Effect of Dietary Fat Source on the Performance of Colostrum-Deprived Neonatal Pigs

N. J. Lawrence, C. V. Maxwell and D. S. Buchanan

Story in Brief

The effect of dietary fat source in liquid, semipurified diets was studied in a trial utilizing 22 Yorkshire pigs derived by cesarean section. The four treatment groups included diets containing 32 percent fat on a dry-matter basis. Fat sources used were butterfat, corn oil, coconut oil and lard.

There were no significant differences in feed efficiency for 0 to 14 days or 14 to 20 days. However, for the entire 20-day treatment period, feed efficiency values for coconut oil were lower than for corn oil ($P<.01$)and lard ($P<.06$). There were no significant differences in average daily gain (ADG) for 0 to 7 or 7 to 14 days. However, ADG from 14 to 20 and from 0 to 20 days was significantly affected by fat source. Pigs fed coconut oil had a higher ADG than pigs fed corn oil ($P<.03$) and lard ($P<.01$) during both time periods. These data suggest that the effectiveness of adding fat to diets for young pigs depends to a large degree upon the source of fat.

Introduction

Sow's milk contains approximately 30 percent fat on a dry-matter basis. Pigs perform well on their mother's milk, and this would suggest that young pigs are capable of utilizing a high-fat diet. It has been suggested that the ability of the neonatal pig to effectively utilize dietary fat is dependent upon fat source. This study was conducted to determine the effects of source of dietary fat on the performance of colostrum-deprived neonatal pigs.

Materials and Methods

The effect of dietary fat source in liquid, semipurified diets was studied in a trial utilizing 22 colostrum-deprived Yorkshire pigs that were derived by cesarean section. The cesarean sections were performed on approximately day 113 of gestation. The four treatment groups included diets containing 32 percent fat on a dry-matter basis. Fat sources used were butterfat, corn oil, coconut oil and lard (Table 1). Sources of fat were selected to vary both chain length and degree of unsaturation of fatty acids (Table 2). Pigs derived from two litters consisting of 11 and 17 pigs were assigned at random within litter and sex to treatment and to isolator.

Pigs were individually housed in sterile isolators from day 0 to 14. The temperature was maintained at approximately 95ºF,and warmed air that passed through a micron filter flowed continuously through the isolators. Florescent lights remained on from 6 a.m. to 10 p.m. daily, and ultra violet lights remained on at all times. The initial feeding at approximately 2 hours post-delivery was 1.18 ounces. The amount of liquid diet fed was increased 0.17 ounces at 6 a.m. and 0.17 ounces more at 2 p.m. each day as long as the pigs appeared healthy and had cleaned up the previous meal. Pigs were fed the warmed diet five times daily at 6 a.m., 10 a.m., 2 p.m., 6 p.m. and 10 p.m. Feed

Table 1. Composition of liquid diets[a]

Composition of liquid diets[b]	
Water	103.45
Fat	11.49
Nutritek - 900 (sweet dairy whey)	7.97
Calcium caseinate (1.3% calcium)	10.62
Citric acid (monohydrate)	0.17
Choline chloride	0.03
Lecithin	0.04
Vitamin premix[c]	0.27
Mineral premix[d]	1.66
Calcium chloride	0.11

[a]Diets formulated to meet approximately 1.3 times NRC requirements for 2.2- to 11-lb pig.
[b]All values expressed as ounces/gallon.
[c]Vitamin premix supplied 0.938 g Vitamin A (500,000 IU/g), 0.094 g Vitamin D_2 (5,000,000 IU/g), 0.028 g thiamine hydrochloride, 0.639 g riboflavin, 4.688 g niacin, 3.012 g calcium pantothenate (92% Pantothenic acid), 0.032 g Vitamin B_6, 4.688 g Vitamin B_{12} (0.1% B_{12} in mannitol), 2.280 g PABA, 7.585 g ascorbic acid, 20.290 g inositol, 0.127 g folic acid (Folacin), 0.021 g biotin, 9.380 g Vitamin E (250 IU/g), 0.426 g Vitamin K and 945.77 g dextrose.
[d]Mineral premix supplied 200 g $NaHCO_3$, 520.20 g KH_2PO_4, 90 g $MgSo_4.7H_2O$, 0.2726 g $MnSo_4.H_2O$, 9.74 g $ZnSO_4.7H_2O$, 0.52 g $CuSo_4.5H_2O$, 8.4 g $FeSO_4$, 0.004 g KI, 170.80 g $CaCl_2$ and 0.016 g $Na_2SeO_4.12H_2O$.

Table 2. Fatty acid composition of fats and oils

	Percent fatty acids[a]							
Fat or oil	10[b]:0[c]	12:0	14:0	16:0	16:1	18:0	18:1	18:2
Butterfat	1.4	3.4	10.3	31.6	7.1	14.0	27.8	4.6
Corn oil		0.8		10.9		2.3	25.6	60.5
Coconut oil	4.2	32.7	26.1	16.3	1.6	3.7	12.3	1.5
Lard		1.3	1.5	21.5	4.0	11.5	46.1	14.1

[a]Fatty acid methyl esters were separated on a diethylene glycol succinate column in a Perkin-Elmer 990 gas-liquid chromatographic column instrument equipped with a hydrogen flame detector operated at 190°C column and 250°C injection port and dector temperature with a nitrogen flow rate of 31 ml/minute.
[b]Number of carbon atoms in fatty acid.
[c]Number of double bonds in fatty acids.

consumption was recorded, and pig weights were taken at 0, 7, 14 and 20 days of age. Pigs were transferred to the nursery room on day 14 where they were randomly allotted to pens and individually housed in elevated, open-topped metal pens until the completion of the trial on day 20. The temperature was maintained at approximately 79°F.

Results and Discussion

Overall survival rate was 84.6 percent, and six pigs per treatment completed the trial with the exception of the lard treatment, which consisted of four pigs. The effect of dietary fat source on the performance of colostrum-deprived neonatal pigs is shown in Table 3. For the entire 20-day trial, feed efficiency (gallons of diet/lb gain) of pigs fed coconut oil was lower than for those fed corn oil ($P<.01$) and lard ($P<.06$). However, there were no significant differences in feed efficiency for 0 to 14 days or 14 to 20 days. Feed efficiency values over the entire treatment period were .46, .52, .42, and .50 gallons/lb for butterfat, corn oil, coconut oil and lard, respectively. Average daily gain (ADG) from 14 to 20 and 0 to 20 days was significantly affected by fat source. There were no significant treatment differences in ADG for 0 to 7 ($P>.96$) or 7 to 14 days ($P>.21$). Pigs fed coconut oil had a higher ADG than pigs fed corn oil ($P<.03$) and lard ($P<.01$) during both time periods. ADG values for the entire treatment period were

Table 3. Effect of fat source on feed efficiency and rate of gain

Variables	Treatment			
Fat source	Butter fat	Corn oil	Coconut oil	Lard
Number of pigs	6	6	6	4
Feed intake (gallons)				
Litter one				
Day 0-20	3.07	3.07	3.07	3.07
Day 0-14	1.72	1.72	1.72	1.72
Day 14-20	1.35	1.35	1.35	1.35
Litter two				
Day 0-20	3.00	3.00	3.00	3.00
Day 0-14	1.73	1.73	1.73	1.73
Day 14-20	1.27	1.27	1.27	1.27
Feed efficiency (gallons/lb)				
Day 0-20	.458 ± .02[ab]	.516 ± .02[a]	.424 ± .02[b]	.500 ± .03[ab]
Day 0-14	.454 ± .02	.501 ± .02	.442 ± .02	.477 ± .03
Day 14-20	.470 ± .06	.572 ± .06	.416 ± .06	.560 ± .07
ADG (lb/day)				
Day 0-20	0.33 ± .02[abc]	0.31 ± .02[ac]	0.35 ± .02[b]	0.31 ± .02[ac]
Day 0-14	0.26 ± .02	0.24 ± .02	0.29 ± .02	0.26 ± .02
Day 14-20	0.46 ± .02[abc]	0.42 ± .02[ac]	0.53 ± .02[b]	0.40 ± .02[ac]
Day 0-7	0.15 ± .02	0.15 ± .02	0.15 ± .02	0.15 ± .02
Day 7-14	0.40 ± .02	0.35 ± .02	0.40 ± .02	0.37 ± .02

[abc]Means in the same row with different superscripts differ significantly ($P<.05$).

.33, .31, .35 and .31 lb/day for butterfat, corn oil, coconut oil and lard respectively.

It has been suggested that differential utilization of dietary fat may be partially due to fatty acid composition. The fats used in this study were chosen to vary both chain length and degree of unsaturation of fatty acids. Generally, pigs fed coconut oil, which contains primarily short-chain, highly saturated fatty acids, performed better than pigs fed the other diets although they were not significantly different than those fed butterfat. Butterfat contains fatty acids which are intermediate in both chain length and degree of unsaturation and was used primarily as a control in this study. Pigs fed corn oil, which contains predominately long-chain, unsaturated fatty acids, tended to perform better than those fed lard, which contains predominately long-chain fatty acids, but is more saturated than corn oil.

Very little research has been conducted to study the utilization of fat by the neonatal pigs. However, data suggests that the neonatal pig can utilize liquid diets high (32 percent on a dry-matter basis) in butterfat and that energy from butterfat appears to be used as efficiently for growth as energy from glucose. The results of this trial indicated that the ability of the neonatal pig to utilize dietary fat may be influenced by the source of fat. The differential performance of pigs may be primarily due to fatty acid composition of the fat. More research is needed before the utilization of dietary fat may be predicted from its fatty acid composition.