2

[1] Phase 1, 2, and 3 diets were fed from d 0 to 28, d 28 to 56, and d 56 to 84, respectively.
[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 2. Chemical analysis of diets (as-fed basis)[1]

	Phase 1[2]				Phase 2[2]				Phase 3[2]			
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	3.0	3.4	1.9	2.4	2.8	2.3
NDF	6.5	8.0	8.0	6.6	5.9	5.2	6.0	5.4	7.1	8.4	8.4	6.8
Crude fiber	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, 2, and 3 diets were fed from d 0 to 28, d 28 to 56, and d 56 to 84, respectively.

[2] Control = no added fat; tallow = 4% beef tallow; soy = 4% soybean oil; blend = 2% soybean oil and 2% tallow.

[3] Values represent the mean of one composite sample of each diet.

Table 3. Fatty acid analysis of ingredients and treatment diets

			Diets[1]											
	Ingredients		Phase 1				Phase 2				Phase 3			
Item	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/100 g[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 4. Effects of added fat source and feeding duration on finishing pig growth performance and carcass characteristics[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], $P <$					
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 42	186.2	191.6	193.0	187.8	188.8	186.8	185.2	191.4	188.3	182.6	4.11	0.179	0.089	0.067	0.078	0.832	0.121
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	0.001	-	-	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	0.001	-	-	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 × 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, J vs. B, C, E, F, H, 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, I vs. B, D, E, G, H, 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) and carcass characteristics contrast statements are as follows: 1 = no added fat vs. added fat both periods (treatment A vs. B, E, H); 2 = added fat both periods vs. added fat only during a single period (treatments B, E, H vs. C, D, F, G, I, J); 3 = added fat only during period 1 vs. added fat only during period 2 (treatments C, F, I vs. D, G, J); 4 = tallow vs. blend (treatments B, C, D vs. E, F, G); 5 = blend vs. soy oil (treatments E, F, G vs. H, I, J); 6 = tallow vs. soy oil (treatments B, C, D, vs. H, I, J).

[7] Adjusted using HCW as a covariate.

[8] Fat-free lean index was calculated using the NPPC (2001) equation.

Table 5. Effects of fat source and feeding duration on backfat fatty acid profiles[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		Contrasts[4,5], $P <$					
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

continued

Table 5. Effects of fat source and feeding duration on backfat fatty acid profiles[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		Contrasts[4,5], $P <$					
d 42 to 84:	Control	Tallow	Control	Tallow	Blend	Control	Blend	Soy	Control	Soy	SEM	1	2	3	4	5	6
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/100 g[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 fat source × feeding duration 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).
[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.
[a,b,c,d] Within a row, superscripts represent significant ($P < 0.05$) main effects where a = control vs. fat (treatments A, D, G, J vs. B, C, E, F, H, 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, I vs. B, D, E, G, H, 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).

Table 6. Effects of fat source and feeding duration on belly fat fatty acid profiles[1,2]

Treatment[3]:	A	B	C	D	E	F	G	H	I	J		Contrasts[4,5], $P <$					
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	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

continued

Table 6. Effects of fat source and feeding duration on belly fat fatty acid profiles[1,2]

Treatment[3]:	A	B	C	D	E	F	G	H	I	J		Contrasts[4,5], $P <$					
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
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] 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 fat source × feeding duration interaction ($P < 0.005$) for all variables except 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).
[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.
[a,b,c,d] Within a row, superscripts represent significant ($P < 0.05$) main effects where a = control vs. fat (treatments A, D, G, J vs. B, C, E, F, H, 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, I vs. B, D, E, G, H, 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).

Table 7. Effects of fat source and feeding duration on jowl fat fatty acid profiles[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		Contrasts[4,5], $P <$					
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

continued

Table 7. Effects of fat source and feeding duration on jowl fat fatty acid profiles[1,2]

Treatment[3]:	A	B	C	D	E	F	G	H	I	J		Contrasts[4,5], $P <$					
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
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 fat source × feeding duration 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).

[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.

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