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Comparison of irradiated feed and food grade spray-dried animal plasma on nursery pig performance (2001)

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COMPARISON OF IRRADIATED FEED AND FOOD GRADE SPRAY-DRIED ANIMAL PLASMA ON NURSERY PIG PERFORMANCE

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Summary

Two experiments were conducted to determine the effects of initial bacterial concentrations in animal plasma on growth performance of weanling pigs. In Exp. 1 during the experimental period (d 0 to 14), pigs fed plasma had increased ADG and ADFI compared to pigs fed the control diet. Pigs fed the irradiated AP 920, as well as source 1 and source 2 regular (nonirradiated) food grade plasma had increased ADG compared to the control diet. Furthermore, pigs fed irradiated AP 920, regular AP 820, regular and irradiated source 1 food grade and regular source 2 food grade animal plasma had improved ADFI compared to pigs fed the control diet. No differences in F/G were observed between treatments. No differences were detected between pigs fed diets that contained irradiated plasma compared to those fed it in the regular form. For the overall experiment (d 0 to 24), pigs fed irradiated AP 920 had a tendency for improved F/G compared to pigs fed the control diet. In Exp. 2 during the experimental period (d 0 to 14), pigs fed diets containing plasma had improved ADG and F/G compared to pigs fed the control diet. Pigs fed irradiated AP 820 food grade plasma had higher ADG compared to pigs fed regular AP 820. For the overall experiment (d 0 to 24), pigs fed diets containing irradiated AP 820 had increased ADG, final body weight, and ADFI compared to pigs fed regular AP 820. Since irradiation of food grade plasma (low initial bacteria) did not improve growth performance while irradiation of feed grade plasma (initially high bacteria) improved performance, the initial bacteria level of animal plasma appears to influence growth performance of nursery pigs.

(Key Words: Nursery Pigs, Animal Plasma, Irradiation.)

Introduction

We have recently shown that nursery pig performance can be improved when irradiated feed grade animal plasma is fed compared to animal plasma that has not been irradiated. The mode of action of this increase in performance is unclear, but one theory is the response is due to a reduction in the bacterial concentration resulting from irradiation. Animal blood used for food grade plasma is collected in a more controlled procedure than blood collected for feed grade plasma. Thus, food grade plasma has a lower initial total bacterial concentration. In addition, bacterial concentrations increase as storage time increases from the collection of the blood from the animal until the time the blood is spray-dried. Thus, the use of food grade plasma subjected to different storage times and irradiation may serve as a model to determine whether the improvement in pig performance is due to the reduction in bacterial concentration or another factor.

Materials and Methods

Experiment 1. A total of 360 weanling pigs (BW of 13.8 lb and 17 ± 2 d of age) were used in a 24-d growth assay. Pigs were blocked by weight and allotted to one of nine

[1]Food Animal Health and Management Center.

dietary treatments. There were five pigs/pen and six 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 waterer to provide ad libitum access to feed and water. Initial temperature was 90°F for the first 5 d, and was lowered approximately 3°F each week thereafter.

Experimental diets (Table 1) were fed in pelleted form and included a control diet or the control diet with 5% spray-dried animal plasma from one of four different sources from American Protein Corporation, Ames, IA (AP 920, AP 820, food grade low bacteria, food grade high bacteria). All animal plasma sources were either fed irradiated or as-is, and originated from the same lot for each source. In addition, diets containing AP 820 and food grade plasma had slightly lower amino acid contents compared diets with AP 920, because they had a lower CP (72 vs. 79%) level. Irradiated animal plasma was processed with an average dose of 8.5 kGy via electrical pasteurization. All pigs were switched to a common diet that was in meal form on d 14 for the remainder of the trial. Plasma samples were collected prior to feed manufacturing and analyzed for levels of crude protein, IgG, endotoxin, bacteria, coliforms, and *E. coli*. Average daily gain, ADFI, and F/G were determined by weighing pigs and measuring feed disappearance on d 7, 14, and 24 postweaning.

Experiment 2. A total of 175 pigs (13.4 lb and 17 ± d) were used in a 24-d growth assay. The experimental design, housing and care of pigs, and response criteria were similar to that used in Exp. 1, except there were seven pens/treatment. Also, this study included only five of the nine experimental diets from Exp. 1, which included the control diet, and the control diet containing AP 820 (irradiated and as-is) or food grade animal plasma (irradiated and as-is). The animal plasma sources used in this study originated from different lots than that of Exp. 1. Irradiated animal plasma was processed with an average dose of 8.0 kGy via electrical pasteurization.

The MIXED procedures of SAS were used for all statistical analyses, with pen as the experimental unit. Contrasts were used to determine the following: 1) Control versus all plasma added treatments; 2) Control versus regular plasma (nonirradiated); and 3) Irradiated versus regular plasma (non-irradiated).

Results

Experiment 1. Analysis of the animal plasma sources demonstrated that electrical pasteurization decreased bacterial concentrations for all sources used in this study (Table 2). In addition, AP 920 and AP 820 had substantially higher bacterial levels than the two food grade sources, which was anticipated. Bacterial concentrations of the two food grade sources were very low regardless of source with little to no differences between the two sources. In fact, the plasma source initially believed to be the higher bacterial concentration was actually slightly lower in bacterial level than the selected low bacteria plasma lot. Since no major differences existed in the bacterial concentrations of the food grade plasma, they will be referred to as source 1 and source 2. Also, total coliforms and *E. coli* concentrations were below detectable levels except for the low bacteria food grade plasma in Exp. 1. Furthermore, irradiation did not influence the crude protein, IgG, or endotoxin concentration of plasma, when comparing the regular and irradiated individual plasma sources.

For d 0 to 7, pigs fed any of the diets containing animal plasma, regardless of source, had improved ADG, ADFI, and F/G ($P<0.05$) compared to pigs fed the control diet (Table 3). Pigs fed both regular and irradiated AP 820 tended ($P<0.10$) to have improved F/G compared to those fed the control diet. No differences in growth performance were detected between pigs fed diets that contained irradiated plasma and those fed it in the regular form.

For d 7 to 14, no differences were detected among experimental treatments except that pigs fed source 2 food grade plasma tended to have improved F/G compared to pigs fed the control diet. During the overall treatment period (d 0 to 14), pigs fed plasma had increased ADG and ADFI (P<0.05) compared to pigs fed the control diet. Pigs fed irradiated AP 920, as well as source 1 and source 2 regular food grade plasma had increased ADG (P<0.05) compared to the control diet. Pigs fed irradiated AP 920, regular AP 820, regular and irradiated source 1 food grade and regular source 2 food grade had improved ADFI (P<0.05) compared to pigs fed the control diet. No differences in F/G were observed among treatments. No differences were detected between pigs fed diets that contained irradiated plasma and those fed it in the regular form.

From d 14 to 24 (common period), pigs fed irradiated AP 920 had a tendency for decreased ADFI (P<0.10) compared to pigs fed the control diet. For the overall experiment (d 0 to 24), pigs fed irradiated AP 920 had a tendency (P<0.10) for improved F/G compared to pigs fed the control diet. No other differences in growth performance were detected among treatment diets.

Experiment 2. Chemical analyses of the plasma used in this experiment closely matched results of Exp. 1 (Table 4).

For d 0 to 7, pigs fed diets containing animal plasma had improved ADG, ADFI, and F/G (P<0.05) compared to pigs fed the control diet (Table 5). Also, pigs fed irradiated AP 820 had a tendency for increased ADG and ADFI (P<0.10) compared to pigs fed regular AP 820.

From d 7 to 14, no significant effects were detected when comparing diets containing plasma versus the control diet. However, pigs fed irradiated AP 820 had greater ADG (P<0.05) and tended to have increased ADFI (P < .10) compared to pigs fed regular AP 820. Overall (d 0 to 14), pigs fed plasma had improved ADG and F/G (P<0.05) compared to pigs fed the control diet. Also, pigs fed either irradiated AP 820, regular food grade or irradiated food grade plasma had increased ADG (P<0.05) compared to the control diet. Pigs fed irradiated AP 820 food grade plasma had higher ADG (P<0.05) compared to pigs fed regular AP 820.

For d 14 to 24 (common period), ADFI was greater (P<0.05) for pigs previously fed irradiated AP 820 and tended (P<0.10) to be higher for pigs fed the control diet compared to pigs fed diets containing regular AP 820. Overall (d 0 to 24), no benefit in growth performance (P>0.10) was detected for pigs fed diets containing plasma when comparing the pooled average of treatments containing plasma versus the control diet. However, pigs fed diets containing irradiated AP 820 had increased ADG, final body weight, and ADFI (P<0.05) compared to pigs fed regular AP 820. In addition pigs fed irradiated AP 820 tended (P<0.10) to have increased ADG and final body weight compared to pigs fed the control diet.

Results from these experiments indicate that initial bacterial levels in animal plasma may affect the growth response in pigs fed irradiated plasma. This is supported by the fact that no improvements in growth performance were detected from the irradiation of food grade plasma, which has a low amount of initial bacteria. Although no irradiation effects were detected in Exp. 1, pigs fed irradiated AP 920 had increased ADG compared to the control pigs, whereas pigs fed regular AP 920 did not. The effects of irradiation of AP 820 on growth performance differed between the two experiments, a significant response for improved growth was observed in the second experiment. In all experiments to date, only irradiation of feed grade animal plasma, which has a high initial bacteria level, has resulted in improved growth performance when it is fed in the irradiated form compared to the regular form (nonirradiated).

Irradiation does not effect the analyzed chemical composition of animal plasma at the dosage used in this study. Other unknown anti-nutritional factors associated with feed grade plasma may be preventing maximum performance in nursery pigs that irradiation may reduce or eliminate. However, the results of this experiment support the hypothesis that a reduction in bacteria level is he reason that irradiation of animal plasma improves growth performance.

Table 1. Composition of Experimental and Common Diet (Exp. 1 and 2)

	Treatment Diets[a]			
Ingredient, %	No Plasma[c]	AP 920[d]	Other Plasma Sources	Common[b]
Corn	36.47	43.91	43.91	46.97
Soybean meal (46.5%)	38.14	26.18	26.18	31.11
Spray-dried whey	15.00	15.00	15.00	10.00
Spray-dried animal plasma	-	5.00	5.00	-
Spray-dried blood cells	-	-	-	2.50
Soy oil	5.00	5.00	5.00	5.00
Medication[f]	1.00	1.00	1.00	1.00
Monocalcium phosphate (21% P)	1.55	1.44	1.44	1.29
Limestone	0.99	1.13	1.13	1.00
Salt	0.42	0.30	0.30	0.35
Sodium bicarbonate	0.38	-	-	-
Zinc oxide	0.39	0.39	0.39	0.25
Vitamin premix	0.25	0.25	0.25	0.25
Trace mineral premix	0.15	0.15	0.15	0.15
L-lysine HCl	0.15	0.15	0.15	0.05
DL-methionine	0.09	0.11	0.11	0.09
L-threonine	0.01	-	-	-
Total	100.00	100.00	100.00	100.00
Calculated Analysis				
Lysine, %	1.50	1.50	1.46	1.40
Met:lysine ratio, %	29	28	28	29
Met & cys:lysine ratio,%	55	58	58	55
Threonine:lysine ratio, %	62	64	64	62
Tryptophan:lysine ratio, %	20	19	19	20
ME, kcal/lb	1,560	1,580	1,574	1,573
Calcium, %	0.90	0.90	0.90	0.80
Phosphorus, %	0.80	0.80	0.72	0.70
Available phosphorus, %	0.51	0.46	0.45	0.41
Sodium, %	0.43	0.43	0.43	0.26
Chloride, %	0.53	0.53	0.60	0.43

[a]Diet fed from d 0 to 14 after weaning.
[b]Diet fed from d 14 to 28 after weaning.
[c]Exp. 1 and 2.
[d]Exp. 1 only.
[e]AP 820 and food grade plasma, Exp. 1 and 2.
[f]Provided 50 g per ton carbadox.

Table 2. Chemical Analyses of Spray-Dried Animal Plasma (Exp. 1) [a]

	AP 920		AP 820		Food Grade Source 1		Food Grade Source 2	
Item	Regular	Irradiated	Regular	Irradiated	Regular	Irradiated	Regular	Irradiated
Crude protein, %	79.9	80.4	73.0	73.2	71.1	71.3	70.9	71.0
IgG, %	22.9	22.6	N/A[b]	18.6	16.3	16.5	16.3	15.3
Endotoxin, ng/g	7,116	21,388	N/A[b]	249,740	3,962	16.4	4.8	62.2
Aerobic plate count, cfu/g	$> 3.0 \times 10^5$	1.0×10^2	1.7×10^4	$< 1.0 \times 10^2$	6.5×10^3	$< 1.0 \times 10^2$	7.0×10^2	1.0×10^2
Total coliforms, cfu/g	< 3.0	< 3.0	< 3.0	< 3.0	2.3×10^1	< 3.0	< 3.0	< 3.0
E. coli, cfu/g	< 3.0	< 3.0	< 3.0	< 3.0	2.3×10^1	< 3.0	< 3.0	< 3.0

[a]Samples collected prior to complete diet manufacturing.
[b]Not available at time of publishing.

Table 3. Effect of Irradiation on Various Types of Spray-Dried Animal Plasma on Growth Performance of Nursery Pigs (Exp. 1)[a]

		AP 920		AP 820		Food Grade Source 1		Food Grade Source		
Item	Control	Regular	Irradiated	Regular	Irradiated	Regular	Irradiated	Regular	Irradiated	SEM[g]
Initial wt, lb	13.87	13.85	13.85	13.89	13.85	13.86	13.83	13.88	13.89	0.75
d 0 to 7										
ADG, lb[b]	0.42	0.51[c]	0.57[e]	0.53[c]	0.53[e]	0.56[c]	0.58[e]	0.60[c]	0.58[e]	0.04
ADFI, lb[b]	0.37	0.45[c]	0.47[e]	0.45[c]	0.44[e]	0.48[c]	0.50[e]	0.51[c]	0.47[e]	0.03
F/G[b]	0.93	0.89	0.86	0.84[d]	0.84[f]	0.86	0.87	0.86	0.83[e]	0.03
d 7 to 14										
ADG, lb	0.72	0.72	0.73	0.74	0.71	0.75	0.69	0.73	0.69	0.04
ADFI, lb	0.75	0.78	0.78	0.81	0.78	0.81	0.77	0.82	0.76	0.04
F/G	1.05	1.07	1.08	1.09	1.10	1.07	1.11	1.12[d]	1.11	0.03
d 0 to 14										
ADG, lb[b]	0.57	0.62	0.65[e]	0.64[d]	0.62	0.66[c]	0.64[f]	0.67[c]	0.63[f]	0.03
ADFI, lb[b]	0.56	0.61	0.63[e]	0.63[c]	0.61	0.64[c]	0.63[e]	0.66[c]	0.62[f]	0.03
F/G	1.00	0.99	0.98	0.98	0.99	0.98	1.00	1.00	0.98	0.02
d 14 to 24										
ADG, lb	0.88	0.90	0.86	0.88	0.89	0.84	0.90	0.86	0.85	0.04
ADFI, lb	1.26	1.23	1.15[f]	1.21	1.19	1.17	1.24	1.20	1.19	0.05
F/G	1.44	1.38	1.34	1.40	1.35	1.39	1.39	1.40	1.42	0.07
d 0 to 24										
ADG, lb	0.70	0.74	0.74	0.74	0.73	0.73	0.75	0.75	0.72	0.03
ADFI, lb	0.85	0.87	0.85	0.87	0.85	0.86	0.89	0.89	0.86	0.03
F/G	1.22	1.18	1.15[f]	1.18	1.17	1.18	1.19	1.19	1.19	0.03
Final wt, lb	31.58	31.75	31.36	31.23	31.48	31.62	31.77	31.54	31.04	1.28

[a]A total of 360 pigs (5 pigs per pen and 8 pens per treatment) with an average initial BW of 13.8 lb.
[b]Control vs. mean of plasma treatments (P<0.05).
[c]Control vs. regular, P<0.05.
[d]Control vs. regular, P<0.10.
[e]Control vs. irradiated, P<0.05.
[f]Control vs. irradiated, P<0.10.
[g]No irradiation effect, P>0.10.

Table 4. Chemical Analyses of Spray-Dried Animal Plasma (Exp. 2)[a]

	AP 820		Food Grade	
Item	Regular	Irradiated	Regular	Irradiated
Crude protein, %	N/A[b]	N/A[b]	N/A[b]	N/A[b]
IgG, %	17.3	17.6	15.7	15.4
Endotoxin, ng/g	N/A[b]	N/A[b]	N/A[b]	N/A[b]
Aerobic plate count, cfu/g	> 3.0 x 10^5	2.0 x 10^2	5.6 x 10^3	1.0 x 10^2
Total coliforms, cfu/g	< 3.0	< 3.0	< 3.0	< 3.0
E. coli, cfu/g	< 3.0	< 3.0	< 3.0	< 3.0

[a]Samples collected before complete diet manufacturing.
[b]Not available at time of publishing.

Table 5. Effect of Irradiation on Various Types of Spray-Dried Animal Plasma on Growth Performance of Nursery Pigs (Exp. 2)[a]

		AP 820		Food grade		
Item	Control	Regular	Irradiated	Regular	Irradiated	SEM
Initial wt, lb	13.43	13.37	13.45	13.46	13.43	0.03
d 0 to 7						
ADG, lb[b]	0.23	0.32[c]	0.37[eh]	0.40[c]	0.43[e]	0.02
ADFI, lb[b]	0.23	0.26	0.30[eh]	0.35[c]	0.35	0.02
F/G[b]	1.03	0.81[c]	0.83[e]	0.86[c]	0.83[e]	0.03
d 7 to 14						
ADG, lb	0.77	0.72	0.81[g]	0.75	0.76	0.05
ADFI, lb	0.81	0.76	0.83[h]	0.78	0.81	0.05
F/G	1.05	1.04	1.03	1.05	1.08	0.03
d 0 to 14						
ADG, lb[b]	0.50	0.52	0.59[eg]	0.57[c]	0.59[e]	0.03
ADFI, lb	0.52	0.51	0.57[f]	0.56	0.58[f]	0.03
F/G[b]	1.04	0.97[c]	0.96[e]	0.98[c]	0.98[e]	0.02
d 14 to 24						
ADG, lb	0.92	0.88	0.96	0.94	0.91	0.05
ADFI, lb	1.23	1.08[d]	1.26[g]	1.23	1.18	0.07
F/G	1.33	1.23[d]	1.32[h]	1.32	1.30	0.04
d 0 to 24						
ADG, lb	0.69	0.67	0.74[fg]	0.73	0.73	0.03
ADFI, lb	0.81	0.75[d]	0.86[g]	0.84	0.83	0.04
F/G	1.19	1.11[c]	1.15	1.16	1.14	0.02
Final wt, lb	29.89	29.45	31.32[fg]	30.89	30.99	0.80

[a]A total of 175 pigs (5 pigs per pen and 7 pens per treatment) with an average initial BW of 13.4 lbs. All pigs were fed experimental diets from d 0 to 14, and then switched to a common phase II diet from d 14 to 24.
[b]Control vs. mean of plasma treatments (P<0.05).
[c]Control vs. regular, P<0.05.
[d]Control vs. regular, P<0.10.
[e]Control vs. irradiated, P<0.05.
[f]Control vs. irradiated, P<0.10.
[g]Irradiated vs. regular, P<0.05.
[h]Irradiated vs. regular, P<0.10.