Effects of Reducing Metabolizable Energy Concentration in Diets Containing Either Spray-Dried Porcine Plasma or Soy Protein Concentrate on Weanling Pig Performance

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Story in Brief

An experiment was conducted to determine the effects of reducing the metabolizable energy (ME) concentration of diets containing either soy protein concentrate (SPC) or spray-dried porcine plasma (SDPP) on weanling pig performance. A total of 168 pigs (avg BW = 5.8 kg) were weaned at approximately 21 d and allotted to four dietary treatments (7 pens/trt) in a 2 x 2 factorial design with two crude protein (CP) sources (SPC vs SDPP) and two ME levels (3,523 vs 3,323). All diets contained 1.35% digestible Lys and were composed primarily of corn, soybean meal, dried whey, lactose, SPC or SDPP, fish meal, and soybean oil or cornstarch. All pigs were housed (6-7 pigs/pen) in a temperature-controlled nursery for 18 d. Pigs and feeders were weighed on d 0, 7, 14, and 18 to determine ADG, ADFI, and feed:gain (F:G) ratio. Pigs fed SDPP tended to have improved (P<.08) ADG, ADFI, F:G, and gain/ME intake than pigs fed SPC from d 0 to 18. Reducing ME had no effect (P>.10) on growth performance, but it increased (P<.10) gain/ME intake. The improvement in weight gain/ME intake associated with reducing ME of the diet tended to be greater for pigs fed SPC than for pigs fed SDPP (CP source x ME level, P<.10). In addition, for pigs fed SPC, reduced ME decreased F:G ratio (d 0 to 18) and increased weight gain/Lys intake but there was no effect for pigs fed SDPP (CP source x ME level, P<.08). These results suggest that the source of dietary protein may affect energy (fat) utilization but further investigation is needed to elucidate underlying mechanisms.

Key Words: Weanling Pig, Porcine Plasma, Metabolizable Energy

Introduction

In a previous experiment, decreasing the metabolizable energy (ME) level in diets containing SDPP for weanling pigs resulted in linear increase in body weight gain/100 kcal ME intake. To reduce the ME level of the diet, the added fat in the form of soybean oil was replaced with cornstarch. The use of fat in starter diets is controversial and results have not been consistent. Pigs fed a control diet gained more than pigs consuming diets with added fat, and fat in the diet increased the energy required per unit of weight gain (Frobish et al., 1970, 1971; Jones et al., 1992). The major factor seen as a reason for the low fat digestibility is the low lipase activity in the weanling pig. Total lipase activity increased quadratically from birth to 4 wk then dramatically decreased immediately post weaning (Lindemann et al., 1986), probably due to the very low fat content of the weanling pig diet compared to the high fat content of sow milk.

But some authors have reported benefits from the addition of fat to weanling pig diets, although most of these benefits were seen at three to five wk post weaning. Frobish et al. (1970) reported that addition of fat to diets, irrespective of protein source, resulted in significantly improved gains and feed efficiency. These authors further noted that digestibility coefficients for fat were

higher for diets containing casein compared to soybean protein diets, implying that protein source may influence fat utilization.

This study was performed to compare the effects of reduced ME concentration of diets containing either SPC or SDPP on weanling pig performance.

Materials and Methods

The effect of reducing the ME concentration in weanling pig diets supplemented with either SPC or SDPP was investigated using a 2 x 2 factorial design. A total of 168 crossbred pigs (ave BW = 5.8 kg) were weaned at approximately 21 d and allotted to four dietary treatments (7 pens/trt) in a 2 x 2 factorial design with two CP sources (SPC vs SDPP) and two ME levels (3,523 vs 3,323). Weight, sex, and breed were equalized across treatment groups. The composition of the diets is shown in Table 1 and was as follows: 1) diet containing SPC with ME = 3525 kcal/kg, 2) SPC diet with ME = 3325 kcal/kg, 3) SDPP diet with ME = 3525 kcal/kg, and 4) SDPP diet with ME = 3325 kcal/kg. Substitutions were made on an equal lysine basis. To lower the ME concentration, soybean oil was replaced by cornstarch and in part by corn grain. All diets were pelleted and formulated to contain 1.35% digestible lysine, 0.90 % Ca, and 0.75% P. Feed and water were provided on an ad libitum basis using nipple waterers and a common feeder per pen. Pigs and feeders were weighed on d 0, 7, 14, and 18 to determine average daily gain (ADG), average daily feed intake (ADFI) and feed:gain (F:G) ratio.

Table 1. Composition of the diets

Treatment	1	2	3	4
Protein source	SPC	SPC	SDPP	SDPP
ME concentration, kcal/kg	3523	3323	3523	3323
Ingredients				
Corn grain	27.12	27.12	29.73	29.73
Soybean meal (48% CP)	20.00	20.00	20.00	20.00
Whey, spray dried	20.00	20.00	20.00	20.00
Lactose	10.00	10.00	10.00	10.00
Soy protein concentrate	9.47	9.47	0	0
Plasma, spray dried	0	0	6.00	6.00
Fish meal, menhaden	5.55	5.55	5.55	5.55
L-lysine HCl	.05	.05	.05	.05
DL-methionine	.15	.15	.27	.27
L-threonine	.03	.03	.03	.03
Soybean oil	5.00	.47	5.74	1.21
Calcium phosphate (dicalcium)	.51	.51	.33	.33
Limestone, ground	.66	.66	.84	.84
Sodium chloride	.50	.50	.50	.50
Antibiotic	.25	.25	.25	.25
ZnO	.28	.28	.28	.28
Ethoxyquin	.03	.03	.03	.03
OSU Vitamin mix	.25	.25	.25	.25
OSU Trace Min mix	.15	.15	.15	.15
Cornstarch	0	4.53	0	4.53

Composition of the diet				
Crude Protein, %	23.80	23.80	22.65	22.65
Total lysine, %	1.56	1.56	1.58	1.58
Apparent ileal digestible AA, %				
Lysine	1.35	1.35	1.35	1.35
Meth+Cys	.80	.80	.80	.80
Threonine	.85	.85	.85	.85
Total lysine: ME, g/Mcal	4.42	4.96	4.48	5.03

The pigs were housed in an environmentally regulated nursery with pens measuring 1.14 x 1.5 m on a raised woven wire floor. The temperature of the nursery was maintained at 88 to 90°F throughout the experimental period.

Statistical Analysis. Data were analyzed as a 2x2 factorial in a randomized complete block design using procedures described by Steel et al. (1997). Main effects for CP source and ME levels and CP x ME interaction were tested. The pen served as experimental unit.

Results and Discussion

The inclusion of SDPP in the diet increased ADG (P<.02), ADFI (P<.03), and decreased F:G ratio for d 0 to 7 (P<.01) and d 0 to 18 (P<.09) as shown in Table 2. Decreasing ME level did not affect growth performance but increased (P<.01) weight gain/100 kcal ME intake. For pigs fed SPC, reduced ME decreased F:G ratio (d 0 to 18) and increased weight gain/Lys intake but there was no effect for pigs fed SDPP (CP source x ME level, P<.08). In addition, improved weight gain/100 kcal ME intake associated with low ME levels was more pronounced in pigs fed SPC (CP source x ME level, P<.09).

Table 2. Growth performance of weanling pigs[a]

Protein source	SPC	SPC	SDPP	SDPP	SE	SPC vs	ME	Interaction
ME concentration, kcal/kg	3523	3323	3523	3323		SDPP	Level	
Fat inclusion, %	5.0	.47	5.74	1.21				
Initial weight, kg	5.81	5.82	5.81	5.81	.01	.82	.78	.89
Final weight, kg	15.90	15.79	16.53	16.18	.27	.14	.25	.91
Day 0-7								
ADG, g	84.09	80.91	117.27	124.54	9.64	.01	.84	.58
ADFI, g	133.6	124.1	166.4	161.8	8.59	.01	.42	.77
F:G	1.70	1.68	1.49	1.36	.09	.01	.41	.54
Day 7-14								
ADG, g	267.3	283.6	296.8	313.2	11.86	.02	.18	.99
ADFI, g	306.4	296.4	311.8	329.1	9.95	.07	.72	.19
F:G	1.15	1.04	1.05	1.05	.03	.12	.07	.07
Day 0-18								
ADG, g	220.0	233.6	255.5	262.3	9.55	.01	.30	.76
ADFI, g	278.2	280.9	305.0	315.5	9.50	.01	.50	.69
F:G	1.27	1.21	1.20	1.21	.02	.09	.18	.07
Avg daily ME intake, kcal	980.0	932.9	1074.2	1047.7	32.48	.01	.27	.76

Wt gain (g)/100 kcal ME	22.35	24.95	23.68	24.95	.38	.10	.01	.09
Avg daily lysine intake, g	4.17	4.21	4.57	4.73	.14	.01	.50	.69
Wt gain (g)/lysine intake, g	52.54	55.34	55.68	55.32	.86	.09	.17	.08
[a]Least squares means for 7 pens (6 to 7 pigs/pen)/trt.								

Different factors related to the type of fat used in weanling pig diets may affect performance. For example, vegetable oils have shown higher apparent digestibility than animal fat sources (Cera et al., 1988; Jones et al., 1992) due to the higher proportion of unsaturated vs saturated fatty acids (Freeman, 1969). Among the vegetable oils, coconut oil was observed to effect more rapid and efficient gains (Frobish et al., 1970; Lawrence and Maxwell, 1983) due to its lower molecular weight and having mostly medium chain fatty acids compared to the higher molecular weight fat sources like soybean oil which contain about 86% long chain fatty acids of C18 (Jones et al., 1992). However, results have not always been in agreement. Mahan (1991) and Li et al. (1990) reported that neither coconut oil nor soybean oil had any effect on the ADG, feed intake and gain:feed ratio of piglets in the first two weeks postweaning. In other experiments, pigs fed the control diet gained more than pigs given diets with added fat and fat in the diet increased the energy required per unit of weight gain (Frobish et al., 1970, 1971; Jones et al., 1992), similar to the results obtained in the present experiment.

In addition, digestibility coefficients of fat may be influenced by the protein source being used. Frobish et al. (1970) noted that digestibility coefficients for fat were higher for diets containing casein compared to soybean protein diets. Thus, protein source may influence fat utilization and may explain why the improved G:F ratio and weight gain/100 kcal ME associated with reduced ME levels tended to be more pronounced for pigs fed SPC.

Implications

Reducing ME had no effect on growth performance of weanling pigs, but it increased weight gain/ME intake. The improvement in weight gain/ME intake associated with reducing the ME of the diet tended to be greater for pigs fed SPC than for pigs fed SDPP. Also, pigs fed SPC with reduced ME had lower F:G ratio (d 0 to 18) and higher weight gain/Lys intake, but there was no effect for pigs fed SDPP. These results suggest that the source of dietary protein may affect energy (fat) utilization. However, further investigation is needed to clarify the mechanisms by which low ME (low fat) diets improve ME utilization in weanling pigs and how dietary protein affects fat utilization.

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