Effects of Reducing Metabolizable Energy Concentration in Diets Containing Spray-Dried Porcine Plasma on Weanling Pig Performance

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Story in Brief

An experiment was conducted to determine the effects of reducing the ME concentration of diets containing spray-dried porcine plasma (SDPP) on weanling pig performance. A total of 232 pigs (avg BW = 5.8 kg) were weaned at approximately 21 d and housed (6-7 pigs/pen) in a temperature-controlled nursery for 18 d. Pigs were blocked by weight and randomly allotted to four dietary treatments (9 pens/trt). Diet 1 (3,471 kcal ME/kg) was composed primarily of corn, soybean meal, dried whey, lactose, soy protein concentrate (SPC), fish meal, and soybean oil. Diet 2 (3,471 kcal/kg) was similar to Diet 1 with the exception that SDPP replaced SPC. Diets 3 and 4 were similar to Diet 2 except that soybean oil was decreased to provide 3,371 and 3,271 kcal ME/kg, respectively. All diets contained 1.35% digestible Lys. Pigs and feeders were weighed on d 0, 7, 14, and 18 to determine ADG, ADFI, and feed:gain (F:G) ratio. On d 0, 7, and 14, blood was collected from two pigs per pen for determination of blood urea nitrogen, triglycerides, and glucose. Pigs fed SDPP had greater ($P<.01$) ADG, ADFI, and F:G than pigs fed SPC from d 0 to 18. Decreasing the ME in SDPP diets had no effect ($P>.10$) on growth performance, but it increased (linear, $P<.01$) gain/ME intake. Blood urea nitrogen was lower ($P<.03$) in pigs fed SDPP than those fed SPC. On d 7, blood glucose was higher ($P<.03$) while triglyceride levels were lower ($P<.03$) in pigs fed SDPP compared to pigs fed SPC. The results suggest that lowering ME in SDPP diets does not affect growth performance of weanling pigs.

Key Words: Weanling Pig, Porcine Plasma, Metabolizable Energy

Introduction

Spray-dried porcine plasma (SDPP) has become a popular protein source in post-weaning pig diets. Van Dijk et al. (2001a), in a review on the effects of spray dried animal plasma, concluded that dietary spray-dried animal plasma levels up to 6% improved average daily gain (ADG) and average daily feed intake (ADFI) in the first two wk post weaning. In addition, up to 6% SDPP improved feed:gain ratio.

It has been proposed that the immunoglobulin and albumin fractions of SDPP may have a role in enhancing the immune status of the piglet (Owen et al., 1995; Pierce at al., 1995). The inclusion of SDPP in weanling pig diets also has been shown to reduce small intestinal growth (Jiang et al., 2000b). Le Dividich and Sève (2000) noted that metabolizable energy (ME) intake at the end of the first wk post weaning is only 60 to 70% of the pre-weaning milk ME intake. Yet, despite the reduced intake, the relative weight of the small intestine increases by 25% at 3 to 7 d post weaning and by 52% at 10 to 14 d. Reduced intestinal growth in pigs fed SDPP may suggest a lower ME requirement for the intestine, thus increasing ME available for body growth.

This experiment was performed to determine the effects of reducing the ME concentration of diets containing SDPP on weanling pig performance.

Materials and Methods

The effect of reducing the ME concentration in weanling pig diets supplemented with SDPP was investigated using a randomized complete block design. A total of 232 crossbred pigs (avg BW = 5.8 kg) were weaned at approximately 21 d and housed (6-7 pigs/pen) in a temperature-controlled nursery for 18 d. Pigs were blocked by weight and randomly allotted to four dietary treatments (9 pens/trt). The composition of the diets is shown in Table 1 and was as follows: 1) Control diet containing soy protein concentrate (SPC) with ME = 3471 kcal/kg, 2) SDPP replaced SPC, ME = 3471 kcal/kg, 3) SDPP diet with ME level reduced by 100 kcal/kg, and 4) SDPP diet with ME level reduced by 200 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.

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.

Table 1. Composition of the diets

Treatment	1	2	3	4
Protein source	SPC	SDPP	SDPP	SDPP
ME concentration, kcal/kg	3471	3471	3371	3271
Ingredients				
Corn grain	27.44	30.04	30.04	30.04
Soybean meal (48% CP)	20.00	20.00	20.00	20.00
Whey, lactose, fish meal[a]	30.55	30.55	30.55	30.55
Soy protein concentrate	9.45	0	0	0
Plasma, spray dried	0	6.00	6.00	6.00
L-lysine HCl	.05	.05	.05	.05
DL-methionine	.15	.27	.27	.27
L-threonine	.03	.03	.03	.03
Soybean oil	4.26	5.00	2.75	0.50
Dicalcium phosphate	.51	.27	.27	.27
Limestone, ground	.66	.87	.87	.87
Other	1.90	1.92	4.17	4.52
Apparent ileal digestible lysine, %	1.35	1.35	1.35	1.35
Total lysine: ME, g/Mcal	4.49	4.55	4.69	4.83

[a]Consisted of 20% dried whey, 10% lactose and 5.55% fish meal. [b]Consisted of .50% salt, 1.0% antibiotic, .15% vitamin mix, .25% trace mineral mix, with the remainder as corn starch.

Blood was collected from two randomly selected pigs (one male and one female) per pen. Blood samples were taken via the vena cava on d 0, 7 and 18 using vacutainer tubes with anticoagulant. Collected blood was centrifuged and plasma was frozen until blood chemistry determination. Blood urea nitrogen, triglycerides and glucose were determined via colorimetric procedures using a Cobas Mira Clinical Analyzer.

Statistical Analysis. All data were analyzed as a randomized complete block design using procedures described by Steel et al. (1997). The model included the effects of replication (block), treatment, and replication x treatment (error). Orthogonal contrasts were used to compare treatment means for 1) SPC vs SDPP, 2) linear effects within pigs fed SDPP with decreasing ME levels, and 3) quadratic effects within pigs fed SDPP. The pen served as experimental unit.

Results and Discussion

Growth performance. The inclusion of spray-dried plasma protein (SDPP) in the diets, regardless of ME level, improved overall ADG (P<.01) and ADFI (P<.01) from d 0 to18 (Table 2) and decreased (P<.01) F:G ratio on d 0 to 7 and d 0 to 18.

Table 2. Growth performance of weanling pigs

Treatment	1	2	3	4				
Protein source	SPC	SDPP	SDPP	SDPP	SE	SPC vs	Linear	Quad
ME concentration, kcal/kg	3471	3471	3371	3271		SDPP		
Initial weight, kg	5.81	5.82	5.80	5.82	.02	.97	.99	.48
Final weight, kg	15.90	16.37	16.56	16.83	.20	.01	.12	.85
Day 0-7								
ADG, g	57.27	114.54	100.00	97.73	9.27	.01	.22	.60
ADFI, g	107.7	143.2	128.2	130.5	8.18	.01	.28	.39
F:G	1.92	1.28	1.30	1.38	.08	.01	.37	.72
Day 7-14								
ADG, g	212.3	230.5	228.6	240.5	12.27	.16	.56	.65
ADFI, g	244.5	264.1	271.8	276.4	11.41	.06	.45	.92
F:G	1.19	1.16	1.19	1.16	.05	.66	.95	.53
Day 0-18								
ADG, g	174.5	205.5	215.9	216.4	8.68	.01	.39	.66
ADFI, g	232.3	261.8	266.8	265.5	8.86	.01	.78	.77
F:G	1.34	1.28	1.24	1.23	.02	.01	.13	.64
Avg daily ME intake, kcal	806.4	908.7	899.4	867.8	30.20	.02	.35	.77
Wt gain (g)/100 kcal ME intake	21.59	22.55	23.94	24.89	.43	.01	.01	.69
Avg daily lysine intake, g	3.48	3.93	4.00	3.98	.13	.01	.78	.77
Wt gain (g)/lysine intake (g)	50.00	52.22	53.85	54.34	.99	.01	.14	.64

[a]Least squares means for 9 pens (6-7 pigs/pen) per treatment.

The positive effect of the inclusion of SDPP on growth and feed intake of weanling pigs is significant in the first two wk post weaning (Grinstead et al., 2000; Van Dijk et al., 2001a). In this experiment, pigs fed SDPP consistently had higher gain and feed intake from d 0-18 post weaning compared to pigs fed SPC. In addition, the F:G ratios were lower in pigs fed SDPP for d 0-18 compared to pigs fed SPC. De Rodas et al. (1995) and Kats et al. (1994) did not report any improvement in F:G although Van Dijk et al. (2001a) concluded, based on 15 published studies, that up to 6% SDAP improves F:G.

The computed average daily ME (P<.02) and lysine intakes (P<.01) were higher in pigs fed SDPP compared to pigs fed SPC. The weight gain/100 kcal ME and gain/lysine intake were also higher (P<.01) in pigs fed SDPP. There was a linear improvement (P<.01) in gain/100 kcal ME as the level of ME decreased.

The process of weaning is associated with a variety of stressors resulting in growth reduction. The drastic decrease in feed intake immediately post weaning seems to be the major factor causing metabolic and endocrine adjustments (Le Dividich and Sève, 2000) and histological and biochemical changes in the small intestine of the weanling pig (Pluske et al., 1997). Villous atrophy is not prevented by supplementation of SDPP to the diet (Jiang et al., 2000a; Van Dijk et al., 2001b). However, the results of Jiang et al. (2000b) showed that SDPP reduced intestinal mass with lower jejunal and ileal DNA masses and lower intravillous lamina propria cell density, thus speculating that SDPP may suppress intestinal inflammation.

The reduction in feed intake at weaning is variable but regardless of weaning age, the ME intake of piglets during the first wk post weaning is only 60 to 70% of the pre-weaning milk ME intake (Le Dividich and Sève, 2000). Yet, both gastric and intestinal mucosal weights dramatically increase even with the growth check immediately post weaning. Thus, much of the nutrient intake of the newly weaned piglet is probably channeled towards gastrointestinal and other organ growth and less toward lean tissue deposition. Energy is also spent on the mobilization of the immune system especially along the intestinal lining where major changes are taking place. This may imply that a healthy gastrointestinal tract with reduced inflammatory reaction would have a lower ME requirement for maintenance.

The effect of decreasing the ME levels in pigs fed SDPP was therefore not expected. Pigs given diets with lower ME levels generally performed better and the results suggest that pigs fed SDPP utilized the lower ME levels more efficiently as shown by the higher gain/100 kcal ME when ME level was decreased by 100 or 200 kcal.

Blood chemistry. Blood urea nitrogen levels on d 7 were lower in pigs fed SDPP (P<.03), decreasing even further on d 18 (P<.01), compared to the levels in pigs fed SPC (Table 3). On d 7, blood glucose levels were higher (P<.03) while triglyceride levels were lower (P<.03) in pigs fed SDPP compared to pigs fed SPC.

Table 3. Blood chemistry of weanling pigs

Treatment	1	2	3	4				
Protein source	SPC	SDPP	SDPP	SDPP	SE	SPC vs	Linear	Quad
ME concentration, kcal/kg	3471	3471	3371	3271		SDPP		
Blood urea nitrogen, mg/dl								
Day 7	10.91	9.33	9.13	8.22	.08	.03	.32	.61
Day 18	10.43	8.05	8.57	7.69	.47	.00	.56	.33
Glucose, mg/dl								
Day 7	106.6	118.5	113.5	119.1	3.73	.03	.88	.27
Day 18	113.5	122.9	121.5	122.4	5.03	.12	.99	.92
Triglycerides, mg/dl								
Day 7	50.14	43.19	39.55	38.06	3.60	.03	.33	.81
Day 18	41.22	38.72	38.38	35.06	3.56	.36	.48	.74

[a]Least square means for 9 pens (2 pigs/pen) per treatment.

Cera et al. (1990) observed that serum urea concentration was higher on d 7 post weaning compared to subsequent weekly periods and tended to be highest when fat was added to the diets. Blood urea nitrogen was numerically higher on d 7 compared to d 18 and was lower in pigs given SDPP compared to the levels in pigs given SPC. Reduced plasma urea concentration in pigs fed SDPP was reported by Jiang et al. (2000a and b). Spray dried porcine and bovine plasma (vs extruded soy protein) increased efficiency of dietary protein use for lean tissue growth in weanling pigs, expressed as the ratio of weight gain to protein intake, although the mechanism remains to be elucidated whether this change in amino acid metabolism is taking place in the gut or in other tissues such as the liver (Jiang et al., 2000b). Lysine intake was higher for pigs fed SDPP compared to those fed SPC, and SDPP increased efficiency of lysine use by the greater gain per gram of lysine intake.

The addition of fat to diets increased serum triglycerides (Jones et al., 1992). Pigs fed the SDPP diets (with or without added fat) had lower triglycerides compared to pigs fed SPC with fat. It cannot be determined whether the lower triglyceride levels in pigs fed SDPP signify lower digestion and consequent absorption of fat or a better utilization of the fat absorbed.

Implications

Spray dried porcine plasma may suppress intestinal inflammation and lower ME requirement for maintenance in the gut therefore increasing ME available for lean tissue deposition. However, reducing ME concentration in SDPP diets did not affect growth performance of weanling pigs in this experiment, but linearly increased weight gain/ME intake. In the course of reducing the ME level of the diet, the added fat in the form of soybean oil was reduced. Because the newly-weaned pig has a reduced capacity to digest fat due to the low lipase activity in the immediate post-weaning period, this might explain why pigs fed diets with low fat levels had higher weight gain/ME intake. However, the mechanisms contributing to the responses observed need further investigation.

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