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Abstract

Two trials were conducted to determine the effects of irradiation of individual ingredients or the whole diet on growth performance in nursery pigs. The response was similar for both trials with pigs fed diets containing irradiated spray-dried animal plasma or soybean meal having increased (P<0.05) ADG compared with pigs fed the control diet with no irradiated ingredients or the complete diet that was irradiated. Also, ADFI (P<0.05) was higher for pigs consuming the diet with irradiated soybean meal compared with those fed the irradiated whole diet. Pigs fed irradiated spray-dried animal plasma also had superior F/G (P<0.05) compared with those fed diets containing irradiated microingredients or if all ingredients had been irradiated before manufacturing. Therefore, irradiation of certain feed ingredients can improve growth performance in nursery, whereas irradiation of all ingredients in the diet or the whole diet does not enhance performance.; Swine Day, Manhattan, KS, November 15, 2001

Keywords

Swine day, 2001; Kansas Agricultural Experiment Station contribution; no. 02-132-S; Report of progress (Kansas State University. Agricultural Experiment Station and Cooperative Extension Service); 880; Swine; Nursery pig; Feed ingredients; Irradiation

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EFFECTS OF INGREDIENT AND WHOLE DIET IRRADIATION ON NURSERY PIG PERFORMANCE

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Summary

Two trials were conducted to determine the effects of irradiation of individual ingredients or the whole diet on growth performance in nursery pigs. The response was similar for both trials with pigs fed diets containing irradiated spray-dried animal plasma or soybean meal having increased ($P<0.05$) ADG compared with pigs fed the control diet with no irradiated ingredients or the complete diet that was irradiated. Also, ADFI ($P<0.05$) was higher for pigs consuming the diet with irradiated soybean meal compared with those fed the irradiated whole diet. Pigs fed irradiated spray-dried animal plasma also had superior F/G ($P<0.05$) compared with those fed diets containing irradiated microingredients or if all ingredients had been irradiated before manufacturing. Therefore, irradiation of certain feed ingredients can improve growth performance in nursery, whereas irradiation of all ingredients in the diet or the whole diet does not enhance performance.

(Key Words: Nursery Pig, Feed Ingredients, Irradiation.)

Introduction

Research has established that irradiation of dried blood products before adding them to diets for nursery pigs improves growth performance compared with dried blood products that have not been irradiated. However, irradiation of other protein, carbohydrate, energy, and microingredient sources used in nursery pig diets has not been thoroughly researched. Irradiation of other ingredients that are typically included in nursery diets may enhance growth performance similar to that of dried blood products. Therefore, it was our objective to determine the effects of irradiation of individual ingredients or the whole diet on nursery pig performance.

Procedures

Two experiments were conducted to determine the effects of irradiation of individual ingredients or the whole diet on growth performance in nursery pigs. In Exp. 1, 400 pigs (BW of 10.8 lb and 15 ± 2 d of age) were used in a 14-d growth assay. In Exp. 2, 480 pigs (BW of 11.3 lb and 15 ± 2 d of age) were used in a 12-d growth assay. Pigs were blocked by weight and allotted to one of 10 dietary treatments in both experiments. In Exp. 1, there were eight pigs/pen and five pens/treatment, whereas there were eight pigs/pen and six pens/treatment in Exp 2. For both experiments, pigs were housed in an environmentally controlled nursery in 5 × 5 ft pens on a commercial farm in N.E. Kansas. All pens contained one self-feeder and two nipple waterers to provide ad libitum access to feed and water.

All diets were fed in pelleted form, and pigs were assigned to one of 10 dietary treatments. First, a control diet was used containing ingredients that were not irradiated. Other treatments included diets that had specific ingredients irradiated, which included corn, soybean meal, whey,

[1]Food Animal Health and Management Center.

animal plasma, fishmeal, soybean oil, all microingredients combined (antibiotic, salt, monocalcium phosphate, limestone, zinc oxide, vitamin and trace mineral premixes, and DL-methionine). Finally, a diet including all ingredients that had been irradiated and a diet that was manufactured and subsequently irradiated were utilized. All irradiated ingredients and complete feed were exposed to an average irradiation dose of 8.5 kGy from gamma ray (colbalt-60 source) irradiation in Exp. 1 and electron beam irradiation in Exp. 2. The diet used in this experiment was formulated to contain 1.50% lysine, 0.90 Ca, and 0.50 available P. For Exp. 1, ADG, ADFI, and F/G were determined by weighing pigs and measuring feed disappearance on d 7 and 14, while in Exp. 2 this was accomplished on d 6 and 12. Data for both experiments was pooled and analyzed using the GLM procedure of SAS as a randomized complete block design with pen as the experimental unit. Phase I data represents means from d 0 to 7 of Exp. 1 and d 0 to 6 of Exp. 2, while Phase II data represents means from d 7 to 14 for Exp. 1 and d 6 to 12 for Exp. 2.

Results

Irradiation of individual feed ingredients and the complete diet proved to be successful in reducing the total aerobic bacteria concentrations (Table 2). Bacteria levels in regular plasma and corn were noticeably the highest with minimal concentrations detected in spray-dried whey and soybean oil. Reductions in total bacterial concentrations in diets that had individual ingredients irradiated were minimal compared with the control diet, but if all ingredients or the entire diet had undergone irradiation treatment the bacterial concentration was substantially reduced (Table 3).

For Phase I, nursery pigs fed diets containing either irradiated soybean meal or spray-dried animal plasma had improved ($P<0.05$) ADG while pigs fed irradiated corn tended ($P<0.07$) to have increased ADG compared with pigs fed the control diet (Table 4). In addition, pigs fed irradiated corn, soybean meal, or spray-dried animal plasma had increased ADFI ($P<0.05$) compared with pigs fed the diet that was manufactured and subsequently irradiated. Also, pigs fed diets containing irradiated soybean meal, spray-dried animal plasma, or the diet that was manufactured and then irradiated had improved F/G ($P<0.05$) compared with the control diet with no irradiated ingredients, while those fed irradiated fishmeal, soybean oil, or the diet with all ingredients irradiated tended ($P<0.08$) to do the same.

Table 1. Composition of Diet (As Fed Basis)

Ingredient	%
Corn	38.98
Soybean meal (46.5%)	15.72
Spray-dried whey	25.00
Spray-dried animal plasma	6.00
Select menhaden fish meal	6.00
Soybean oil	5.00
Medication[a]	1.00
Monocalcium phosphate (21% P)	0.57
Limestone	0.60
Zinc oxide	0.39
Vitamin premix	0.25
Salt	0.25
Trace mineral premix	0.15
DL-methionine	0.09
Total	100.00
Calculated Analysis	
Lysine, %	1.50
Met:lysine ratio, %	30
Met & Cys:lysine ratio,%	60
Threonine:lysine ratio, %	68
Tryptophan:lysine ratio, %	19
ME, kcal/lb	1,595
Protein, %	22.1
Calcium, %	0.90
Phosphorus, %	0.80
Available phosphorus, %	0.50

[a]Provided 50 g per ton carbadox.

For Phase II, ADG and ADFI were not affected by dietary treatment, but F/G was improved ($P<0.05$) for pigs consuming diets with irradiated spray-dried animal plasma compared with those fed the diet with all ingredients irradiated.

Overall, ADG was increased (P<0.05) for pigs fed the diet with irradiated spray-dried animal plasma compared with those fed either the control, the diet containing irradiated microingredients, or the diet that was manufactured and subsequently irradiated. Also, pigs fed irradiated soybean meal had increased (P<0.05) ADFI compared with the manufactured diet that was irradiated and tended to improve ADFI (P<0.07) compared with those fed the control. In addition, pigs feed irradiated spray-dried animal plasma had improved (P<0.05) F/G compared with those fed the diet with all ingredients irradiated. Furthermore, they had a moderate increase (P<0.06) in efficiency of gain compared with pigs fed the control. Finally, the addition of irradiated corn, whey, fishmeal, soybean oil, microingredients, or if all ingredients or whole diet was irradiated did not influence growth performance (P>0.12) compared with the control for any of the growth parameters measured in this study.

In conclusion, the bacteria concentration of ingredients commonly used in nursery pig diets was reduced when subjected to irradiation treatment. Bacterial concentration of ingredients varied greatly with highest levels measured in spray-dried animal plasma, corn, and soybean meal and the lowest levels cultured in spray-dried whey and soybean oil. Use of irradiation on individual ingredients improved performance in certain instances, but no uniform pattern was detected in regards to the total aerobic bacterial concentrations in each ingredient. Although the largest improvements in growth performance were elicited from two of the irradiated protein sources (spray-dried animal plasma and soybean meal) used in this study, the benefits from irradiating these ingredients were lost when all ingredients or whole diet was irradiated compared with the inclusion of each ingredient individually. The reasons for this loss of improvement is not currently known, and further research needs to be conducted to determine why certain ingredients that are irradiated improve growth performance.

Table 2. Aerobic Bacteria Concentration of Feed Ingredients[a]

	Total Plate Count, CFU/g		Total Coliform Count, CFU/g	
Ingredient	Regular	Irradiated[a]	Regular	Irradiated[a]
Corn	1.4×10^5	1.3×10^2	6.8×10^4	1.0×10^1
Soybean meal (46.5%)	4.1×10^4	8.5×10^1	5.7×10^2	0
Spray-dried whey	2.3×10^2	9.0×10^1	0	0
Spray-dried animal plasma	4.1×10^5	8.0×10^1	0	0
Select menhaden fish meal	1.5×10^3	4.0×10^2	0	0
Soybean oil	1.5×10^2	1.2×10^1	0	0
Micronutrients[b]	3.2×10^3	1.4×10^2	$2.1\ 6 \times 10^2$	0

[a]Irradiated at an average dose of 8.5 kGy.
[b]Medication, monocalcium phosphate (21% P), limestone, zinc oxide, vitamin and trace mineral premixes, salt, and DL-methionine.

Table 3. Aerobic Bacteria Concentrations of Manufactured Diets[a]

		Portion of Diet Treated with Irradiation Prior to Manufacturing								
Item	Control	Corn	SB Meal	Whey	Plasma	Fishmeal	SB Oil	Micro's[b]	All	Complete[c]
Total Plate Count	5.1×10^4	1.4×10^4	1.3×10^4	2.6×10^4	2.2×10^4	9.1×10^4	4.2×10^3	1.2×10^3	8.9×10^2	4.5×10^2
Total Coliform Count	3.0×10^3	8.0×10^2	4.4×10^3	3.0×10^3	1.0×10^2	5.5×10^3	1.7×10^2	2.0×10^1	2.0×10^2	2.0×10^2

[a]Irradiated at an average dose of 8.5 kGy.
[b]Medication, monocalcium phosphate (21% P), limestone, zinc oxide, vitamin and trace mineral premixes, salt, and DL-methionine.

Table 4. Effects of Irradiation of Ingredients and Whole Diet on Nursery Pig Performance[a]

		Portion of Diet Treated with Irradiation Prior to Manufacturing									
Item	Control	Corn	SB Meal	Whey	Plasma	Fishmeal	SB Oil	Micro's[b]	All	Complete[c]	SEM
Phase I[d]											
ADG, lb	0.35^{f}	0.40^{fg}	0.41^{g}	0.38^{fg}	0.41^{g}	0.39^{fg}	0.38^{fg}	0.36^{fg}	0.40^{fg}	0.36^{fg}	0.022
ADFI, lb	0.40^{fg}	0.44^{f}	0.44^{f}	0.43^{fg}	0.44^{f}	0.43^{fg}	0.42^{fg}	0.40^{fg}	0.43^{fg}	0.38^{g}	0.019
F/G	1.17^{f}	1.13^{fg}	1.07^{g}	1.12^{fg}	1.07^{g}	1.09^{fg}	1.10^{fg}	1.12^{fg}	1.09^{dg}	1.07^{g}	0.035
Phase II[e]											
ADG, lb	0.63	0.63	0.67	0.67	0.68	0.63	0.65	0.63	0.62	0.64	0.024
ADFI, lb	0.79	0.82	0.85	0.83	0.83	0.79	0.82	0.83	0.83	0.80	0.024
F/G	1.30^{fg}	1.33^{gf}	1.28^{fg}	1.28^{fg}	1.25f	1.27^{fg}	1.30^{fg}	1.33^{fg}	1.36^{g}	1.30^{fg}	0.036
Overall											
ADG, lb	0.49^{h}	0.52^{fgh}	0.54^{fg}	0.53^{fgh}	0.55^{f}	0.51^{fgh}	0.51^{fgh}	0.50^{gh}	0.51^{fgh}	0.50^{h}	0.017
ADFI, lb	0.60^{fg}	0.63^{fg}	0.64^{f}	0.63^{fg}	0.64^{fg}	0.61^{fg}	0.62^{fg}	0.62^{fg}	0.63^{fg}	0.59^{g}	0.018
F/G	1.24^{fg}	1.22^{fg}	1.19^{fg}	1.21^{fg}	1.17^{f}	1.20^{fg}	1.22^{fg}	1.25^{g}	1.25^{g}	1.20^{fg}	0.025

[a]Values are representative of two trials. Trial I had a total of 400 pigs (8 pigs per pen and five pens per treatment) with an average initial BW of 10.8 lb. Trial 2 had 480 pigs (8 pigs per pen and six pens per treatment) with an average initial BW of 11.3 lb. [b]Antibiotic, salt, monocalcium phosphate, limestone, zinc oxide, vitamin and trace mineral premixes, and DL-methionine. [c]Complete diet manufactured then irradiated. [d]Phase I is from d 0 to 7 in Trial 1 and d 0 to 6 in Trial 2. [e]Phase II is from d 7 to 14 in Trial 1 and d 6 to 12 in Trial 2. [f,g,h]Means in same row with superscripts differ ($P<0.05$).

Table 5. Probability of Irradiation of Ingredients and Whole Diet Versus Control on Nursery Pig Performance[a]

	Portion of Diet Treated with Irradiation Prior to Manufacturing vs. Control Diet									
Item	Corn	SB Meal	Whey	Plasma	Fish Meal	SB Oil	Micro's[b]	All	Complete[c]	SEM
Phase I[d]										
ADG, lb	0.07	0.03	0.22	0.03	0.13	0.15	0.62	0.11	0.67	0.022
ADFI, lb	0.14	0.16	0.33	0.15	0.31	0.60	0.90	0.37	0.40	0.019
F/G	0.33	0.04	0.24	0.03	0.08	0.06	0.29	0.07	0.04	0.035
Phase II[e]										
ADG, lb	0.98	0.22	0.30	0.15	0.99	0.33	0.95	0.72	0.86	0.024
ADFI, lb	0.37	0.12	0.26	0.25	0.96	0.40	0.27	0.28	0.81	0.024
F/G	0.48	0.74	0.71	0.33	0.57	0.69	0.52	0.21	0.98	0.036
Overall										
ADG, lb	0.23	0.02	0.12	0.02	0.30	0.20	0.71	0.43	0.69	0.017
ADFI, lb	0.17	0.07	0.20	0.12	0.61	0.39	0.49	0.22	0.77	0.018
F/G	0.71	0.22	0.37	0.06	0.25	0.19	0.78	0.73	0.27	0.025

[a]Values are representative of two trials. Trial 1 had 400 pigs (8 pigs per pen and five pens per treatment) with an average initial BW of 10.8 lb. Trial 2 had 480 pigs (8 pigs per pen and six pens per treatment) with an average initial BW of 11.3 lb.
[b]Antibiotic, salt, monocalcium phosphate, limestone, zinc oxide, vitamin and trace mineral premixes, and DL-methionine.
[c]Complete diet manufactured then irradiated.
[d]Phase I is from d 0 to 7 in Trial 1 and d 0 to 6 in Trial 2.
[e]Phase II is from d 7 to 14 in Trial 1 and d 6 to 12 in Trial 2.