Effects of irradiation of feed ingredients added to meal or pelleted diets on growth performance of weanling pigs[1]

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ABSTRACT: Two experiments were conducted to evaluate the effects of irradiated ingredients in meal and pelleted diets on nursery pig performance. In Exp. 1, a total of 192 pigs (initial BW, 6.0 kg) were used in a 25-d experiment. Pigs were blocked by BW and randomly allotted in a 2 × 2 factorial arrangement of treatments with main effects of diet form (meal or pellet) and either irradiated (11.92 kGy) or nonirradiated spray-dried animal plasma (SDAP). Irradiated SDAP had less total bacterial amounts than nonirradiated SDAP, and pelleted diets also had less bacterial amounts than diets in meal form. However, the complete diets with and without irradiated SDAP had similar bacterial concentrations. There was a diet form × SDAP irradiation interaction ($P < 0.05$) for ADG from d 0 to 11 and d 0 to 25. Pigs fed irradiated SDAP in meal form had increased ADG compared with pigs fed the nonirradiated meal diet, with no change in ADG of pigs fed pelleted diets. In addition, from d 0 to 11, pigs fed irradiated SDAP or pelleted diets had greater G:F ($P < 0.01$) compared with pigs fed regular SDAP and meal diets, respectively. In Exp. 2, a total of 350 pigs (initial BW, 4.9 kg) were used in a 22-d experiment to determine the effects of feeding irradiated protein sources (SDAP, soybean meal, fish meal, or all 3) in meal and pellet diets on pig performance. Pigs were blocked by BW and randomly allotted to 1 of 10 treatments consisting of a single diet formulation fed in either meal or pellet form containing either no irradiated protein sources or irradiated SDAP, soybean meal, fish meal, or all 3 irradiated protein sources (10.20 kGy). Irradiated SDAP, soybean meal, and fish meal tended to have reduced total bacterial concentrations compared with nonirradiated plasma, and pelleted diets had reduced bacterial concentrations compared with diets in meal form. No irradiation × diet form interactions ($P > 0.16$) were observed. From d 0 to 11, pigs fed diets containing irradiated protein sources had greater ($P < 0.03$) G:F compared with pigs fed the control diets, with no difference in ADG or ADFI. From d 0 to 11, and overall (d 0 to 22), pigs fed pellet diets had greater G:F ($P < 0.01$) compared with pigs fed meal diets, with no difference in ADG and ADFI. These studies indicate that both irradiation and pelleting are manufacturing processes that can reduce bacteria concentrations in feed ingredients and diets. Irradiated SDAP, soybean meal, and fish meal improved G:F compared with control diets containing nonirradiated ingredients. Furthermore, pigs fed pelleted diets had increased G:F compared with pigs fed meal diets.

Key words: irradiation, pellet, pig, spray-dried animal plasma

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INTRODUCTION

Specialty proteins, such as spray-dried animal plasma (**SDAP**), dried whey, and fish meal, are used in nursery diets to stimulate pig feed intake immediately after weaning (Kats et al., 1994; Grinstead et al., 2000). Typically, starter pig diets containing these specialty protein sources are fed in pelleted form. Recent studies suggest that nursery pigs started on pelleted diets have increased BW gain and feed intake compared with pigs begun on meal diets (Steidinger et al., 2000; Groesbeck et al., 2007b). A 10 to 12% improvement in ADG and G:F to pelleting was observed in the diets fed immediately after weaning (<7 d), after which improvements in pig performance were reduced to the 3 to 5% range from d 7 to 14 after weaning (Steidinger et al., 2000). The heating and conditioning of ingredients before and during conditioning can affect microbial populations in complete pelleted feeds (Myint et al., 2007). Effects of bacteria from nonpelleted ingredients on pig growth

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performance are not well understood. Previous research demonstrated improvement in growth performance when nursery pigs were fed diets containing irradiated SDAP (DeRouchey et al., 2003a,b, 2004), suggesting that ingredient bacterial concentrations may affect growth performance in meal diets. DeRouchey et al. (2003a) also demonstrated that nursery pigs fed diets containing irradiated soybean meal had increased ADG, ADFI, and G:F, and pigs fed diets containing irradiated fish meal tended to have improved G:F. Therefore, the objectives of these experiments were to determine the effects of nonirradiated or irradiated SDAP fed in either meal or pellet form, and to evaluate the effects of irradiated protein sources (SDAP, soybean meal, and fish meal) in the diet, fed in either meal or pelleted form, on nursery pig performance.

MATERIALS AND METHODS

The Kansas State University Animal Care and Use Committee approved all experimental protocols used in these experiments.

All pigs in the aforementioned experiments were 21 ± 3 d of age at weaning, randomly allotted, and blocked by weaning weight to dietary treatments. All diets were formulated to meet or exceed NRC (1998) nutrient requirement estimates. Nursery temperature was maintained at 32°C for wk 1 and decreased by approximately 1°C each week thereafter. All pens contained a self-feeder and waterer to provide ad libitum access to feed and water.

Raw ingredient samples were collected before diet manufacturing, and complete feed samples were collected for analysis at the beginning of each experiment. Bacterial concentrations were determined on ingredients and the final diets by total plate and coliform counts (Carter and Cole, 1990).

Exp. 1

A total of 192 pigs (PIC 337 × C22, PIC, Hendersonville, TN) with initial average BW of 6.0 ± 0.82 kg were used in a 25-d growth assay. Pigs were blocked by BW and randomly allotted to 1 of 4 treatments, with 6 pigs per pen and 8 replications per treatment. Pigs were housed in an environmentally controlled nursery in 1.2 × 1.5-m pens with woven metal flooring.

Pigs were allotted in a 2 × 2 factorial arrangement. Main effects included diet form (meal or pellet) and either nonirradiated (regular) or irradiated SDAP. Treatment diets were fed from d 0 to 11 (Table 1). Treatments consisted of a single diet containing 5% SDAP (nonirradiated or irradiated) fed in either meal or pelleted form. For phase 2 (d 11 to 25), all pigs were fed a common diet in meal form. The SDAP (AP920, American Protein Corporation, Ames, IA) used in this experiment was obtained from the same lot. The SDAP was irradiated at the Iowa State University Linear Accelerator Facility (Ames) with an average irradiation dose of 11.92 kGy. Two meal diets were manufactured, 1 with irradiated SDAP and 1 with nonirradiated SDAP. One-half of each meal batch was conditioned with a single-pass conditioner at 60°C for 20 to 30 s by adjusting the steam flow rate and pelleted using a pellet mill (Master Model HD, Series 2000, California Pellet Mill, Crawfordsville, IN) equipped with a die that had an effective thickness of 31.8 mm and holes 3.18 mm in diameter. Pellets were cooled using a double-pass perforated deck cooler (Wenger Manufacturing, Sabetha, KS). Pigs were weighed, and feed disappearance was measured on d 0, 11, and 25 to determine ADG, ADFI, and G:F.

Table 1. Ingredient composition of experimental diets (Exp. 1 and 2; as-fed basis)[1,2]

Item	SDAP	Common[3]
Ingredient, %		
Corn	44.01	53.95
Soybean meal, 46.5% CP	19.40	31.54
Spray-dried whey	20.00	10.00
Spray-dried animal plasma	5.00	—
Fish meal	5.00	—
Soybean oil	3.00	—
Monocalcium phosphate, 21% P	0.75	1.50
Limestone	0.65	0.95
Salt	0.25	0.35
Vitamin and trace mineral premix[4]	0.40	0.40
Antibiotic[5]	0.70	0.70
Zinc oxide	0.38	—
L-Lys·HCl	0.23	0.33
DL-Met	0.15	0.15
L-Thr	0.08	0.13
Total	100.00	100.00
Calculated analysis		
Total Lys, %	1.50	1.30
ME, kcal/kg	3,422	3,250
CP, %	22.6	20.9
Ca, %	0.88	0.84
P, %	0.80	0.76
Available P, %	0.57	0.46
Lys:ME, g/Mcal	4.38	4.00

[1]In Exp. 1, the phase 1 (d 0 to 11) spray-dried animal plasma (SDAP) diet was fed in either meal or pelleted form with irradiated SDAP or nonirradiated SDAP.

[2]In Exp. 2, the phase 1 (d 0 to 11) diet was fed in either meal or pelleted form with irradiated protein sources (SDAP, soybean meal, fish meal, or a diet containing all 3 irradiated protein sources).

[3]Phase 2 was a common diet fed to all pigs in meal form, Exp. 1 (d 11 to 25) and Exp. 2 (d 11 to 22).

[4]Provided (per kilogram of complete diet): 11,025 IU of vitamin A; 1,654 IU of vitamin D; 44 IU of vitamin E; 4.4 mg of vitamin K (as menadione dimethylpyrimidinol bisulfate); 55.1 mg of niacin; 33.1 mg of pantothenic acid (as D-calcium pantothenate); 9.9 mg of riboflavin; 0.044 mg of vitamin B_{12}; 16.5 mg of Cu as $CuSO_4 \cdot 5H_2O$; 165.4 mg of Fe as $FeSO_4H_2O$; 39.7 mg of Mn as $MnSO_4 \cdot H_2O$; 0.30 mg of Se as Na_2SeO_3; 165.4 mg of Zn as ZnO; and 0.30 mg of I as $C_2H_2(NH_2)_2 \cdot 2HI$.

[5]Provided 140 g of neomycin sulfate and 140 g of oxytetracycline hydrochloride per ton of complete feed. Antibiotics supplied by Penfield Animal Health, Omaha, NE.

Exp. 2

A total of 350 pigs (PIC 337 × 1050) with an initial average BW of 4.9 ± 0.95 kg were used in a 22-d

Table 2. Aerobic bacteria concentration (Exp. 1)[1]

Item	Total plate count	Total coliform count
SDAP, cfu/g		
Nonirradiated	1.1×10^5	$<1.0 \times 10^1$
Irradiated	$<1.0 \times 10^1$	$<1.0 \times 10^1$
Diet with nonirradiated SDAP, cfu/g		
Meal	2.6×10^4	3.9×10^2
Pellet	2.0×10^3	$<1.0 \times 10^1$
Diet with irradiated SDAP, cfu/g		
Meal	2.1×10^4	$<1.0 \times 10^1$
Pellet	4.8×10^3	$<1.0 \times 10^1$

[1]Spray-dried animal plasma (SDAP) was irradiated at the Iowa State University Linear Accelerator Facility (Ames) with an average irradiation dose of 11.92 kGy.

growth assay. Pigs were blocked by BW and randomly allotted to 1 of 10 treatments, with 5 pigs per pen and 7 pens per treatment. Pigs were housed in an environmentally controlled nursery in 1.2 × 1.2-m pens with woven metal flooring.

Treatments consisted of a single diet formulation that was fed in either meal or pelleted form (Table 1). Within each form, the diet was fed without irradiated ingredients or with irradiated SDAP, soybean meal, fish meal, or all 3 irradiated protein sources. These diets were fed from d 0 to 11. All pigs were then fed a common diet in meal form for phase 2 (d 11 to 22). The SDAP, soybean meal, and fish meal were irradiated at the Iowa State University Linear Accelerator Facility with an average irradiation dose of 10.20 kGy. The 5 meal diets were manufactured with one-half of each of the meal diet steam conditioned to 65.5°C and pelleted as in Exp. 1, thus resulting in the 10 experimental dietary treatments. Pigs were weighed, and feed disappearance was measured on d 0, 14, and 22 to determine ADG, ADFI, and G:F.

Statistical Analysis

Analyses were performed using the MIXED procedure (SAS Inst. Inc., Cary, NC). Data from Exp. 1 were analyzed as a 2 × 2 factorial (pellet or meal, and nonirradiated or irradiated SDAP), with pen as the experimental unit. Main effects and 2-way interactions were evaluated. Experiment 2 was analyzed as a randomized complete block design with pen as the experimental unit. Contrasts were used to evaluate differences between diets with nonirradiated and irradiated ingredients and meal and pelleted diets. Bacterial concentrations determined on ingredients or final diets were not statistically analyzed.

RESULTS

Exp. 1

Irradiated SDAP had a reduced concentration of total bacteria compared with nonirradiated SDAP (Table 2), but total coliform counts were generally small and not different between treatments. Pelleting of diets resulted in a slight decrease in total plate counts compared with meal diets, but again, resulted in no real differences in total coliform counts. No difference in total plate counts or total coliform counts was observed when comparing complete diets with or without irradiated SDAP.

There was a diet form × irradiated SDAP interaction ($P < 0.05$) on ADG (d 0 to 11; Table 3). Pigs fed irradiated SDAP in meal form had increased ADG, compared with pigs fed the nonirradiated meal diet. There was no effect of irradiation in pigs fed pelleted diets. There was no difference ($P < 0.18$) in ADFI between meal and pelleted treatments. In addition, from d 0 to 11, pigs fed pelleted diets and pigs fed irradiated SDAP had increased G:F ($P < 0.01$) compared with pigs fed meal diets and regular SDAP, respectively.

From d 11 to 25 (Table 3), there was a diet form × irradiated SDAP interaction for both ADG ($P < 0.03$) and ADFI ($P < 0.04$). Pigs previously fed irradiated SDAP in meal form had increased ADG and ADFI compared with those fed nonirradiated SDAP also in meal form. Pigs fed pelleted diets with irradiated SDAP had similar ADG and ADFI compared with pigs fed nonirradiated SDAP. Pigs previously fed a meal diet had a tendency for increased ($P < 0.08$) G:F compared with pigs fed diets in pelleted form.

Overall (d 0 to 25; Table 3), there was a diet form × irradiated SDAP interaction on ADG ($P < 0.02$) and a tendency for an interaction for ADFI ($P < 0.06$). Pigs fed irradiated SDAP in meal form had increased ADG, and ADFI compared with those fed the meal diet without irradiated SDAP. For pigs fed pelleted diets, there were no changes in ADG or ADFI among those fed either irradiated or nonirradiated SDAP. Pigs fed the pelleted diets had a tendency ($P < 0.06$) for increased G:F compared with pigs fed the meal diets. Pigs fed diets containing irradiated SDAP had a tendency ($P < 0.06$) for increased G:F compared with pigs fed diets containing nonirradiated SDAP.

Exp. 2

Irradiation of SDAP, soybean meal, and fish meal reduced total bacteria and coliform plate counts (Table

Table 3. Effects of meal and pelleted diets with or without irradiated spray-dried animal plasma (SDAP; Exp. 1)[1,2]

	Nonirradiated SDAP		Irradiated SDAP			Probability, $P <$		
Item	Meal	Pellet	Meal	Pellet	SE	Diet form	SDAP irradiation	Diet form × SDAP irradiation
d 0 to 11								
ADG, g	283	360	348	374	16.5	0.01	0.01	0.05
ADFI, g	346	373	378	371	15.7	0.18	0.37	0.15
G:F, g/g	0.82	0.96	0.92	1.01	0.02	0.01	0.01	0.16
d 11 to 25								
ADG, g	398	434	435	429	13.8	0.10	0.08	0.03
ADFI, g	516	579	569	574	19.1	0.02	0.08	0.04
G:F, g/g	0.77	0.75	0.76	0.75	0.01	0.08	0.60	0.87
d 0 to 25								
ADG, g	353	404	401	407	14.1	0.01	0.01	0.02
ADFI, g	449	496	494	495	17.2	0.05	0.08	0.06
G:F, g/g	0.79	0.81	0.81	0.83	0.01	0.06	0.06	0.58

[1]A total of 192 pigs (6 pigs per pen and 8 pens per treatment) with an average initial BW of 6.0 ± 0.82 kg were used in the study. The phase 2 (d 11 to 25) diet was a common diet fed to all pigs in meal form.

[2]Spray-dried animal plasma (SDAP) was irradiated at the Iowa State University Linear Accelerator Facility (Ames) with an average irradiation dose of 11.92 kGy.

4). Pelleting diets also resulted in a reduction in total bacterial counts compared with meal diets.

No irradiation × diet form interactions ($P > 0.16$) were observed for any growth performance criterion during any period (Table 5). From d 0 to 11, pigs fed diets containing irradiated protein sources had increased ($P < 0.03$) G:F compared with pigs fed control diets, with no difference in ADG or ADFI. Pigs fed pelleted diets had greater ($P < 0.01$) G:F compared with pigs fed meal diets, with no difference in ADG and ADFI.

From d 11 to 22 (Table 5), pigs previously fed meal diets had a tendency for greater ($P < 0.10$) ADFI compared with pigs previously fed pelleted diets, with no difference in ADG or G:F.

Overall (d 0 to 22; Table 5), pigs fed pelleted diets had increased ($P < 0.01$) G:F compared with pigs fed meal diets. Pigs fed diets containing irradiated protein sources had a tendency for increased ($P < 0.10$) G:F compared with pigs fed control diets.

DISCUSSION

Nursery pig diets are a complex formulation of several ingredients including grains, protein sources, lactose sources, and AA. Because of problems in flow ability of diets containing these specialty ingredients, these diets are typically pelleted. Two studies have reported that weanling pigs begun on pelleted diets have increased

Table 4. Aerobic bacteria concentration (Exp. 2)[1]

Item	Total plate count	Total coliform count
Protein source, cfu/g		
SDAP	4.8×10^4	2.9×10^2
Soybean meal	3.3×10^3	3.8×10^2
Fish meal	5.4×10^5	2.6×10^2
Irradiated protein source, cfu/g		
SDAP	3.0×10^1	$<1.0 \times 10^1$
Soybean meal	1.8×10^1	$<1.0 \times 10^1$
Fish meal	4.1×10^1	$<1.0 \times 10^1$
Complete meal diet, cfu/g		
Control	1.5×10^5	3.6×10^2
Irradiated SDAP	2.0×10^3	$<1.0 \times 10^1$
Irradiated soybean meal	2.1×10^3	$<1.0 \times 10^1$
Irradiated fish meal	1.8×10^4	$<1.0 \times 10^1$
All 3 irradiated sources	1.8×10^3	$<1.0 \times 10^1$
Complete pelleted diet, cfu/g		
Control	1.7×10^2	$<1.0 \times 10^1$
Irradiated SDAP	1.4×10^2	$<1.0 \times 10^1$
Irradiated soybean meal	1.8×10^2	$<1.0 \times 10^1$
Irradiated fish meal	1.6×10^2	$<1.0 \times 10^1$
All 3 irradiated sources	1.4×10^2	$<1.0 \times 10^1$

[1]The spray-dried animal plasma (SDAP), fish meal, and soybean meal were irradiated at the Iowa State University Linear Accelerator Facility (Ames) with an average irradiation dose of 10.20 kGy.

Table 5. Effects of irradiated protein sources fed in meal or pelleted diets on nursery pig growth performance (Exp. 2)[1,2,3]

Item	Meal diet					Pelleted diet					SE	Probability, $P <$	
		Irradiated ingredient					Irradiated ingredient						
	Control	SDAP	SBM	Fish meal	All 3	Control	SDAP	SBM	Fish meal	All 3		Irradiated vs. nonirradiated	Meal vs. pellet
d 0 to 11													
ADG, g	233	237	256	236	257	228	246	256	257	235	21.0	0.28	0.95
ADFI, g	275	268	275	261	268	249	246	259	268	254	18.0	0.99	0.17
G:F, g/g	0.84	0.87	0.93	0.90	0.95	0.91	0.99	0.98	0.96	0.92	0.03	0.03	0.01
d 11 to 22													
ADG, g	592	577	591	585	560	587	552	582	569	573	30.0	0.37	0.57
ADFI, g	764	724	754	723	722	715	697	722	725	695	36.0	0.33	0.10
G:F, g/g	0.78	0.80	0.78	0.81	0.77	0.82	0.80	0.82	0.78	0.83	0.03	0.97	0.21
d 0 to 22													
ADG, g	358	353	378	361	364	358	353	374	368	354	22.0	0.71	0.90
ADFI, g	447	423	449	427	429	418	404	427	431	409	23.0	0.59	0.12
G:F, g/g	0.80	0.83	0.84	0.84	0.84	0.85	0.87	0.88	0.85	0.87	0.02	0.10	0.01

[1]A total of 350 pigs (5 pigs per pen and 7 pens per treatment) with an average initial average BW of 4.9 ± 0.95 kg were used in the study.
[2]The phase 1 (d 0 to 11) diet was fed in either meal or pelleted form with irradiated protein sources [spray-dried animal plasma (SDAP), soybean meal (SBM), fish meal, or a diet containing all 3 irradiated protein sources]. The phase 2 (d 11 to 22) diet was a common diet fed to all pigs in meal form.
[3]No interactions ($P > 0.16$) between irradiation of protein source × diet form were observed.

ADG and G:F compared with pigs begun on meal diets (Steidinger et al., 2000; Groesbeck et al., 2007b). Steidinger et al. (2000) observed a 10% improvement in ADG and G:F when pigs were fed pelleted diets from d 0 to 7 after weaning compared with those fed a meal diet. However, from d 0 to 14 the improvement in both ADG and G:F was only 7%. Traylor et al. (1996) also observed greater than 15% improvements in ADG and G:F from d 0 to 7 after weaning in pigs fed pelleted diets compared with those fed a meal diet. However, the overall response (d 0 to 29) was 2 and 5% for ADG and G:F, respectively. In a review by Hancock and Behnke (2001), the summarized data suggest that pigs (greater than 20 kg) fed pelleted diets generally had a 6 to 7% improved ADG and G:F. In Exp. 1, we observed a 14 and 12% improvement in ADG and G:F, respectively, from d 0 to 11, followed by only a 6% improvement in G:F overall. Therefore, it appears that for the first few days after weaning, we can anticipate greater than a 10% improvement in ADG and feed conversion with pelleting, but the response decreases to approximately 5 to 6% as the pigs become older. In contrast to the aforementioned observations, in Exp. 2, we saw no advantages of pelleting on ADG but saw a 6% improvement in G:F from d 0 to 11 and a 4% improvement from d 0 to 25. We have no explanation for why the pigs in Exp. 2 did not show a greater response to pelleting; however, they were approximately 1 kg lighter and initially consumed only two-thirds the amount of feed as those in Exp. 1. Another difference between Exp. 1 and 2 was the conditioning temperature, 60 vs. 65.5°C. However, Steidinger et al. (2000) observed that pigs conditioned to diets and exposed to temperatures below 77°C exhibited similar growth performance; therefore, conditioning temperature appears not to be a factor in the present study.

One factor we speculate might contribute to the difference in growth performance responses between pigs fed meal diets and pigs fed pelleted diets in our experiments is bacterial concentration in the feed. As expected, data from both experiments demonstrated that meal diets have a slightly greater concentration of total bacteria counts than pelleted diets, indicating that meal diets have a greater potential of containing pathogenic bacteria. Spray-dried animal plasma, fish meal, and soybean meal are ingredient sources that have potential for greater bacterial concentrations (Kume et al., 1982; DeRouchey et al., 2004; Maciorowski et al., 2007). Fish meal has even been shown to be a source of *Salmonella* (Morris et al., 1970), which can reduce the growth performance of weanling pigs. The bacteria reduction can be attributed to heat treatment of the feed during conditioning and pelleting (Skoch et al., 1983; Myint et al., 2007).

The potential for similar growth performance by reducing bacteria concentrations with pelleting the whole diet, irradiation of ingredients, or a combination of both was the objective of our studies. We speculated that irradiating SDAP might give the same response as pelleting because both methods reduce bacteria concentrations. We observed this in Exp. 1, but not in Exp. 2.

DeRouchey et al. (2003b, 2004) conducted 6 experiments evaluating the irradiation of SDAP (feed and food grade). Within some experiments, more than 1 source of SDAP was evaluated. In 1 experiment, there were no responses to irradiation with 2 sources of food grade SDAP. However in the remaining comparisons of irradiated and nonirradiated feed grade SDAP, there was an average improvement of greater than 10% in ADG from d 0 to 7 after weaning and generally no improvement in G:F. In contrast, Cook et al. (2002) and Groesbeck et al. (2007a) observed no change in ADG with irradiated SDAP in the diet. Irradiating the complete diets has also been shown not to improve pig growth performance (Cook et al., 2002; DeRouchey et al., 2003b, 2004; Keegan et al., 2003). In Exp. 1 of our study, irradiation of SDAP improved ADG by 11% and G:F by 8%, with the greatest improvement observed between meal diets with and without irradiation. In Exp. 2, there was no improvement in ADG, but G:F improved by 7%. Again, we have no explanation why ADG in Exp. 2 did not respond to pelleting or irradiation. The range of total plate counts before and after irradiation was similar between the observations of DeRouchey et al. (2003b, 2004) and ours. The experiment herein and those by DeRouchey et al. (2003b, 2004) also observed very small and similar total coliform counts.

In conclusion, both irradiation and pelleting are manufacturing processes that can reduce bacteria concentrations in feed ingredients and diets. In Exp. 1, both pelleting and irradiation improved weanling pig growth and to a greater extent in meal-fed diets. Irradiation of SDAP, soybean meal, and fish meal improved G:F compared with control diets containing nonirradiated ingredients. Some of the discrepancies may be related to the initial starting BW of the pigs and their ability to adjust to dry feed immediately after weaning.

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