EFFECT OF WHEY PROTEIN CONCENTRATE SOURCE ON GROWTH PERFORMANCE OF NURSERY PIGS

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Summary

A total of 228 weanling pigs (initially 14.7 lb and 21 ± 3 d of age, PIC L210 × L42) were used to evaluate the effects of whey protein concentrate (WPC) source on growth performance of weanling pigs. Pigs were fed one of seven experimental diets: a negative control, with no WPC (control); a positive control, with 5% spray-dried animal plasma (SDAP); or the negative control diet with one of five WPC sources (Sources 1 through 5). Pigs were fed the experimental diets from d 0 to 14 after weaning, then all pigs were fed a common Phase 2 diet from d 14 to 28 after weaning. From d 0 to 14, pigs fed diets containing WPC from Source 1 had greater ADG (P<0.05) than did pigs fed the control diet or WPC from Source 3. Pigs fed SDAP also had greater ADG and ADFI (P<0.05) than did pigs fed WPC from Source 3. Pigs fed WPC tended to have poorer ADFI (P<0.09) than that of pigs fed SDAP. All pigs fed WPC diets had improved F/G (P<0.01), however, compared with pigs fed the control. Overall (d 0 to 28), pigs fed WPC from Source 1 had greater ADG (P<0.05) than did pigs fed WPC from Source 3, but there were no treatment differences in ADFI and F/G. In summary, variation in growth performance with pigs fed WPC confirms our previous results in that variation between sources does exist. Furthermore, pigs fed diets containing high-quality WPC, from a reliable and consistent source, can improve ADG and have similar performance to pigs fed spray-dried animal plasma.

(Key Words: Nursery Pig, Spray-dried Animal Plasma, Whey Protein Concentrate.)

Introduction

Research previously reported at the 1998 Kansas State University Swine Day showed that high-protein whey protein concentrate (WPC) can improve growth performance of nursery pigs. However, in the Kansas State University Swine Day 2004 report, no improvements were shown when evaluating WPC. Variation between manufacturers in the production and processing of WPC potentially can alter its quality as an ingredient for nursery pig diets. Therefore, the objectives of this study were to compare the effects of five different sources of high-protein WPC on growth performance of nursery pigs and to further determine if WPC can replace spray-dried animal plasma in nursery diets.

Procedures

A total of 228 weanling pigs (initially 14.7 lb and 21 ± 3 d of age, PIC L210 × L42) were blocked by initial weight and randomly allotted to one of seven dietary treatments in an

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unbalanced complete-block design. There were either five or six pigs per pen (equalized within block), with five replications for each control treatment and six replications for each WPC treatment.

All diets were fed in meal form (Table 2). All pigs were fed Phase 1 treatment diets from weaning to d 14 after weaning. There were seven experimental diets: negative control, with no WPC (control); positive control, with 5% spray-dried animal plasma (SDAP; American Proteins, Ames, IA); or the negative control diet and 5.0% WPC from Land O' Lakes (Source 1, St. Paul, MN); 5.0% WPC from Proliant (Source 2, Ames, IA); 5.0% WPC from CalPro Ingredients (Source 3, Corona, CA); 5.0% WPC from Formost Farms, USA (Source 4, Baraboo, WI); or 5.0% WPC from Agri•Mark (Source 5, Onalaska, WI). Synthetic amino acids were used in various amounts to maintain similar levels of soybean meal and amino acids for all diets except the control. All pigs were then fed the same common diet from d 14 to 28 after weaning. Phase 1 (d 0 to 14 after weaning) diets were formulated to contain 1.50% lysine, 0.85% Ca, and 0.50% available phosphorus. Phase 2 (d 14 to 27 after weaning) diets were formulated to contain 1.45% lysine, 0.82% Ca, and 0.45% available phosphorus.

The trial was conducted in an environmentally controlled nursery facility at the Kansas State University Swine Teaching and Research Center. Each pen contained one self-feeder and one nipple waterer to provide *ad libitum* access to feed and water. Average daily gain, ADFI, and F/G were determined by weighing pigs and feeders on d 7, 14, and 28 after weaning. Data were analyzed as an incomplete block design (5 replications of the two control treatments and 6 replications of the five WPC treatments), with pen as the experimental unit. Analysis of variance was performed by using the MIXED procedure of SAS.

Results and Discussion

From d 0 to 14, pigs fed diets containing WPC from Source 1 had greater ADG ($P<0.05$) than did pigs fed the control diet or diets containing WPC from Source 3. Pigs fed diets containing SDAP also had greater ADG and ADFI ($P<0.05$) than did pigs fed diets containing WPC from Source 3. Pigs fed all diets containing WPC tended to have poorer ADFI ($P<0.09$) than that of pigs fed diets containing SDAP. But all pigs fed diets containing WPC showed improved F/G ($P<0.01$), compared with that of pigs fed the control diet.

From d 14 to 28, pigs fed the control diet and pigs previously fed diets containing WPC from Source 2 had greater ADG than that of pigs fed diets containing WPC from Source 3. Pigs previously fed diets containing WPC from Source 2 had improved F/G, compared with that of pigs previously fed diets containing WPC from Source 3. There were no differences in ADFI.

Overall (d 0 to 28), pigs fed diets containing WPC from Source 1 had greater ADG ($P<0.05$) than did pigs fed diets containing WPC from Source 3; ADG of pigs fed diets containing WPC from all other sources were intermediate. There were no differences in ADFI and F/G.

The analyzed values (Table 1) for WPC and SDAP were very similar to those used in diet formulation. Analyzed amino acid and CP values for WPC from Sources 1, 2, 3, and 5 were slightly greater than those used in diet formulation, whereas analyzed values for WPC from Source 4 were slightly less, but the variation in WPC between analyzed and formulated values would not be large enough to influence growth performance responses.

The variation in growth performance with pigs fed WPC does, however, confirm our previous results, in that variation between sources does exist. Differences in subsequent growth performance may be caused by manufacturer differences in milk product source, spray-drying and processing methods, and/or particle size. The use of WPC in this experiment showed that it can be a replacement for SDAP when a high-quality WPC is used.

Pigs fed diets containing high-quality whey protein concentrate, from a reliable and consistent source, can improve ADG and have similar performance to pigs fed spray-dried animal plasma.

Table 1. Analyzed Nutrient Composition of Ingredients (As-fed Basis)[a]

Item	Whey Protein Concentrate Source					Spray-dried
	1	2	3	4	5	Animal Plasma
DM, %	93.09	92.58	94.67	92.62	94.69	90.85
CP, %	75.87	77.86	78.70	57.59	80.18	77.95
Ash, %	2.37	2.61	2.77	3.63	2.46	8.60
Amino acids, %						
Arginine	1.93	1.91	1.96	1.73	2.03	4.57
Histidine	1.57	1.60	1.60	1.29	1.56	2.61
Isoleucine	5.09	5.13	4.89	3.36	5.15	2.90
Leucine	8.28	8.51	8.47	6.18	8.69	7.51
Lysine	7.22	7.31	7.31	5.02	7.49	6.90
Methionine	1.65	1.62	1.67	1.15	1.64	0.69
Phenylalanine	2.63	2.71	2.75	2.17	2.65	4.38
Threonine	5.25	5.24	5.35	3.67	5.01	4.33
Tryptophan	1.71	1.79	1.76	1.22	1.61	1.38
Valine	4.76	4.76	4.66	3.34	4.82	5.20

[a]Values represent the means of one sample for each ingredient analyzed in duplicate. Values used in diet formulation are provided in parentheses.

Table 2. Diet Composition (As-fed Basis)

	Phase 1[a]							
		Spray-dried	Whey Protein Concentrate Source					
Ingredient, %	Control	Animal Plasma	1	2	3	4	5	Phase 2[b]
Corn	41.45	49.32	49.21	49.25	49.21	49.05	49.20	50.53
Soybean meal (46.5% CP)	40.33	27.52	27.51	27.49	27.51	27.50	27.51	32.39
Spray dried whey	15.00	15.00	15.00	15.00	15.00	15.00	15.00	---
Spray dried animal plasma	---	5.00	---	---	---	---	---	---
Whey protein concentrate	---	---	5.00	5.00	5.00	5.00	5.00	---
Whey permeate	---	---	---	---	---	---	---	8.50
Select menhaden fish meal	---	---	---	---	---	---	---	2.50
Soy oil	---	---	---	---	---	---	---	2.00
Monocalcium P (21% P)	1.50	1.20	1.50	1.50	1.50	1.50	1.50	1.20
Limestone	0.83	1.05	0.85	0.85	0.85	0.85	0.85	0.70
Salt	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.35
Vitamin premix	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Trace mineral premix	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
Zinc oxide	---	---	---	---	---	---	---	0.25
Neo-Terramycin®	---	---	---	---	---	---	---	0.70
L-threonine	---	---	---	---	---	---	---	0.13
Lysine HCl	0.05	0.08	0.06	0.05	0.06	0.16	0.06	0.20
DL-methionine	0.12	0.11	0.16	0.16	0.16	0.18	0.16	0.15
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Calculated Analysis								
Total lysine, %	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.45
ME, kcal/lb	1,483	1,490	1,482	1,482	1,482	1,483	1,482	1,458
CP, %	24.1	22.7	22.7	22.8	22.6	21.9	22.8	21.3
Ca, %	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.82
P, %	0.82	0.77	0.77	0.77	0.77	0.77	0.77	0.75
Available P, %	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.45

[a]Phase 1 fed from d 0 to 14 post-weaning.
[b]Phase 2 fed from d 14 to 28 post-weaning.

Table 3. Growth Performance of Nursery Pigs Fed Whey Protein Concentrate from Different Sources[d]

			Whey Protein Concentrate Source					Probability, P<			
Item	Control	Spray-dried Animal Plasma	1	2	3	4	5	Trt	Control vs. WPC	SDAP vs. WPC	SE
d 0 to 14											
ADG, lb	0.45[bc]	0.53[ab]	0.55[a]	0.50[abc]	0.45[c]	0.52[abc]	0.52[abc]	0.24	0.15	0.49	0.047
ADFI, lb	0.64[ab]	0.67[a]	0.65[ab]	0.62[ab]	0.57[b]	0.63[ab]	0.62[ab]	0.32	0.36	0.09	0.045
F/G	1.42[a]	1.30[ab]	1.19[b]	1.25[b]	1.25[b]	1.21[b]	1.21[b]	0.08	0.01	0.24	0.078
d 14 to 28											
ADG, lb	1.45[a]	1.38[ab]	1.44[ab]	1.46[a]	1.36[b]	1.38[ab]	1.40[ab]	0.22	0.16	0.85	0.052
ADFI, lb	1.97	1.82	1.94	1.92	1.92	1.92	1.88	0.82	0.23	0.42	0.098
F/G	1.36[ab]	1.32[ab]	1.34[ab]	1.31[b]	1.41[a]	1.40[ab]	1.35[ab]	0.42	0.99	0.36	0.057
d 0 to 28											
ADG, lb	0.94[ab]	0.96[ab]	1.00[a]	0.98[ab]	0.91[b]	0.95[ab]	0.96[ab]	0.38	0.92	0.60	0.041
ADFI, lb	1.30	1.25	1.29	1.27	1.25	1.28	1.26	0.94	0.30	0.86	0.065
F/G	1.37	1.31	1.30	1.29	1.37	1.34	1.31	0.40	0.19	0.69	0.049

[abc]Means in the same row with different superscripts differ ($P<0.05$).

[d]A total of 200 weanling pigs, (PIC L210 × L42; 114 barrows and 86 gilts) initially 14.7 lb.