EVALUATION OF WHEAT GLUTEN AND SPRAY-DRIED ANIMAL PLASMA ON GROWTH PERFORMANCE OF NURSERY PIGS

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Summary

A total of 440 weanling pigs (initially 14.3 lb) were used in two studies to evaluate the effects of increasing wheat gluten (WG) and spray-dried animal plasma (SDAP) on growth performance of early weaned pigs. In Exp. 1, the six dietary treatments included a negative control, containing no wheat gluten or animal plasma, the control diet containing either 3, 6, 9, or 12% lightly modified spray-dried wheat gluten, and a positive control diet containing 5% spray-dried animal plasma. The diets containing 9% WG and 5% SDAP had the same amount of soybean meal to make a direct comparison of the two protein sources. From d 0 to 7, 7 to 14, and 0 to 14, increasing wheat gluten had no effect on ADG, ADFI, or feed efficiency. From d 0 to 7, pigs fed 5% SDAP had greater ADG than pigs fed the diet containing 9% WG but similar ADG to pigs fed the negative control. For the common period, d 14 to 28, a quadratic ($P<0.01$) response was observed for feed efficiency with F/G becoming poorer as wheat gluten was added up to 9% then improving as wheat gluten increased up to 12%.

In Exp. 2, the five dietary treatments included a negative control, which contained no SDAP or WG, or the control diet with 4.5% and 9% WG, or 2.5% and 5% SDAP. The wheat gluten source used was different than in Exp. 1 and was enzymatically hydrolyzed. The diets containing 4.5% and 9% wheat gluten contained the same amount of soybean meal as the diets with 2.5% and 5% SDAP, respectively. From d 0 to 7 and 0 to 14, increasing SDAP increased ($P<0.04$) ADG. Increasing WG had no effect. There were no differences found in ADG from d 7 to 14 and no differences found in feed intake from d 0 to 7. No differences ($P<0.05$) were found in feed efficiency. During the common period, d 14 to 35, no differences were found in ADG and ADFI. Pigs previously fed the diets containing 2.5% and 5% SDAP had ($P<0.05$) the best feed efficiency with the pigs previously fed the control having the worst. The pigs fed the diets containing 4.5% WG and 9% WG were intermediate in efficiency. These results suggest that increasing WG in diets fed immediately after weaning produced no improvement in growth performance relative to SDAP.

(Key Words: Wheat Gluten, Spray-Dried Animal Plasma.)

Introduction

Spray-dried animal plasma has been successful in improving the growth performance of nursery pigs. However, blood products are expensive compared to refined protein products of plant origin. Spray-dried wheat gluten is slightly modified to improve textural characteristics. Previous research has

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evaluated inclusion rates of up to 8% spray-dried wheat gluten in diets for weanling pigs, but no research data is available that has evaluated wheat gluten at higher levels. Another processing method of wheat gluten is enzymatic hydrolyzation. Enzymatically hydrolyzed ring-dried wheat gluten is designed specifically for use in feed application. Protein hydrolysis increases the digestibility of wheat gluten and also obtains a soluble wheat protein that may be used in milk replacers. This wheat gluten is dried with a low temperature process to ensure maximal protein digestibility. Therefore, our first objective was to determine the optimal inclusion rate of spray-dried wheat gluten and our second objective is to compare that inclusion rate on the same protein basis with spray-dried animal plasma.

Procedures

In Exp. 1, a total of 240 pigs (initially 13.4 lb and 21 ± 3 d of age) were used in a 28-d growth assay. Five replications consisted of six pigs per pen and two replications consisted of five pigs per pen for a total of seven pens per treatment. Experimental diets were fed to all pigs from d 0 to 14 after weaning. All diets were corn-soybean meal-based and formulated to 1.50% total lysine and at least 1.27% digestible lysine, 1.04% Ca, and 0.56% available phosphorus (Table 1). The six dietary treatments were a negative control diet with no WG or SDAP, the control with 3, 6, 9, and 12% WG, and a positive control containing 5% SDAP. Pigs were fed the same common diet from d 14 to 28 after weaning. All pigs were housed in the Kansas State University Swine Teaching and Research Center's environmentally controlled nursery.

In Exp. 2, a total of 200 pigs (initially 13.3 lb and 21 ± 3 d of age) were used in a 35-d growth assay. There were five pigs per pen and eight pens per treatment. Experimental diets were fed to all pigs from d 0 to 14 after weaning. All diets were corn-soybean meal-based and formulated to 1.27% digestible lysine corresponding to 1.50% total lysine, 0.85% Ca, and 0.43% available phosphorus (Table 2). The five dietary treatments were a negative control containing no WG or SDAP, and diets containing 4.5% and 9% WG, or 2.5% and 5% SDAP. The diets containing 2.5% and 5% SDAP were replaced with 4.5% and 9% wheat gluten, respectively, and L-lysine on an equal lysine basis. Pigs were fed the same Phase II diet from d 14 to 35 after weaning. All pigs were housed in the Kansas State University Segregated Early Weaning Facility. In both experiments 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 measuring feed disappearance every 7 days.

Data were analyzed using the MIXED procedures of SAS as a randomized complete block design with pen as the experimental unit. For Exp. 1, linear and quadratic contrasts determined the effects of increasing wheat gluten. In Exp. 2, linear and quadratic contrasts determined the effects of 9% wheat gluten to 5% SDAP. Least significant differences were used for making pairwise comparisons of the treatment means in each experiment.

Results and Discussion

In Exp. 1, from d 0 to 7, 7 to 14, and d 0 to 14, increasing WG had no affect on ADG, ADFI, or F/G. Pigs fed the diet containing 5% SDAP had greater ADG ($P<0.05$) than the pigs fed the diet containing 9% WG. However, pigs fed 5% SDAP had only numerically greater ADG than pigs fed the control diet. For the common period, d 14 to 28, there were no differences in ADG or ADFI from either protein source fed from d 0 to 14. However, F/G became poorer (quadratic, $P<0.01$) as WG increased to 9% then became better as WG increased to 12%.

In Exp. 2, ADG increased (linear, $P<0.06$) from d 0 to 7 and d 0 to 14 with increasing spray-dried animal plasma. Increasing WG had no affect on growth performance and the mean ADG of pigs fed SDAP ($P<0.10$) was greater than pigs fed WG. From d 14 to 35, pigs previously fed diets containing WG had similar ADG and ADFI to those fed SDAP. However, pigs previously fed increasing SDAP had poorer F/G (linear, $P<0.05$). In conclusion, in diets for early-weaned pigs, increasing wheat gluten had no effect on ADG, ADFI, or F/G. In both studies, from d 0 to 7 after weaning, spray-dried animal plasma improved nursery pig ADG compared to wheat gluten.

Table 1. Diet Composition (Exp. 1)[a]

	Wheat Gluten, %					5%
Ingredient, %	0%	3%	6%	9%	12%	Plasma
Corn	36.07	36.75	37.44	38.13	38.82	42.52
Soybean meal, 46.5%	36.70	32.92	29.13	25.34	21.55	25.34
Spray-dried whey	20.00	20.00	20.00	20.00	20.00	20.00
Wheat gluten	-	3.00	6.00	9.00	12.00	-
Spray-dried animal plasma	-	-	-	-	-	5.00
Lysine	0.15	0.24	0.33	0.41	0.50	0.13
Soy oil	3.00	3.00	3.00	3.00	3.00	3.00
Monocalcium phosphate, 21% P	1.05	1.06	1.08	1.09	1.10	0.75
Limestone	0.85	0.86	0.88	0.89	0.90	1.08
Antimicrobial[b]	1.00	1.00	1.00	1.00	1.00	1.00
Salt	0.30	0.30	0.30	0.30	0.30	0.30
Vitamin premix	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
Zinc oxide	0.35	0.35	0.35	0.35	0.35	0.35
Threonine	0.04	0.04	0.04	0.04	0.04	0.04
DL-Methionine	0.10	0.09	0.07	0.06	0.04	0.10
Total	100.00	100.00	100.00	100.00	100.00	100.00
Calculated analysis						
Digestible lysine, %	1.27	1.28	1.29	1.31	1.32	1.27
Total lysine, %	1.50	1.50	1.50	1.50	1.50	1.50
Isoleucine:lysine, %	67	67	67	68	68	60
Met & Cys:lysine, %	55	56	56	56	56	58
Threonine:lysine, %	64	65	65	65	66	67
Tryptophan:lysine, %	20	19	19	18	18	20
Valine:lysine, %	73	73	74	75	75	74
ME, kcal/lb	1,520	1,520	1,521	1,521	1,522	1,534
Protein, %	22.6	23.3	24.1	24.8	25.6	21.7
Ca, %	0.80	0.80	0.80	0.80	0.80	0.80
P, %	0.72	0.71	0.69	0.68	0.67	0.68
Available P, %	0.43	0.43	0.43	0.43	0.43	0.43
Lysine:calorie ratio, g/mcal	4.48	4.48	4.47	4.47	4.47	4.44

[a]Values calculated on an as-fed basis.
[b]Provided 50g/ton carbadox.

Table 2. Diet Composition (Exp. 2)[a]

	Wheat gluten, %			Spray-dried animal plasma	
Ingredient, %	0	4.5	9.0	2.5	5.0
Corn	35.93	37.23	38.47	39.44	42.94
Soybean meal, 46.5%	36.71	30.74	24.79	30.74	24.79
Spray-dried whey	20.00	20.00	20.00	20.00	20.00
Wheat gluten	-	4.50	9.00	-	-
Spray-dried animal plasma	-	-	-	2.50	5.00
Soy oil	3.00	3.00	3.00	3.00	3.00
Monocalcium phosphate, 21% P	1.04	1.07	1.11	0.89	0.75
Limestone	0.98	1.00	1.03	1.09	1.19
Antimicrobial[b]	1.00	1.00	1.00	1.00	1.00
Salt	0.30	0.30	0.30	0.30	0.30
Vitamin premix	0.25	0.25	0.25	0.25	0.25
Trace mineral premix	0.15	0.15	0.15	0.15	0.15
Zinc oxide	0.35	0.35	0.35	0.35	0.35
Threonine	0.38	0.38	0.06	0.02	-
Lysine HCl	0.15	0.30	0.45	0.15	0.15
DL-Methionine	0.11	0.08	0.05	0.13	0.14
Total	100.00	100.00	100.00	100.00	100.00
Calculated analysis					
Digestible lysine, %	1.27	1.29	1.32	1.27	1.27
Total lysine, %	1.50	1.50	1.50	1.50	1.50
Isoleucine:lysine, %	67	67	67	63	60
Met & Cys:lysine, %	56	59	62	58	59
Threonine:lysine, %	64	64	64	64	64
Tryptophan:lysine, %	20	19	19	20	19
Valine:lysine, %	73	74	74	73	73
Protein, %	22.50	23.50	24.40	22.00	21.50
Calcium, %	0.85	0.85	0.85	0.85	0.85
Phosphorus, %	0.72	0.69	0.67	0.70	0.68
Available phosphorus , %	0.43	0.43	0.43	0.43	0.43
Lysine:calorie ratio, g/mcal	4.48	4.48	4.48	4.46	4.44

[a]Values calculated on an as-fed basis.
[b]Provided 50g/ton carbadox.

Table 3. Effect of Increasing Wheat Gluten on Growth Performance of Nursery Pigs[a]

							Contrasts, Probability (*P*<)				
	Wheat gluten, %						Linear Wheat	Quad Wheat	9% WG vs 5%	0% WG vs 5%	
Item	0	3	6	9	12	5% Plasma	Gluten[d]	Gluten[e]	Plasma[f]	Plasma[g]	SEM
D 0 to 7											
ADG, lb	0.45	0.42	0.44	0.37	0.43	0.51	0.55	0.64	0.04	0.36	0.05
ADFI, lb	0.36	0.32	0.35	0.30	0.34	0.40	0.72	0.57	0.15	0.61	0.05
Feed/gain	0.81	0.75	0.79	0.79	0.82	0.79	0.69	0.42	0.96	0.72	0.05
D 7 to 14											
ADG, lb	0.96	0.98	0.89	0.95	0.93	0.95	0.60	0.76	0.95	0.91	0.05
ADFI, lb	1.07	1.07	1.00	0.98	1.00	1.07	0.15	0.62	0.21	0.99	0.05
Feed/gain	1.12	1.09	1.12	1.03	1.08	1.13	0.27	0.79	0.13	0.96	0.05
D 0 to 14[b]											
ADG, lb	0.70	0.70	0.67	0.66	0.68	0.73	0.43	0.59	0.17	0.58	0.04
ADFI, lb	0.72	0.69	0.67	0.64	0.67	0.73	0.26	0.51	0.10	0.76	0.05
Feed/gain	0.97	0.92	0.95	0.91	0.95	0.96	0.58	0.41	0.26	0.81	0.03
D 14 to 28[c]											
ADG, lb	1.13	1.15	1.05	1.04	1.09	1.09	0.11	0.23	0.36	0.39	0.04
ADFI, lb	1.49	1.55	1.48	1.45	1.49	1.47	0.38	0.37	0.79	0.67	0.05
Feed/gain	1.36	1.44	1.43	1.48	1.38	1.42	0.45	<0.01	0.19	0.15	0.03
D 0 to 28											
ADG, lb	0.92	0.92	0.86	0.85	0.89	0.91	0.10	0.22	0.11	0.82	0.03
ADFI, lb	1.10	1.12	1.08	1.05	1.08	1.10	0.20	0.69	0.21	0.94	0.04
Feed/gain	1.16	1.18	1.19	1.19	1.16	1.19	0.88	0.15	0.89	0.38	0.02

[a]A total of 240 pigs initially 15.3 lb.
[b]D 0 to 14 treatment diets.
[c]D 14 to 28 common Phase II diets.
[d]Linear effect of wheat gluten (0, 3, 6, 9, and 12%).
[e]Quadratic effect of wheat gluten (0, 3, 6, 9, and 12%).
[f]9% wheat gluten vs. 5% plasma.
[g]0% wheat gluten/plasma vs. 5% plasma.

Table 4. Effect of Spray-Dried Animal Plasma and Wheat Gluten on the Growth Performance of Nursery Pigs[a]

						Contrasts, Probability (*P*<)					
	Control	Wheat gluten, %		Animal plasma, %		Wheat gluten		Animal plasma		WG vs	
Item	0	4.5	9.0	2.5	5.0	Linear[d]	Quadratic[e]	Linear[f]	Quadratic[g]	Plasma[h]	SEM
D 0 to 7											
ADG, lb	0.27	0.29	0.27	0.36	0.39	0.97	0.75	0.04	0.53	0.04	0.05
ADFI, lb	0.24	0.26	0.24	0.30	0.34	0.97	0.77	0.17	0.84	0.16	0.06
Feed/gain	0.94	0.93	0.92	0.85	0.87	0.73	0.95	0.19	0.21	0.33	0.03
D 7 to 14											
ADG, lb	0.87	0.87	0.82	0.91	0.92	0.40	0.63	0.37	0.84	0.08	0.05
ADFI, lb	0.95	0.91	0.88	0.97	1.02	0.28	0.93	0.28	0.82	0.03	0.06
Feed/gain	1.09	1.05	1.07	1.08	1.11	0.62	0.39	0.76	0.53	0.43	0.03
D 0 to 14[b]											
ADG, lb	0.57	0.58	0.55	0.63	0.66	0.60	0.61	0.06	0.59	0.02	0.04
ADFI, lb	0.59	0.58	0.56	0.64	0.68	0.51	0.90	0.15	0.99	0.04	0.05
Feed/gain	1.01	0.99	0.99	0.96	0.99	0.52	0.54	0.44	0.16	0.89	0.02
D 14 to 35[c]											
ADG, lb	1.25	1.22	1.23	1.32	1.22	0.61	0.47	0.33	0.38	0.65	0.04
ADFI, lb	1.67	1.65	1.70	1.66	1.68	0.60	0.47	0.90	0.79	0.97	0.05
Feed/gain	1.33	1.36	1.37	1.38	1.38	0.16	0.69	0.05	0.21	0.56	0.02
D 0 to 35											
ADG, lb	0.98	0.96	0.96	0.98	0.99	0.48	0.81	0.68	0.74	0.27	0.03
ADFI, lb	1.24	1.23	1.24	1.25	1.28	0.99	0.65	0.38	0.84	0.69	0.04
Feed/gain	1.20	1.21	1.22	1.22	1.22	0.49	0.93	0.29	0.96	0.71	0.01

[a]A total of 200 pigs initially 13.3 lb.
[b]D 0 to 14 treatment diets.
[c]D 14 to 35 common Phase II diets.
[d]Linear effect of wheat gluten (0, 4.5, and 9%).
[e]Quadratic effect of wheat gluten (0, 4.5, and 9.0%).
[f]Linear effect of plasma (0, 2.5, and 5.0%).
[g]Quadratic effect of plasma (0, 2.5, and 5.0%).
[h]9% wheat gluten vs. 5% plasma.