THE EFFECT OF FAT SOURCE AND MEDIUM-CHAIN TRIGLYCERIDE LEVEL ON PERFORMANCE OF THE EARLY-WEANED PIG

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Story in Brief

The effect of dietary fat source and medium chain triglyceride level was studied in two trials utilizing 71 early-weaned pigs. The five treatment groups were fed diets containing 10% fat. Fat sources used were butterfat, lard, and increasing levels of medium-chain triglycerides substituted at the expense of lard. Pigs were housed in an environmentally controlled room in individually elevated pens with temperature maintained at 86°F and 84°F for weeks 1 and 2, respectively. Trial length was 14 days with gain and efficiency of gain estimates obtained weekly. All pigs were fed a common starter diet for an additional 3-week period. There were no significant differences in average daily gain or efficiency of gain between pigs fed butterfat and lard, although pigs fed butterfat tended to grow faster and were more efficient. There was a linear increase in average daily gain and efficiency of gain with increasing level of medium-chain triglycerides in the ration for week 1 and during the 2-week experimental period. No differences (P>.76) were observed among dietary treatments for average daily feed intake. Average daily gain, gain-to-feed ratio, and average daily feed intake during the subsequent 3-week period were not affected by treatment. This study suggests that medium-chain triglycerides may be superior to lard or butterfat as an energy source for early weaned pigs.

(Key Words: Early Weaned Pig, Fat Source.)

Introduction

Several studies have indicated that source of fat influences its utilization by the young pig and further that fat utilization may be influenced by fatty acid composition. Studies also indicate that fat sources high in medium-chain or unsaturated fatty acids are preferentially utilized. Wolfe et al. (1977) has suggested that the young pig is capable of efficiently utilizing a high fat diet

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when butterfat, which is intermediate in both chain length and degree of saturation, is used as the fat source.

Recently, medium-chain triglycerides (MCT), which are composed primarily of a mixture of C8:0 (65 to 75%) and C10:0 (25 to 35%), have been manufactured and may offer an alternative fat source for the early-weaned pig. This study was conducted to compare lard with butterfat as a fat source and to determine the effect of replacing a portion of lard with medium-chain triglycerides (Captex 300 medium-chain triglycerides)[3] on the performance of early-weaned pigs.

Materials and Methods

Seventy-one Yorkshire pigs were used to compare lard with butterfat as a fat source and to determine the effect of different medium-chain triglycerides levels on performance of early-weaned pigs. A total of 71 pigs in two replicates were allotted by sex, litter, and weight to one of five dietary treatments after weaning at 22 to 23 days of age. During the first fourteen days (Period 1), treatment groups were fed diets containing 10% fat. Fat sources used were butterfat (T1), lard (T2), 8% lard with 2% captex 300 medium-chain triglycerides (T3), 6% lard with 4% captex 300 medium-chain triglycerides (T4), and 4% lard with 6% captex 300 medium-chain triglycerides (T5; Table 1). Pigs had ad libitum access to feed and water. All diets were formulated to contain 1.40% lysine, .90% Ca and .70% P. Sources of fat were selected to vary in fatty acid composition (Table 2).

Pigs were individually housed in metabolism crates measuring 18.5 x 30 inches in an environmentally controlled room. The temperature was maintained at 86°F during the first week and was decreased 2°F per week for the remainder the experiment.

In the subsequent 21-day period (Period 2), all pigs were fed a common 18% crude protein diet (Table 1) to test for any carry-over effects from Period 1.

During the 5-week trial, individual pig weights and feed intake by pen were measured, while feed efficiency (G:F) was calculated weekly. Waste feed was collected in pans directly under individual feeders and dried to correct feed intake for waste. Protein, moisture, ether extract of feed and the fatty acid composition of the fat sources were determined.

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[3]Capital City Products, Columbus, OH

Table 1. Composition of diets.

Ingredient	Treatments[a], Period 1					Period 2 Diet
	10% Butterfat	10% Lard	8% Lard 2% MCT	6% Lard 4% MCT	4% Lard 6% MCT	
Yellow corn	--	--	--	--	--	67.30
Soybean meal, 44% CP	--	--	--	--	--	28.50
Soybean meal, 50% CP	14.00	14.00	14.00	14.00	14.00	--
Whey, dried whole	20.00	20.00	20.00	20.00	20.00	--
Dried skim milk	10.00	10.00	10.00	10.00	10.00	--
Corn, ground	37.73	37.73	37.73	37.73	37.73	--
Butterfat[b]	10.00	.00	.00	.00	.00	--
Lard[b]	.00	10.00	8.00	6.00	4.00	--
Captex 300 MCT[bc]	.00	.00	2.00	4.00	6.00	--
Fish meal	6.00	6.00	6.00	6.00	6.00	--
Lysine, HCI	.18	.18	.18	.18	.18	.15
Calcium carbonate	.33	.33	.33	.33	.33	.90
Dicalcium phosphate	.42	.42	.42	.42	.42	1.95
Apralan	.10	.10	.10	.10	.10	--
Vit. TM premix[d]	.94	.94	.94	.94	.94	.37
Salt	.30	.30	.30	.30	.30	.40
Copper sulfate	--	--	--	--	--	.08
Banmith (pyrantel tartrate-48 g/lb)	--	--	--	--	--	.10
Mecadox - 10 (carbadox - 10 g/lb)	--	--	--	--	--	.25

Table 1. (Continued).

Ingredient	Treatments[a], Period 1					Period 2 Diet
	10% Butterfat	10% Lard	8% Lard 2% MCT	6% Lard 4% MCT	4% Lard 6% MCT	
Calculated analysis						
Crude protein	19.67	19.67	19.67	19.67	19.67	18.48
Calcium	.90	.90	.90	.90	.90	.85
Phosphorus	.70	.70	.70	.70	.70	.70
Lysine	1.40	1.40	1.40	1.40	1.40	1.10
Tryptophan	.25	.25	.25	.25	.25	.22
Threonine	.89	.89	.89	.89	.89	.75
Met + Cys	.72	.72	.72	.72	.72	.61
M.E. (Mcal/lb)	1.67	1.67	1.67	1.67	1.67	1.43
Actual analysis						
Crude protein (N X 6.25)	19.75	19.48	19.90	20.00	20.00	20.60
Ether extract	14.49	14.56	14.71	14.60	14.63	--

[a] As fed basis, percent.
[b] Each was stabilized with ethoxyquin (624 ppm).
[c] From Capital City Products Company, Columbus, OH.
[d] Period 1 diet supplied 8,800 IU Vitamin A, 880 IU Vitamin D, 37 IU Vitamin E, 44 mg Panothenic acid, 59 mg Niacin, 8.8 mg Riboflavin, 7.3 mg Menadione, .04 mg Vitamin B_{12}, 880 mg choline chloride, .2 mg selenium, .06 g manganese, .2 g zinc, .2 g iron, .2 g copper, .4 mg iodine, 3 mg biotin, 8.7 mg pyridoxine, 2 mg folic acid, 10 mg thiamine, per kg of feed, .02% magnesium and .10% potassium (Period 2 diet does not include Mg and K).

Table 2. Fatty acid composition (%) of fats.

Fatty acid, %	Fat		
	Butterfat[a]	Captex 300[b]	Lard[a]
C 6[c]:0[d]		1.7	
C 8:0	1.4	68.6	
C 10:0	4.1	29.1	
C 12:0	4.7	0.6	
C 14:0	14.2		2.3
C 16:0	32.4		28.6
C 16:1	3.2		2.8
C 18:0	10.6		14.0
C 18:1	24.8		43.8
C 18:2	2.2		8.5
C 18.3	0.5		
	1.9		

[a] Fatty acid mehyl esters were separated on a crosslinked 50% phenylmethyl silicone 25m x .2mm x .17mm film thickness column in a Perkin-Elmer 5890 gas-liquid chromatographic equipped with a flame ionization detector operated at 285°C. Temperature program 125 - 225°C at 10°C/min.

[b] Analysis from Capital City Products Company, Columbus, OH.

[c] Number of carbon atoms in fatty acid.

[d] Number of double bonds in fatty acid.

Results and Discussions

The effect of dietary fat source and medium-chain triglyceride level on average daily gain is shown in Table 3. During the first week, pigs fed 10% butterfat grew 19% faster than those fed 10% lard although differences between the means were not significant.

Average daily gain during the first week increased with increasing dietary level of medium-chain triglycerides (Diet 2 to Diet 5, linear effect, $P<.01$). These results suggest that the level of medium-chain triglycerides improve gain and have the greatest effect on gain when added at the highest level (6%) evaluated. Pigs fed 6% medium chain triglycerides and 4% lard outperformed those fed 10% lard and 8% lard with 2% MCT by 49 and 20%, respectively. In addition, pigs fed 6% lard with 4% MCT grew 25% faster than those fed 10% lard. Average daily gain over the entire 14-day experimental period continue to

Table 3. The effect of fat source and medium-chain triglyceride (MCT) level on average daily gain, feed efficiency and average daily feed intake[a].

Item	Diet					SE
	10% Butterfat	10% Lard	8% Lard 2% MCT	6% Lard 4% MCT	4% Lard 6% MCT	
No. of pigs	14	12	14	13	13	
Average daily gain, lb						
day 0-7[b]	.56	.47	.58	.61	.70	.04
day 0-14[b]	.75	.72	.76	.79	.84	.02
day 14-35	1.14	1.14	1.17	1.17	1.18	.04
Feed efficiency, gain/feed						
day 0-7[b]	.92	.80	.92	.98	1.07	.05
day 0-14[b]	.89	.84	.89	.91	.96	.02
day 14-35	.70	.69	.68	.67	.69	.01
Average daily feed intake, lb						
day 0-7	.60	.57	.62	.62	.64	.04
day 0-14	.83	.82	.84	.86	.86	.03
day 14-35	1.63	1.64	1.72	1.75	1.70	.05

[a] Least squares means.
[b] Linear response ($P<.01$) to increasing level of medium-chain triglyceride (Treatment 2 to Treatment 5).

be greater for pigs fed 10% butterfat than for those fed 10% lard; however the magnitude of difference was lower than that observed during the first week. As was observed in week 1, average daily gain increased linearly (P<.01) with increasing level of medium-chain triglyceride in the diet during the entire 14-day experimental period. Pigs fed the highest level of MCT grew 17% faster than those fed 10% lard and 11% faster than those fed 2% MCT. Average daily gain was similar among all treatments during the subsequent three weeks (days 14 to 35), although pigs fed 10% lard continued to show reduced gains.

Initial pig weights averaged 14.01, 15.11, 14.39, 14.39,and 14.89 lb for Treatments 1 through 5, respectively (Table 4). After week l, pigs fed 10% butterfat were heavier than those fed 10% lard. Pig weight increased linearly with increasing level of medium-chain triglycerides in the diet during the first 2 weeks on trial (P<.01). Differences in pig weight continued throughout the 3-week carryover period when pigs were fed a common diet. A linear increase in pigs' weight at the end of week 3 (P<.01), week 4, and week 5 (P<.05) was observed with increasing levels of medium-chain triglyceride in the previous diet. Pigs fed 10% lard weighed less at the completion of the trial when compared to the other dietary treatments; however, differences were not significant. Differences in weight during the final 3 weeks were primarily the results of differences observed in weight gain during the initial 2-week experimental period.

Feed required per unit of gain followed a pattern similar to that observed for gain (Table 3). Pigs fed 10% butterfat gained 15% more per unit of feed during the first week on trial than those fed 10% lard, although this difference was not significant. Gain-to-feed ratio increased linearly as medium-chain triglycerides increased in the diet (P<.01). Pigs fed 6% MCT had a 34% and 16% higher gain-to-feed ratio (G:F) than those fed 10% lard and 8 with lard with 2% MCT, respectively. Also pigs fed Diet 4 had a 22% higher gain-to-feed-ratio than those fed 10% lard. Over the entire 14-day experimental period, efficiency of feed utilization increased linearly (P<.01), with increasing medium-chain triglyceride level in the diet. Gain-to-feed ratio was similar among all treatments during the subsequent 3-week period .

The effect of the dietary fat source and the medium-chain triglyceride level on average daily feed intake (ADFI) is presented in Table 3. Average daily feed intake during the first week was similar among all treatments, although pigs fed the diet supplemented with 10% butterfat consumed 5% more feed per day than those fed 10% lard. Pigs fed the medium-chain triglyceride-supplemented diet at the level of 6% had 12% greater intake when compared to pigs fed the 10% lard-supplemented diet. Average daily feed intake during the overall 14-day experimental period was similar among treatments, even though pigs fed medium-chain triglyceride supplemented diets had greater intakes when compared to pigs fed the 10% lard-supplemented diet. The effect of medium-chain triglyceride level on ADFI during the subsequent 21-day period was

Table 4. The effect of fat source and medium-chain triglyceride (MCT) level on pig weight, lb[a].

Item	Diet					SE
	10% Butterfat	10% Lard	8% Lard 2% MCT	6% Lard 4% MCT	4% Lard 6% MCT	
No. of pigs	14	12	14	13	13	--
Initial weight	14.01	15.11	14.39	14.39	14.89	--
Week 1[b]	18.44	17.82	18.59	18.81	19.40	.29
Week 2[b]	24.99	24.57	25.12	25.63	26.29	.40
Week 3[b]	31.29	30.82	31.17	32.36	32.99	.59
Week 4[c]	39.84	38.85	40.61	40.46	41.91	.92
Week 5[c]	49.01	48.42	49.65	50.29	51.00	.88

[a] Least squares means.
[b] Linear response ($P<.01$) to increasing level of medium-chain triglyceride (Treatment 2 to Treatment 5).
[c] Linear response ($P<.05$) to increasing level of medium-chain triglyceride (Treatment 2 to Treatment 5).

similar to that observed in Period 1, with a trend toward increased feed intake in pigs fed the medium-chain triglycerides supplemented diets when compared to pigs fed the 10% lard supplemented diet.

In general, diet supplementation with butterfat, which is intermediate in both chain length and degree of saturation, did not significantly affect average daily gain and gain-to-feed ratio relative to the lard supplement diet; however, pigs fed butterfat grew more rapidly and had a better G:F ratio than pigs fed lard. Lawrence and Maxwell (1983) and Frobish et al. (1970) also reported that pigs fed butterfat had better performance than those fed lard, but these differences were not significant.

Diet supplementation of early-weaned pigs with 6% medium-chain triglycerides significantly increased average daily gain and feed efficiency (G:F) during the first week postweaning relative to diets supplemented with 10% lard or butterfat. A linear response in average daily gain and G:F, with increasing levels of medium-chain triglycerides was also observed during the overall 14-day experimental period. Although the mechanism by which medium-chain triglycerides improved the average daily gain and the gain-to-feed ratio cannot be determined from the present study, a number of possibilities exist. Fatty acids of medium-chain triglycerides are readily hydrolyzed and absorbed from the digestive tract and transported to the liver via the portal vein, thereby enhancing the opportunity for hepatic uptake. In addition, medium-chain fatty acids do not require the carnitine acyltransferase system for transport into the mitochondria for oxidation (Breemer, 1983). As such, medium chain fatty acids could result in greater potential for hepatic uptake and oxidation when compared with the long-chain fatty acids (Frost and Wells, 1981).

Lloyd and Crampton (1957) reported a highly inverse relationship between mean molecular weight (chain length) and apparent digestibility, with short-chain fatty acids being more efficiently utilized than long-chain fatty acids. Frobish et al. (1970) and Lawrence and Maxwell (1983) reported that young pigs showed greater and more efficient gains when fed lower molecular weight fat sources (butterfat and coconut oil) than those fed higher molecular weight fats (lard, corn oil, and soybean oil). The authors suggested that the differential performance of pigs may be partially due to the fatty acid composition of the fat.

Several studies indicated that short-chain fatty acids are oxidized more rapidly than long chain fatty acids. Duee et al. (1985) and Lepine et al. (1989) using hepatocytes of neonatal pigs, reported a greater oxidation rate of octanoate relative to long-chain fatty acids. Miller et al. (1971) reported that lauric acid was oxidized more rapidly than palmitic, oleic, and linoleic acid, suggesting that short chain fatty acids are oxidized more rapidly than long chain fatty acids, an observation which generally supports the finding of this study.

In general, the results of this study indicate that faster growth and a higher gain-to-feed ratio can be achieved during the first week postweaning when pigs weaned at 3 weeks of age are fed a diet supplemented with 6% medium-chain

triglycerides and 4% lard in place of a diet supplemented with 10% lard or 10% butterfat. Similar gain and efficiency of gain can be achieved after the first week postweaning. Feeding butterfat to the young pig during the first week postweaning appears to provide some advantage over lard; however, differences were relatively small.

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