EVALUATION OF IRRADIATION AND TERMIN-8® ADDITION TO SPRAY-DRIED ANIMAL PLASMA, BASE MIX AND/OR WHOLE DIET ON GROWTH PERFORMANCE OF NURSERY PIGS

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Summary

Two studies were conducted to evaluate the effects of irradiation of spray-dried animal plasma and Termin-8® treatment to spray-dried animal plasma, base mix (specialty protein products, milk products, ground oat groats, soy flour, flow agent, vitamins, and minerals), or whole diet on nursery pig performance. Overall (d 0 to 14) in Exp. 1, pigs fed diets containing irradiated plasma had increased ADG and pigs fed Termin-8® treated plasma had increased ADG and ADFI compared to pigs fed diets with regular plasma or whole diets (containing either regular or irradiated plasma) treated with Termin-8. No differences in F/G were observed among treatments. In Exp. 2, pigs fed diets that contained either animal plasma or base mix treated with Termin-8 in the SEW diet had increased ADG and F/G from d 0 to 13 compared to no Termin-8 treatment, but no differences were observed overall (d 0 to 40). Therefore, the use of irradiated spray-dried animal plasma and Termin-8 treated spray-dried animal plasma and base mix improves growth performance in nursery pigs during the initial period after weaning.

(Key Words: Irradiation, Termin-8®, Nursery Pig.)

Introduction

We have observed improvements in growth performance of nursery pigs fed diets containing irradiated spray-dried animal blood products compared to their regular form. Irradiation of these blood products dramatically decreases the total amount of bacteria contained in the ingredient. Although not confirmed at this time, the reduction in bacteria or a deactivation of an antinutritional factor associated with these ingredients may possibly contribute to the increased growth performance. Termin-8 is an antibacterial feed additive produced by the Anitox Corporation. It contains a mixture of formaldehyde, propionic acid, d-limonene, mono- and di-glycerides of edible oils and may provide a model that can be used and as a means for reducing bacteria in feed ingredients and the entire diet. However, the effects of Termin-8 have not yet been examined in diets for nursery pigs. Therefore, our objective was to determine the effects of irradiation of spray-dried animal plasma as well as Termin-8 treatment to specialty ingredients included in a nursery base mix or the whole diet on nursery pig performance in both university and commercial research facilities.

Procedures

Experiment 1. A total of 325 pigs (BW of 12.7 lb and 17 ± 2 d of age) were blocked by weight and allotted to one of five dietary treatments. There were five pigs/pen and 13 pens/treatment. Pigs were housed in the Kansas State University Segregated Early Weaning Facility. Each pen was 4 × 4 ft and contained one self-feeder and one nipple

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waterer to provide ad libitum access to feed and water. Initial temperature was 90°F for the first 7 d, and was lowered approximately 3°F for the second week of the experiment.

Experimental diets (Table 1) were fed in meal form and formulated to contain 1.50% lysine, 0.90 Ca, and 0.80 P. Treatment diets included the following: 1) Control diet with regular spray-dried plasma; 2) Control diet with irradiated plasma; 3) Control diet with Termin-8 treated plasma; 4) Control diet with Termin-8 treatment to the whole diet; 5) Treatment 2 with Termin-8 treatment to the whole diet. Termin-8 application was provided at the FDA approved level of 6 lb/ton of total product (plasma or complete diet) and was performed by the Anitox Corporation, Lawrenceville, GA. Irradiation dosage used for the irradiated animal plasma treatments was 9.75 kGy. All individual ingredients used in the diets originated from similar lots, thus no influence of product variation should be present among treatments. Diets were formulated to meet or exceed the recommendations for all vitamins, minerals and amino acid ratios relative to lysine as set forth by the NRC (1998). Average daily gain, ADFI, and F/G were determined by weighing pigs and measuring feed disappearance on d 7 and 14. In addition, spray-dried animal plasma and diet samples were collected for bacterial analysis.

Data were analyzed through the MIXED procedures of SAS as a randomized complete block design with pen as the experimental unit. The Least Square Difference (LSD) test was utilized to determine differences among treatments ($P<0.05$), as well as to compare experimental diets vs. the control diet.

Experiment 2. A total of 1,698 pigs (BW of 11.03 lb and 17 ± 2 d of age) were used in a 40 d growth assay to determine the effect of Termin-8 treatment to either the spray-dried animal plasma or base mix portion of the SEW diet on pig performance in a commercial facility. Pigs were placed into pens by body size and allotted to one of three dietary treatments. There were 12 to 19 pigs/pen (uniform within block) and 36 pens/treatment. The trial was conducted at a commercial nursery facility at Holdenville, OK.

Diets for the entire experiment were provided in four stages. The diets (Table 2) were formulated to contain 1.67, 1.47, 1.35, and 1.24 % total lysine. Each pig was budgeted 5 and 2.5 lb of feed, respectively, for the SEW (d 0 to 10) and transition (d 10 to 13) diets, with phase II (d 13 to 28) and phase III (d 28 to 40) diets fed for the remainder of the experimental period. However, only the SEW (first phase) diet was involved in the treatment period, with all other phases (transition, phase II, and phase III) fed to determine subsequent performance. Treatment diets were formulated to identical nutrient compositions and included the following: 1) Control diet with no ingredients treated with Termin-8; 2) Control diet with Termin-8 treated spray-dried animal plasma; 3) Control diet with Termin-8 treated base mix (specialty protein products, milk products, ground oat groats, soy flour, flow agent, vitamins, and minerals). Termin-8 application was provided at the FDA approved level of 6 lb/ton of total product (plasma, base mix, or complete diet) and was performed by the Anitox Corporation, Lawrenceville, GA. Average daily gain, ADFI, and F/G were determined by weighing individual pens of pigs and calculating feed disbursement for each pen on d 8, 13, 28, and 40.

Data were analyzed through the MIXED procedures of SAS as a randomized complete block design with pen as the experimental unit. The Least Square Difference (LSD) test was utilized to determine differences among treatments ($P<0.05$). In addition, initial pig weight was used as a covariate for all analyses of growth performance and ending weights. This was used because differences in the beginning weight of pigs among treatments were detected ($P<0.05$).

Results and Discussion

Experiment 1. From d 0 to 7 (Tables 3 and 4), pigs fed diets containing irradiated plasma had increased ADG ($P<0.05$) compared to pigs fed the control diet and whole

diets (containing either regular or irradiated plasma) treated with Termin-8, while ADFI ($P<0.05$) was improved over the latter two. In contrast, pigs fed Termin-8 treated plasma had increased ADFI ($P<0.05$) compared to the pigs fed the control and whole diets (containing either regular or irradiated plasma) treated with Termin-8, while ADG ($P<0.05$) was improved over the latter two. In addition, pigs fed the control diet tended to have increased ADFI ($P<0.09$) compared to the whole diets containing Termin-8 treatment. No differences in F/G were observed among treatments.

From d 7 to 14, pigs fed diets containing Termin-8 treated plasma had greater ADG and ADFI ($P<0.05$) then pigs fed whole diets (containing either regular or irradiated plasma) treated with Termin-8®. In addition, pigs fed diets containing Termin-8® treated plasma tended to have greater ADG ($P<0.10$) and ADFI ($P<0.13$) compared to pigs fed the control diet. Pigs fed the control diet had an improved F/G ($P<0.05$) compared to pigs fed the whole diet treated with Termin-8 that contained regular plasma.

Overall (d 0 to 14), pigs fed diets containing irradiated plasma had greater ADG ($P<0.05$) while pigs fed diets containing Termin-8 treated plasma had improved ADG and ADFI ($P<0.05$) compared to pigs fed the control and whole diets treated with Termin-8. Also, pigs fed the control diet tended ($P<0.06$) to have greater ADFI then pigs fed the whole diet treated with Termin-8 that contained regular plasma. No differences in feed efficiency were observed between dietary treatments. Furthermore, Termin-8 treatment to the whole diet did not influence growth in this study, but numerical depressions in ADFI were evident.

Irradiation of spray-dried animal plasma eliminated all detectable bacteria (Table 3), while the use of Termin-8 reduced the bacterial concentration by approximately one-half compared to non-treated spray dried animal plasma. In addition, use of Termin-8 lowered the bacterial concentrations of the total diet compared to those not treated with Termin-8.

Experiment 2. From d 0 to 8 (Table 5), pigs fed diets containing Termin-8 treated plasma or base mix had improved ADG, F/G, and d 8 weight ($P<0.01$) compared to pigs fed the control diet. In addition, pigs fed Termin-8® treated plasma gained faster and were heavier ($P<0.01$) and tended to have improved F/G ($P<0.10$) compared to those fed diets that had Termin-8 treated base mix. No differences in ADFI were observed among dietary treatments.

Pigs were budgeted 5 lb of SEW treatment diets, then switched to a common transition diet (budgeted at 2.5 lb/pig) until d 13. Because no differences in ADFI were observed among treatments, all pigs were switched to the Transition diet on d 10. No differences in ADG, ADFI, and F/G were detected between d 8 to 13. However, pigs fed diets with Termin-8 treatment to either the plasma or base mix portion of the diet were heavier ($P<0.01$) at the end of d 13 than the control pigs.

For d 13 to 28 (phase II common diet), pigs fed the control diet had improved ADG compared to pigs fed Termin-8 treated plasma ($P<0.05$) and base mix ($P<0.10$), but no differences in ADFI or F/G were observed. The reason why pigs previously fed the control diet had increased growth performance after the treatment period is currently unknown. Additionally, there were no differences in growth performance from d 28 to 40 (phase III common diet) as well as for the overall experiment (d 0 to 40). Furthermore, no differences in final body weight between treatments was observed; however, pigs fed Termin-8 treated plasma or base mix maintained the majority of the weight advantage that occurred during the treatment period.

In conclusion, as previous research has shown, the use of irradiated spray-dried animal plasma compared to its regular form improves growth performance in nursery pigs. In Exp. 1, pigs fed irradiated or Termin-8 treated spray-dried animal plasma had similar improvements in growth performance. However, Termin-8 treatment to the whole diet did not improve nursery pig performance and actually diminished the improvement seen when pigs were fed irradi-

ated plasma. In the commercial facilities used in Exp. 2, Termin-8 application to the animal plasma or base mix stimulated growth immediately postweaning; however, the initial difference in growth performance diminished when pigs were placed on common diets for the remainder of the nursery phase. Additional studies to determine the appropriate amount of Termin-8 application to spray-dried animal plasma or whole diet need to be conducted to establish an amount that will achieve maximum growth performance in pigs. Research is also needed on how to maintain the initial advantage in growth performance over the entire nursery phase. Finally, the mode of action by which either irradiation or Termin-8 application to spray-dried animal plasma or base mix improves growth performance needs to be determined.

Table 1. Composition of Treatment Diets for Exp. 1[a]

Ingredient, %	Control	Irradiated Plasma	Termin-8 Plasma[b]	Termin-8 Whole Diet[b]	Termin-8 Whole Diet[b] with Irradiated Plasma
Corn	49.06	49.06	49.06	49.06	49.06
Soybean meal (46.5%)	25.74	25.74	25.74	25.74	25.74
Spray-dried whey	15.00	15.00	15.00	15.00	15.00
Spray-dried animal plasma	5.00	5.00	5.02	5.00	5.00
Termin-8	--	--	--	0.30	0.30
Corn starch	0.30	0.30	0.28	--	--
Medicationc[c]	1.00	1.00	1.00	1.00	1.00
Monocalcium phosphate (21% P)	1.38	1.38	1.38	1.38	1.38
Limestone	1.15	1.15	1.15	1.15	1.15
Salt	0.30	0.30	0.30	0.30	0.30
Zinc oxide	0.39	0.39	0.39	0.39	0.39
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
L-lysine HCl	0.15	0.15	0.15	0.15	0.15
Dl-methionine	0.13	0.13	0.13	0.13	0.13
Total	100.00	100.00	100.00	100.00	100.00
Calculated Analysis					
Lysine, %	1.50	1.50	1.50	1.50	1.50
Met:lys ratio, %	30	30	30	30	30
Met & Cys:lys ratio,%	60	60	60	60	60
Threonine:lys ratio, %	64	64	64	64	64
Tryptophan:lys ratio, %	19	19	19	19	19
ME, kcal/lb	1463	1463	1463	1468	1468
Calcium, %	0.90	0.90	0.90	0.90	0.90
Phosphorus, %	0.80	0.80	0.80	0.80	0.80
Available phosphorus, %	0.46	0.46	0.46	0.46	0.46
Sodium, %	0.43	0.43	0.43	0.43	0.43
Chloride, %	0.53	0.53	0.53	0.53	0.53

[a]Experimental diets fed from d 0 to 14.
[b]Termin-8 inclusion rate of 6 lb/ton.
[c]Provided 50 g/ton carbodox.

Table 2. Composition of Diets for Exp. 2

Ingredient, %	SEW[a]	Transition[b]	Phase II[c]	Phase III[d]
Corn	30.62	30.75	44.04	51.42
Soybean meal (46.5%)	15.00	22.49	29.65	36.39
SEW premix[f]	47.00	--	--	--
Transition premix[g]	--	38.48	--	--
Phase II premix[h]	--	--	17.00	--
Bakery meal by-product	--	--	2.50	5.00
Poultry fat	5.00	--	--	--
Animal & vegetable fat	--	4.95	4.35	4.65
Medication[e]	0.20	1.00	0.50	0.12
Monocalcium phosphate (21% P)	1.10	1.70	1.60	1.70
Limestone	0.45	0.05	--	0.30
Salt	0.20	0.22	0.10	0.13
Copper sulfate	--	--	--	0.07
Vitamin premix	--	--	--	0.10
Trace mineral premix	--	--	--	0.10
L-Lysine	0.21	0.19	0.16	--
MHA-Alimet	0.22	0.17	0.10	0.01
L-Threonine	--	--	--	0.01
Total	100.00	100.00	100.00	100.00
Calculated Analysis				
Lysine, %	1.67	1.47	1.35	1.24
Met:lys, ratio, %	0.29	0.31	0.30	0.29
Met & Cys:lys ratio,%	0.59	0.57	0.57	0.60
Threonine:lys ratio, %	0.62	0.68	0.60	0.68
Tryptophan:lys ratio, %	0.18	0.21	0.19	0.22
ME, kcal/lb	1532	1525	1579	1580
Calcium, %	0.90	0.83	0.71	0.78
Phosphorus %	0.74	0.75	0.70	0.61
Available phosphorus, %	0.60	0.65	0.38	0.42
Sodium, %	0.63	0.58	0.26	0.19
Chloride, %	0.61	.59	0.15	0.16

[a]Experimental diet fed from d 0 to 10.
[b]Common diet feed from d 10 to 13.
[c]Common diet fed from d 13 to 28.
[d]Common diet fed from d 28 to 40.
[e]Provided 360 g/ton of tilmicosin for the SEW, transition, and phase II, while tylosin provided 100 g/ton in phase III.
[f]Included animal plasma, red blood cells, dried whey, lactose, ground oat groats, soy flour, flow agent, red iron oxide, zinc oxide, and trace mineral and vitamin premixes.
[g]Included animal plasma, red blood cells, dried whey, ground oat groats, flow agent, zinc oxide, and trace mineral and vitamin premixes.
[h]Included red blood cells, dried whey, zinc oxide, black iron oxide, and trace mineral and vitamin premixes.

Table 3. Effects of Irradiation or Termin-8 Treatment of Plasma and/or Whole Diet on Weanling Pig Growth Performance[a]

Item	Control	Irradiated plasma	Termin-8 Plasma[b]	Termin-8 Whole Diet[b]	Termin-8 Whole Diet[b] with Irradiated Plasma	SEM
d 0 to 7						
ADG, lb	0.34[ce]	0.43[d]	0.41[cd]	0.29[e]	0.31[e]	0.030
ADFI, lb	0.39[ce]	0.43[cd]	0.47[d]	0.33[e]	0.33[e]	0.026
F/G	1.14	1.03	1.17	1.06	1.11	0.089
d 7 to 14						
ADG, lb	0.70[cd]	0.75[cd]	0.77[c]	0.67[d]	0.69[d]	0.036
ADFI, lb	0.85[cde]	0.89[cd]	0.93[c]	0.77[e]	0.80[de]	0.039
F/G	1.24[c]	1.19[cd]	1.22[cd]	1.14[d]	1.18[cd]	0.041
d 0 to 14						
ADG, lb	0.52[e]	0.59[d]	0.59[d]	0.48[e]	0.50[e]	0.027
ADFI, lb	0.62[de]	0.66[cd]	0.70[c]	0.55[e]	0.56[e]	0.029
F/G	1.20	1.12	1.20	1.14	1.14	0.068
Aerobic Plate Count						
Plasma, CFU/g	1.8×10^5	0	9.1×10^4	1.8×10^5	0	
Whole diet, CFU/g	4.8×10^4	5.0×10^4	6.3×10^4	6.5×10^3	1.1×10^4	

[a]A total of 325 pigs (five pigs per pen and 13 pens per treatment) with an average initial BW of 12.7 lb.
[b]Termin-8 inclusion rate of 6 lb/ton of plasma or whole diet.
[cde]Means in same row with different superscripts differ (P<0.05).

Table 4. Probability of Irradiation or Termin-8 Treatment of Plasma and/or Whole Diet on Weanling Pig Growth Performance[a]

	Treatment Diet vs. Control				
Item	Irradiated Plasma	Termin-8 Plasma[b]	Termin-8 Whole Diet[b]	Termin-8 Whole Diet[b] with Irradiated Plasma	SEM
d 0 to 7					
ADG, lb	0.03	0.11	0.20	0.39	0.030
ADFI, lb	0.20	0.02	0.09	0.09	0.026
F/G	0.36	0.81	0.51	0.85	0.089
d 7 to 14					
ADG, lb	0.19	0.10	0.58	0.86	0.036
ADFI, lb	0.50	0.13	0.08	0.30	0.039
F/G	0.29	0.67	0.05	0.21	0.041
d 0 to 14					
ADG, lb	0.04	0.05	0.28	0.54	0.027
ADFI, lb	0.30	0.04	0.06	0.14	0.029
F/G	0.39	0.97	0.52	0.54	0.068

[a]A total of 325 pigs (five pigs per pen and 13 pens per treatment) with an average initial BW of 12.7 lb.
[b]Termin-8 inclusion rate of 6 lb/ton of plasma or whole diet.

Table 5. Effects of Termin-8 on Growth Performance in Weanling Pigs[a,b]

Item	Control	Termin-8 Application		SEM[c]
		Plasma	Base Mix	
Initial wt[dg]	10.80	11.17	11.13	0.13
d 0 to 8				
ADG, lb[fhi]	0.38	0.49	0.45	0.01
ADFI, lb	0.39	0.40	0.41	0.01
F/G[fhj]	1.05	0.84	0.92	0.03
d 8 wt[fhi]	14.05	15.00	14.66	0.08
d 8 to 13				
ADG, lb	0.66	0.65	0.69	0.03
ADFI, lb	0.86	0.87	0.87	0.03
F/G	1.35	1.39	1.30	0.08
d 0 to 13				
ADG, lb[fg]	0.48	0.55	0.54	0.01
ADFI, lb	0.57	0.58	0.58	0.02
F/G[eg]	1.19	1.05	1.07	0.05
d 13 wt, lb[fh]	17.33	18.35	18.13	0.14
d 13 to 28				
ADG, lb[dg]	0.77	0.73	0.73	0.02
ADFI, lb	1.27	1.26	1.24	0.02
F/G	1.68	1.77	1.72	0.05
d 28 to 40				
ADG, lb	1.09	1.10	1.13	0.02
ADFI, lb	2.04	2.01	2.06	0.04
F/G	1.88	1.85	1.84	0.04
d 13 to 40				
ADG, lb	0.92	0.90	0.92	0.01
ADFI, lb	1.62	1.60	1.61	0.02
F/G	1.76	1.79	1.77	0.03
d 0 to 40				
ADG	0.77	0.78	0.79	0.01
ADFI	1.25	1.26	1.27	0.02
F/G	1.63	1.61	1.62	0.02
d 40 wt, lb	41.56	42.16	42.23	0.30

[a]A total of 1698 pigs with 12 to 19 pigs/ pen (uniform within block) and 36 pens/treatment with an avg initial BW of 11.03 lb.

[b]Pigs were budgeted 5 lb of SEW diet, which contained either no Termin-8, only plasma treated with Termin-8, or the entire base mix (specialty protein products, milk products, vitamins, and minerals) treated with Termin-8. Pigs were then fed a common transition, phase II (d 13 to 28), and phase III (d 28 to 40) diets for the remainder of the experimental period.

[c]Initial wt used as a covariate for growth performance and ending wt.

[d]Control vs. base mix with Termin-8 treatment ($P<0.10$).

[e]Control vs. base mix with Termin-8 treatment ($P<0.05$).

[f]Control vs. base mix with Termin-8 treatment ($P<0.01$).

[g]Control vs. plasma with Termin-8 treatment ($P<0.05$).

[h]Control vs. plasma with Termin-8 treatment ($P<0.01$).

[i]Base mix vs. plasma Termin-8 treatment ($P<0.01$).

[j]Base mix vs. plasma Termin-8 treatment ($P<0.10$).