EFFECT OF FAT COMBINATIONS ON STARTER PIG PERFORMANCE AND NUTRIENT DIGESTIBILITY[1]

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Summary

A growth trial was conducted to evaluate the effects of addition of soybean oil, coconut oil, 50% soybean oil: 50% coconut oil, 75% soybean oil: 25% coconut oil, and 25% soybean oil: 75% coconut oil on starter pig performance and nutrient digestibility. Diets were supplemented with 10% fat for the first 2 wk of the study and 5% for the final 3 wk. Fecal samples were collected from pigs by rectal massage, and apparent digestibility of DM, N, total fat, and fatty acids were calculated using chromic oxide (.3%) as an indigestible marker. Results demonstrated that ADG and feed efficiency (F/G) were improved by fat additions, with 50% soybean oil and 50% coconut oil maximizing performance. Pigs gained faster on the soybean oil and coconut oil combinations than on coconut oil and consumed more of the soybean oil plus coconut oil diet than either coconut oil or soybean oil diets. No differences were observed for apparent digestibility of fat and GE or ileal digestibility of DM and N among the fat sources. However, pigs fed the combination of soybean oil and coconut oil tended to have improved ileal digestibility of medium chain fatty acids (≤ 14 C). These trials demonstrate that a combination of soybean oil and coconut oil improves pig performance and tends to improve apparent digestibility of medium chain fatty acid compared to pigs fed diets containing either no added fat or soybean oil or coconut oil alone.

(Key Words: Pig, Digestibility, Fat, Performance.)

Introduction

Dietary fat addition has been shown to have different effects on starter pig performance. These differences may be a result of several factors: absorption of one fatty acid being modified by other fatty acids in the diet, melting point, energy:nutrient ratios, age of pigs, and dietary fat source or fat level. Chain length and degree of saturation of fatty acids and their arrangement within the triglyceride molecule are all important factors in determining the degree of fat digestibility of pigs. Previous research from this station has shown that pigs performed better on diets containing either soybean oil, choice white grease, or coconut oil than on diets containing tallow. Therefore, the objective of this study was to investigate the effect of soybean oil, coconut oil, or various fat combinations on starter pig performance and total tract apparent digestibility of fatty acids, total fat, N, and DM.

[1]The authors express appreciation to Merrick's, Inc., which donated the fat sources tested.

Experimental Procedures

A growth trial was conducted to evaluate the effects of graded levels of soybean oil and coconut oil on the performance and fecal apparent digestibility of fatty acids by starter pigs. Dietary treatments included additions of soybean oil or coconut oil alone or combinations of 25% soybean oil: 75% coconut oil, 50% soybean oil: 50% coconut oil, 75% soybean oil: 25% coconut oil. Two hundred and six pigs weaned at 21 ± 3 d were utilized, with an average initial weight of 10.8 ± 4.2 lb. Pigs were allotted by litter, sex, and weight to the six dietary treatments. Five replications per treatment were used with seven pigs per pen. Pigs were housed in a temperature controlled nursery. Feed and water were fed ad libitum. Feed intake and pigs body weight were recorded weekly. At d 11 postweaning, fecal samples (taken at this age because of limited feed supply) were collected from pigs by rectal massage and frozen until analyzed. Apparent digestibilities of DM, N, total fat, and fatty acids were calculated using chromic oxide (.3%) as the indigestible marker.

Composition of basal diets is shown in Table 1. Control diet in phase 1 contained (calculated) 1.3% lysine, .90% Ca, and .80% P, and the control diet in phase 2 contained 1.25% lysine, .90% Ca, and .80% P. A constant calorie:lysine ratio of 250 calories/g was maintained across all treatments within each phase. Therefore, diets containing fat had a greater percentage of lysine than the control diet to keep the calorie:lysine ratio comparable.

For the first 2 wk (phase 1) of the study, pigs were fed a pelleted diet containing 40% milk products and either 10% or no added fat. For the last 3 wk (phase 2), pigs were fed a pelleted, 20% dried whey diet containing 5% or no added fat.

Results

The analyzed compositions of fat sources investigated are shown in Table 2. All fat sources were assumed to contain 3545 kcal ME/lb.

Pigs fed diets containing different proportions of soybean oil and coconut oil had a greater ($P<.05$) improvement in ADG than pigs fed a diet supplemented with either soybean oil alone or the control diet (Table 3). There were no differences ($P>.05$) in ADG among the combinations of soybean oil and coconut oil.

Fat addition for phase 1 did not affect ADG or F/G but decreased average daily feed intake (ADFI). From 3 to 5 wk postweaning, ADG and ADFI were higher ($P<.05$) for pigs fed diets containing coconut oil and other fat combinations than those fed diets containing soybean oil or the control diet.

Cumulative results for the 5-wk trial demonstrated that pigs fed the control diets had lower ($P<.05$) ADG than pigs fed diets containing added fat. Pigs fed diets containing soybean oil tended to have a greater ($P<.06$) ADG and ADFI than pigs fed the control diet, but lower than pigs fed diets containing other fat sources and combinations. There were no differences in ADG and ADFI among pigs fed diets containing either different proportions of soybean oil and coconut oil or coconut oil alone, but these treatments had higher ($P<.05$) ADG and ADFI

Table 1. Composition of Experimental Diets[a]

Ingredients, %	Phase 1	Phase 2
Corn	42.20	45.55
Soybean meal (44% CP)	15.00	31.00
Dried whey	20.00	20.00
Skim milk	20.00	---
L-lysine HCl	.10	.10
D-L Methionine	.10	---
Salt	.25	.25
Copper sulfate	.10	.10
Trace mineral premix[b]	.15	.15
Vitamin premix[c]	.25	.25
Monocalcium phosphate (21% P,18.5% Ca)	.90	1.35
Limestone (38%)	.60	.60
Antibiotic[d]	.25	.25

[a]Fat (10% - phase 1; 5% - phase 2) and synthetic lysine (.25%- phase 1; .15% - phase 2) were substituted for corn in order to maintain a constant calorie:lysine ratio of 250 calories/g. Calculated analysis in the diet: CP, 19.5, 20.2; Lysine, 1.30, 1.25; Ca, .9, .9; P, .8, .8 % for phase 1 and phase 2, respectively.

[b]Provided the following in the per lb of complete diet (ppm): Zn, 70; Fe, 50; Mn, 25; Cu, 5; Co, .5; I, .7; Se, .3.

[c]Provided the following per lb of complete diet: Vitamin A, 2,000 IU; Vitamin D_3, 20 IU; Vitamin E, 6.67 IU; Vitamin K, 1.32 mg; riboflavin, 2.0 mg; niacin, 12.0 mg; d-pantothenic acid, 8.0 mg; Vitamin B12, 8.0 μg.

[d]Containing carbadox, 20 lb per ton.

than diets containing soybean oil or the control diet. There were no differences in F/G across the treatments tested.

Overall, pigs fed diets supplemented with a single fat or combinations of fat had higher ($P<.03$) apparent digestibility of DM, N, and total fat than pigs fed the control diet (Table 4). Apparent digestibility of saturated, long chain fatty acids was lower ($P<.05$) for pigs fed the diet supplemented with the combination of 75% soybean oil + 25% coconut oil. There were no differences in apparent digestibility of long chain, unsaturated fatty acids or medium chain fatty acids across the treatments. The apparent digestibility of saturated fatty acids in pigs fed diets containing 50% soybean oil : 50% coconut oil tended to be higher ($P<.06$) than that in pigs fed diets with either soybean oil or coconut oil alone. The apparent digestibility of unsaturated fatty acids in pigs fed the diets containing fat combinations was intermediate between those of pigs fed the diets containing soybean oil and coconut oil.

Table 2. Analyses of Fat Sources

Item	Coconut oil	Soybean oil
Moisture, impurities, and unsaponifiable matter	.35	.50
Free fatty acids	.25	1.75
Total fatty acids	86.60	93.70
Peroxide value (mEq/kg)	.80	2.30
Fatty acids, %		
C 8:0[a]	5.90	<.10
C 10:0	5.18	<.10
C 12:0	42.55	.49
C 14:0	18.39	.28
C 16:0	11.24	10.58
C 16:1	.23	<.10
C 16:2	<.10	<.10
C 18:0	3.94	4.07
C 18:1	9.90	23.17
C 18:2	2.38	52.59
C 18:3	<.10	7.66

[a]No. of carbon atoms : no. of double bonds.

Discussion

The pattern of fatty acids in the diet may be one of the factors influencing the performance of pigs. Soybean oil contains a high percentage of long chain, unsaturated fatty acids, and coconut oil contains a high percentage of short chain, saturated fatty acids. The combination of these two may provide a more ideal fatty acid profile that meets the capacity for absorption of both saturated and unsaturated fatty acids by pigs. Addition of 10% fat increased the caloric density of the diet and resulted in a depression of voluntary feed intake during phase 1. This indicates that young pigs eat to meet their energy requirement. However, F/G was not affected, indicating that they are capable of utilizing fat calories as effectively as carbohydrate calories when lysine is kept in a constant ratio to energy. On the other hand, the benefit from fat addition occurred mainly during the third to fifth wk postweaning, not in the first 2 wk postweaning. This may have been caused by a transitory decrease in lipase activity when young pigs are abruptly weaned to dry diets. Average daily gain and F/G were improved during 3 to 5 wk postweaning, which may have resulted from increased lipase activity.

All fat sources and combinations tested, except soybean oil alone, stimulated ADFI by pigs ($P<.05$) and enhanced ADG ($P<.05$) during phase 2, especially for pigs fed the diets supplemented with 50% soybean oil : 50% coconut oil. It is possible that addition of a combination of soybean oil and coconut oil improved palatability of the diets. This suggests that

the lysine requirement was met when a higher amount of dietary energy consumed, which, in turn, stimulated improvement in pig performance.

Fat digestibility is influenced by the chain length and degree of saturation of its fatty acids, with short and medium chain fatty acids being absorbed readily. Pigs fed diets with supplemental fat had higher (P<.02) N digestibility at the end of the first 2-wk postweaning, indicating that dietary fat appears to improve N utilization.

Based on the growth performance data, a 10 to 15% improvement in pig performance can be expected with the addition of a combination of soybean oil and coconut oil to weanling pig diets. However, the large improvement in growth performance with high-fat starter diets may not be seen until after the first 2 wk postweaning. The profile of fatty acids in the diet may affect its nutritive value for starter pigs.

Table 3. Effect of Fat Combinations on Performance of Starter Pigs[a]

Item	Control	Soybean oil	Coconut oil	50% soybean oil + 50% coconut oil	75% soybean oil + 25% coconut oil	25% soybean oil + 75% coconut oil	SE
0 to 11 d; 10% fat							
ADG, lb[b]	.67	.69	.59	.66	.59	.62	.16
AFI, lb	.69	.63	.60	.63	.54	.58	.06
F/G[c]	1.07	.94	1.10	.99	.92	.92	.31
11 to 35 d; 5% fat							
ADG, lb[d]	.80	.92	1.09	1.10	1.04	1.02	.26
AFI, lb[e]	1.32	1.36	1.59	1.54	1.49	1.45	.12
F/G[e]	1.65	1.48	1.46	1.40	1.43	1.42	.73
0 to 35 d							
ADG, lb[e]	.79	.86	.93	.96	.90	.90	.19
AFI, lb[e]	1.15	1.22	1.30	1.30	1.24	1.24	.09
F/G	1.47	1.43	1.41	1.36	1.38	1.38	.42

[a]Each value represents the mean of five replicate pens with 7 pigs/pen; avg initial wt, 10.8 lb.
[b]Soybean oil vs coconut oil (P<.05).
[c]Control vs 75% soybean oil + 25% coconut oil and 25% soybean oil + 75% coconut oil (P<.05)
[d]Control and soybean oil vs coconut oil, 75% soybean oil + 25% coconut oil and 25% soybean oil + 75% coconut oil (P<.05).
[e]Control and soybean oil vs coconut oil, 50% soybean oil +50% coconut oil, 75% soybean oil + 25% coconut oil and 25% soybean oil + 75% coconut oil (P<.05).

Table 4. The Effect of Fat Sources on Fecal Digestibility of Fatty Acids for Starter Pigs

Item	Control	Soybean oil	Coconut oil	50% soybean oil + 50% coconut oil	75% soybean oil + 25% coconut oil	25% soybean oil + 75% coconut oil	SE
DM[a]	85.83	89.81	86.72	87.44	87.87	89.00	1.83
N[a]	79.55	86.38	80.94	82.12	83.94	85.48	3.43
Total fat[a]	87.00	93.96	89.42	91.92	91.32	92.34	2.51
C8:0[b]	90.51	91.61	98.52	98.87	98.28	98.78	3.22
C10:0[b]	87.61	85.25	97.73	80.77	78.74	82.51	8.48
C12:0[b]	91.54	97.89	95.86	97.19	96.67	98.01	2.20
C14:0[ab]	70.72	70.89	73.47	79.17	78.16	80.58	4.75
C16:0[c]	79.83	90.13	76.67	66.29	32.45	80.71	8.62
C16:1	64.10	16.50	52.73	76.39	58.13	74.14	48.34
C18:0	19.74	57.98	46.18	52.70	64.04	37.68	23.76
C18:1[a]	98.87	92.77	86.17	89.15	91.05	91.51	2.41
C18:2[d]	82.58	84.49	76.36	83.44	82.94	84.77	.70
C18:3[e]	-42.43	68.78	23.15	55.47	50.91	65.48	28.00
Medium chain:	74.86	81.59	78.70	82.66	81.95	83.66	2.69
Long chain:							
Saturated:	67.55	81.04	68.36	61.81	38.91	68.88	10.49
Unsaturated:	96.84	94.25	86.02	91.26	90.72	93.49	1.55

[a]Fat vs control (P<.03).
[b]Single fat source vs fat combinations (P<.01).
[c]75% soybean oil + 25% coconut oil vs control, soybean oil, coconut oil, 50% soybean oil + 50% coconut oil, 75% soybean oil + 25% coconut oil, 25% soybean oil + 75% coconut oil (P <.05).
[d]Soybean oil or coconut oil vs 50% soybean oil:50% coconut oil (P<.01).
[e]Soybean oil or coconut oil vs control (P<.01).