Kansas Agricultural Experiment Station Research Reports

Volume 0
Issue 10 *Swine Day (1968-2014)*

Article 804

2000

Effects of gamma ray and electron beam irradiation levels in spray-dried blood meal on nursery pig performance

J C. Woodworth

M J. Webster

B J. James

See next page for additional authors

Recommended Citation

Woodworth, J C.; Webster, M J.; James, B J.; Real, D E.; DeRouchey, Joel M.; Nelssen, Jim L.; Tokach, Michael D.; Goodband, Robert D.; and Dritz, Steven S. (2000) "Effects of gamma ray and electron beam irradiation levels in spray-dried blood meal on nursery pig performance," *Kansas Agricultural Experiment Station Research Reports*: Vol. 0: Iss. 10. https://doi.org/10.4148/2378-5977.6644

Effects of gamma ray and electron beam irradiation levels in spray-dried blood meal on nursery pig performance

Authors

J C. Woodworth, M J. Webster, B J. James, D E. Real, Joel M. DeRouchey, Jim L. Nelssen, Michael D. Tokach, Robert D. Goodband, and Steven S. Dritz

EFFECTS OF GAMMA RAY AND ELECTRON BEAM IRRADIATION LEVELS IN SPRAY-DRIED BLOOD MEAL ON NURSERY PIG PERFORMANCE

J. M. DeRouchey, J. L. Nelssen, M. D. Tokach, R. D. Goodband, S. S. Dritz[1], J. C. Woodworth, M. J. Webster, B. J. James, and D. E. Real

Summary

Three hundred weanling pigs (initially 23.7 lbs and 17 ± 6 d of age) were used in a 19-d growth assay to determine the effects of increasing levels (2.5, 5.0, and 10.0, and 20.0 kGy) of gamma ray and electron beam irradiation of spray-dried blood meal on growth performance. Irradiation of blood meal resulted in decreased concentrations of aerobic bacteria, *E. coli*, mold, and yeast in spray-dried blood meal. The inclusion of irradiated spray-dried blood meal tended to improve F/G from d 0 to 7 and for the overall trial (d 0 to 14), but had no effects on ADG or ADFI. Comparison of the two types of irradiation and dosage level showed no differences in growth performance. In this experiment, the inclusion of spray-dried blood meal did not improve growth performance over that obtained with the control diet.

(Key Words: Nursery Pig, Blood Meal, Irradiation.)

Introduction

Recent research at Kansas State University showed improvements in growth performance of nursery pigs consuming blood products that have undergone irradiation treatment. However, different methods and dosage levels of irradiation are available. Irradiation involves exposing a given substance to ionizing energy to create ions and free radicals. The result of this energy is the destruction of living microorganisms. Also, antinutritional factors can be broken down with an increase in dosage level. Therefore, our objective was to determine the effects of increasing levels (2.5, 5.0, 10.0, and 20.0 kGy) of gamma ray (cobalt-60 source) and electron beam irradiation of spray-dried blood meal on growth performance of weanling pigs.

Procedures

A total of 300 pigs (BW of 23.6 and 17 ± 6 d of age) was used in a 19-d growth assay. Pigs were blocked by weight and allotted to one of 10 dietary treatments. There were five pigs/pen and 10 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 waterers to provide ad libitum access to feed and water.

All pigs were fed the same pelleted SEW and transition diets (Table 1) to 4 d postweaning. All pigs were fed 1 lb of SEW diet, then they were fed the transition diet for the remainder of the 4 d pretreatment period. At d 4, the pigs were switched to experimental diets, which included a control diet with no added spray-dried blood meal, and diets with 5% regular spray-dried blood meal or irradiated 5% spray-dried blood meal. Irradiated treatments included either gamma ray (cobalt-60 source) or electron beam irradiation at increasing dosage levels (2.5, 5.0 10.0, and 20.0 kGy). All blood meal used in this experiment was from the same lot. Treatment diets were fed in meal form and formulated to contain 1.40% lysine, .90 Ca, and .54 available P (Table 1). In addition, all

[1]Food Animal Health and Management Center.

diets were balanced for Na (.26%) and Cl (.43%). Synthetic amino acids were added as well to exceed the pig requirement and ensure that no amino acid would be limiting in the diets. The ADG, ADFI, and F/G were determined by weighing pigs and measuring feed disappearance on d 4, 11, and 18. Blood meal samples were taken for analysis to determine bacterial concentrations prior to manufacturing of the complete diet.

Data were analyzed as a randomized complete block design with pen as the experimental unit. Pigs were blocked based on postweaning weight, and analysis of variance was performed using the GLM procedure of SAS. Linear, quadratic, and cubic polynomial contrasts were used to determine the effects of increasing dosage levels of irradiation. In addition, contrasts were utilized to test differences between irradiated and non-irradiated treatment diets. Initial pig weight at the start of the experimental period was used as a covariate for statistical analysis.

Results and Discussion

Irradiation of blood meal proved effective in the reduction of aerobic bacteria, *E. coli*, mold, and yeast concentrations (Table 2). Blood meal subjected to gamma ray irradiation had lower concentrations of aerobic bacteria than that irradiated by electron beam at each level of irradiation. In fact, at 5.0, 10.0, and 20.0 kGy, no bacteria were detected with gamma ray treatments, but low levels of bacteria were cultured with electron beam treatment.

From d 0 to 7 of the treatment period (Table 3), as well as overall (d 0 to 14), the inclusion of irradiated spray-dried blood meal tended ($P<.09$) to improve F/G with no effects on ADG ($P=.26$) or ADFI ($P=.86$). However, for the overall experiment, ADG and F/G were increased by approximately 9 and 6%, respectively. In addition, the inclusion of spray-dried blood meal did not improve growth performance over the control diet without spray-dried blood meal.

These results indicate that irradiation is an effective technology to reduce or eliminate bacteria, molds, and yeast in spray-dried blood meal. However, increasing the dosage above 2.5 kGy, regardless of source, did not further enhance growth performance of nursery pigs. Also, both electron beam and gamma ray irradiation resulted in similar performance. Previous research at Kansas State University has consistently shown that ADG and ADFI increase when pigs are fed spray-dried blood meal or animal plasma that has been irradiated. However, in this trial, we found a response in feed efficiency, but not in ADG and ADFI. We believe the numerical responses were similar to the significant responses observed in other trials, but the larger variation (SEM, .038 vs .022) observed in this trial prevented the detection of significant responses. This leads us to believe that pigs can more efficiently utilize irradiated spray-dried blood meal, which indicates that this processing technique either reduces antinutritional factors or alters the protein structure to make it more available for the weanling pig.

Table 1. Compositions of Diets (As-Fed Basis)[a]

	Common Diets		Treatment Diets	
Ingredient, %	SEW	Transition	No Blood Meal Control	Added Blood Meal
Corn	33.37	39.81	45.77	53.63
Soybean meal (46.5%)	12.80	23.30	39.45	26.43
Spray-dried whey	25.00	20.00	10.00	10.00
Spray-dried animal plasma	6.70	2.50	-	-
Select menhaden fish meal	6.00	2.50	-	-
Choice white grease	6.00	5.00	-	-
Lactose	5.00	-	-	-
Spray-dried blood cells	1.65	2.50	-	-
Spray-dried blood meal	-	-	-	5.00
Medication[b]	1.00	1.00	1.00	1.00
Monocalcium phosphate	.75	1.30	1.85	1.86
(21% P)	.45	.73	.82	.79
Limestone	.38	.38	.25	.25
Zinc oxide	.25	.25	.25	.25
Vitamin premix	.20	.30	.38	.30
Salt	.15	.15	.15	.15
Trace mineral premix	-	-	-	.17
Calcium chloride	.15	.15	-	-
L-Lysine HCl	.15	.13	.078	.132
DL-Methionine	-	-	.004	.033
L-Threonine	-	-	-	.006
L-Isoleucine				
Total	100.00	100.00	100.00	100.00
Calculated Analysis				
Lysine, %	1.70	1.60	1.40	1.40
Met:lysine ratio, %	30	30	31	33
Met & Cys:lysine ratio,%	57	57	60	60
Threonine:lysine ratio, %	65	65	67	67
Tryptophan:lysine ratio, %	18	19	21	21
ME, kcal/lb	1,595	1,559	1458	1448
Protein, %	22.4	22.5	23.7	22.7
Calcium, %	.90	.90	.90	.90
Phosphorus, %	.80	.80	.86	.81
Available phosphorus, %	.66	.59	.54	.54

[a]One lb per head of SEW diet was fed, then pigs were fed the transition diet for the remainder of the 4 d pretreatment period. Pigs then were switched to treatment diets from d 4 to 18.

[b]Provided 50 g per ton carbadox.

Table 2. Effects of Source and Dosage Level of Irradiation on Bacterial Concentrations in Spray-Dried Blood Meal[a]

Item	No Blood Meal Control	Blood Meal Nonirradiatd	Blood Meal Irradiated Gamma Ray Dosage, kGy 2.5	5.0	10.0	20.0	Blood Meal Irradiated Electron Beam Dosage, kGy 2.5	5.0	10.0	20.0
Blood meal[a]										
Aerobic plate count	N/A	7.9×10^6	1.6×10^4	0	0	0	2.0×10^4	1.0×10^3	3.5×10^4	2.0×10^4
Ecoli coliform count	N/A	2.3×10^3	0	0	0	0	0	0	0	0
Mold and yeast count	N/A	2.40×10^2	0	0	0	0	0	0	0	0
Whole diet[b]										
Total plate count	1.0×10^3	9.2×10^3	6.2×10^2	7.8×10^2	1.2×10^2	4.3×10^2	5.2×10^3	8.2×10^2	9.8×10^2	1.3×10^2
Total coliform count	4.0×10^1	4.1×10^2	2.0×10^1	1.4×10^2	9.4×10^1	0	1.0×10^1	1.5×10^1	3.8×10^1	3.0×10^1

[a]Samples obtained prior to whole diet preparation for analysis. [b]Samples obtained at initiation of experiment for analysis.

Table 3. Effects of Source and Dosage Level of Irradiation on Growth Performance of Nursery Pigs[a]

Item	No Blood Meal Control	Blood Meal Nonirradiated	Blood Meal Irradiated Gamma Ray Dosage, kGy 2.5	5.0	10.0	20.0	Blood Meal Irradiated Electron Beam Dosage, kGy 2.5	5.0	10.0	20.0	SEM[bc]
Day 0 to 7											
ADG, lb	.37	.38	.47	.41	.36	.42	.41	.48	.42	.46	.045
ADFI, lb	.65	.69	.74	.69	.65	.73	.69	.74	.66	.73	.044
F/G[d]	1.76	1.82	1.57	1.68	1.81	1.73	1.68	1.54	1.57	1.59	.121
Day 7 to 14											
ADG, lb	1.03	1.02	1.03	1.09	1.15	1.13	1.09	1.03	1.07	1.04	.051
ADFI, lb	1.26	1.34	1.32	1.39	1.40	1.36	1.35	1.34	1.29	1.31	.053
F/G	1.22	1.31	1.28	1.28	1.22	1.20	1.24	1.30	1.21	1.26	.055
Day 0 to 14											
ADG, lb	.70	.70	.75	.75	.76	.77	.75	.76	.75	.75	.038
ADFI, lb	.96	1.01	1.02	1.04	1.02	1.05	1.02	1.04	.97	1.02	.043
F/G[d]	1.37	1.44	1.36	1.39	1.34	1.36	1.36	1.37	1.29	1.36	.052

[a]A total of 300 pigs (five pigs per pen and 6 pens per treatment) with an average initial BW of 23.7 lbs. [b]No effect of control diet vs added blood meal diets (P>.10). [c]No effect of gamma ray verses electron beam irradiation (P>.10). [d]Nonirradiated vs irradiated blood meal (P<.10).