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EVALUATION OF VARIOUS SPECIALTY PROTEIN SOURCES AS REPLACEMENTS FOR SPRAY-DRIED ANIMAL PLASMA IN DIETS FOR SEGREGATED EARLY-WEANED PIGS[1]

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Summary

We used high-health status, weanling pigs to evaluate six different protein sources as replacements for spray-dried animal plasma. Spray-dried blood meal, spray-dried egg, spray-dried wheat gluten, extruded soy protein concentrate, select menhaden fish meal, and soybean meal each replaced 2.5 or 5.0% spray-dried animal plasma. Pigs fed increasing levels of spray-dried blood meal, spray-dried egg, or soybean meal had decreased ADFI; however, increasing levels of select menhaden fish meal, extruded soy protein concentrate, and spray-dried wheat gluten had no influence or increased ADFI. For the high-health pigs used in this trial, select menhaden fish meal, extruded soy protein concentrate, and soybean meal appear to be effective in replacing a portion of the spray-dried plasma in the segregated-early weaned (SEW) diet. However, in contrast to other studies, the level of spray-dried animal plasma was not observed to have an effect on SEW pig performance. The conflicting results between this study and past trials in the performance of spray-dried blood meal and spray-dried egg indicate that quality standards should be established for all protein sources.

(Key Words: Protein Source, Weanling Pigs.)

Introduction

Specialty protein sources present palatable, highly digestible ingredients to assist in stimulating ADFI and maximizing ADG after weaning. Much research has been accumulated demonstrating the beneficial aspects of adding specialty proteins to weanling pig diets. However, little research has compared performance of pigs fed several specialty proteins in one experiment. Therefore, our objective was to compare various specialty proteins replacing 2.5 or 5% animal plasma in diets for weanling pigs.

Procedures

Animals and Housing. A total of 390 barrows (initially 9.3 lb and 13 ± 2 d of age; Newsham Hybrids) was used in a 26 d growth assay to evaluate different protein sources as replacements for spray-dried plasma. All pigs were housed in 4 × 4 ft pens with one nipple waterer, a five hole self-feeder, and tri-bar flooring in the KSU SEW nurseries. Pigs were allowed ad libitum access to water and feed. For the first week of the trial, nurseries were maintained at 85°F and reduced 3°F per week.

Diet Formulation. Dietary treatments, fed from d 0 to 14 (Table 1) after weaning, were arranged in a 2 × 6 factorial with an additional control treatment. All diets contained 25% dried whey, 5% lactose, and

[1]Appreciation is expressed to Newsham Hybrids, Colorado Springs, CO for providing the pigs used in this experiment.

[2]Food Animal Health and Management Center.

6% select menhaden fish meal; were formulated to contain 1.7% lysine, at least .48% methionine, .9% Ca, and .8% P; and were pelleted. The control diet contained 7.5% plasma and 15.7% soybean meal. Main effects included two levels of spray-dried animal plasma (2.5% and 5%) and six protein sources: spray-dried blood meal (AP 301G), spray-dried egg, spray-dried wheat gluten, extruded soy protein concentrate (Profine-E), select menhaden fish meal, and soybean meal. The protein sources replaced 2.5 or 5.0% spray-dried animal plasma in the control diet on a lysine basis except in the diets containing spray-dried wheat gluten. In these diets, spray-dried animal plasma was replaced on a protein basis, and synthetic lysine was added to compensate for the difference in lysine.

All pigs were fed the same diets from d 14 to 19 and d 19 to 26. The diet fed from d 14 to 19 was formulated to 1.45% total lysine, .40% methionine, .9% Ca, and .8% P. This diet was pelleted and contained 2.5% spray-dried animal plasma, 2.5% spray-dried blood meal, 2.5% select menhaden fish meal, and 20% dried whey. Pigs were fed a common diet from d 19 to 26, formulated to contain 1.35% lysine, .38% methionine, .9% Ca, and .8% P. This diet was fed in meal form and contained 10% dried whey and 2.5% spray-dried blood meal.

Statistical Analysis. Data were analyzed as a randomized complete block design in a 2 × 6 factorial arrangement with contrast statements investigating the mean differences between the control and other diets. Pigs were blocked by initial body weight, and pen served as the experimental unit. Data were analyzed for main effect differences (protein source and plasma replacement level) and two-way interactions. Analysis of variance was performed using the GLM procedure of SAS.

Results and Discussion

A protein source × protein source level interaction ($P < .05$) was observed for ADFI from d 0 to 14 after weaning (Table 2). The interaction was a result of pigs fed increasing levels of spray-dried blood meal, spray-dried egg, or soybean meal having decreased ADFI. However, pigs fed increasing levels of select menhaden fish meal, extruded soy protein concentrate, and spray-dried wheat gluten had constant or increased ADFI (data not shown). We did not observe an effect from increasing the level of plasma. Therefore, the interaction appeared to be influenced more by the amount of other protein sources in the diet than by the level of spray-dried animal plasma.

The level of protein source replacing spray-dried animal plasma did not influence ADG or feed efficiency for the d 0 to 14 period. However, the protein source did. Pigs fed diets containing select menhaden fish meal or extruded soy protein concentrate had increased ($P < .05$) ADG compared to pigs fed spray-dried blood meal, spray-dried egg, or spray-dried wheat gluten. The inclusion of soybean meal in the diet resulted in higher ADG ($P < .05$) than spray-dried egg. Pigs fed the control diet had intermediate ADG. Pigs fed diets containing spray-dried wheat gluten or soybean meal had intermediate F/G, whereas pigs fed diets containing spray-dried egg had decreased F/G ($P < .05$) as compared spray-dried blood meal, select menhaden fish meal, or extruded soy protein concentrate. In addition, pigs fed extruded soy protein concentrate had higher F/G than those fed the control diet.

From d 14 to 26 after weaning, when pigs were fed the same diet, ADG and F/G were not influenced ($P > .05$) by the protein source fed from d 0 to 14. Furthermore, ADG, ADFI, and F/G were not influenced by the amount of spray-dried animal plasma replaced in previous diets. However, pigs previously fed select menhaden fish meal subsequently consumed more feed ($P < .05$) than pigs fed spray-dried wheat gluten, extruded soy protein concentrate, spray-dried egg, spray-dried blood meal, or the control diet. Pigs fed soybean meal from d 0 to 14 after weaning subsequently consumed more feed than pigs initially fed the control diet.

For the overall trial (d 0 to 26 after weaning), the level of spray-dried animal plasma in the diet from d 0 to 14 after weaning had no effect on growth performance. Pigs initially fed spray-dried egg had lower ($P < .05$) ADG than pigs fed select menhaden fish meal, extruded soy protein concentrate, soybean meal, or spray-dried wheat gluten. Additionally, pigs fed select menhaden fish meal from d 0 to 14 after weaning had overall higher ($P < .05$) ADG than pigs fed spray-dried blood meal. Pigs previously fed the control diet had intermediate cumulative ADG. Pigs fed spray-dried blood meal or spray-dried egg from d 0 to 14 after weaning had lower ($P < .05$) ADFI for the overall trial than pigs fed diets containing select menhaden fish meal, extruded soy protein concentrate, and soybean meal. Additionally, pigs initially fed select menhaden fish meal had higher ADFI than pigs initially fed spray-dried wheat gluten or the control. Feed efficiency for the overall trial was not influenced by the dietary protein source fed from d 0 to 14 after weaning.

Spray-dried blood meal has been shown previously to be a superior protein source. In our study, however, the inclusion of spray-dried blood meal did not result in superior performance compared to other protein sources. In fact, spray-dried blood meal resulted in lower ADG than select menhaden fish meal and extruded soy protein concentrate from d 0 to 14 and lower ADG and ADFI than select menhaden fish meal from d 0 to 28.

Spray-dried egg resulted in decreased growth performance when compared to soybean meal, extruded soy protein concentrate, and select menhaden fish meal. In addition, when spray-dried egg replaced more of the spray-dried animal plasma in the diet, the pigs' ADFI was lower from d 0 to 14 after weaning. More research is needed to define quality standards for spray-dried egg to help explain the differences in performance in different trials. Spray-dried wheat gluten has been shown to be an efficacious protein source to replace up to 50% of the spray-dried animal plasma in the diets for weanling pigs. In the present study, spray-dried wheat gluten had intermediate ADG and ADFI compared to the other protein sources.

Soybean meal proved to be as an efficacious protein replacement for spray-dried animal plasma. For pigs of high-health status, extruded soy protein concentrate had no advantage over soybean meal.

Pigs fed select menhaden fish meal consistently had excellent performance for the entire growth study. In addition, pigs had slightly improved ADFI from d 0 to 14 when select menhaden fish meal replaced larger amounts of spray-dried animal plasma. For the cumulative experiment (d 0 to 28) pigs fed select menhaden fish meal had higher ADG than pigs fed spray-dried blood meal and spray-dried egg.

Spray-dried blood meal and spray-dried egg have been shown to be a efficacious protein sources in nursery pig diets. However, in the present study, these sources resulted in the poorest growth performance throughout the experiment. Quality differences might explain the differences in growth performance between trials, so quality standards for protein sources should be established. These standards also would ensure an improvement in weanling pig growth performance as a result of the inclusion of the protein source.

Table 1. Diet Composition (As-Fed Basis), %[a]

		Protein Sources[b] plus Spray-Dried Animal Plasma (5.0-2.5%)											
		SDBM		SDEP		SMFM		ESPC		SBM		SDWG	
Ingredient, %	Control	5.0	2.5	5.0	2.5	5.0	2.5	5.0	2.5	5.0	2.5	5.0	2.5
Corn	31.40	31.67	31.94	29.11	26.82	30.96	30.41	29.78	28.11	27.99	24.58	31.28	31.12
SBM (48% CP)	15.74	15.74	15.74	15.74	15.74	15.74	15.74	15.74	15.74	21.68	27.61	15.74	15.74
SDAP	7.50	5.00	2.50	5.00	2.50	5.00	2.50	5.00	2.50	5.00	2.50	5.00	2.50
Lactose	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
Soybean oil	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00
SDBM	--	2.13	4.25	--	--	--	--	--	--	--	--	--	--
SDEP	--	--	--	4.95	9.90	--	--	--	--	--	--	--	--
SMFM	6.00	6.00	6.00	6.00	6.00	9.61	13.15	6.00	6.00	6.00	6.00	6.00	6.00
ESPC	--	--	--	--	--	--	--	4.14	8.27	--	--	--	--
SDWG	--	--	--	--	--	--	--	--	--	--	--	2.40	4.84
Dried whey	25.00	25.000	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00
Monocalcium phosphate (21% P, 18% Ca)	.66	.80	.94	.68	.71	.34	.04	.72	.78	.69	.73	.80	.94
Antibiotic[c]	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Limestone	.66	.44	.38	.38	.27	.18	--	.46	.41	.46	.41	.44	.38
L-lysine HCl	.15	.15	.15	.15	.15	.15	.15	.15	.15	.15	.15	.33	.50
DL-methionine	.17	.20	.22	.10	.03	.15	.13	.16	.16	.16	.15	.14	.10
Premix	.40	.40	.40	.40	.40	.40	.40	.40	.40	.40	.40	.40	.40
Zinc oxide	.38	.38	.38	.38	.38	.38	.38	.38	.38	.38	.38	.38	.38
Salt	.10	.10	.10	.10	.10	.10	.10	.10	.10	.10	.10	.10	.10
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

[a]Experimental diets were fed from d 0 to 14 and formulated to contain 1.7% lysine, .48% methionine, .9% Ca, and .8% phosphorus.
[b]SDBM (spray-dried blood meal), SDEP (spray-dried egg), SMFM (select menhaden fish meal), ESPC (extruded soy protein concentrate), SDWG (spray-dried wheat gluten), SBM (soybean meal).
[c]Provided 55 μg/kg of carbodox.

Table 2. Main Effects of Replacing a Portion of Spray-Dried Animal Plasma with Specialty Proteins on the Growth Performance of Early-Weaned Pigs[a]

		Protein Source[b]						Plasma Level		
Item	Control	SDBM	SDEP	SMFM	ESPC	SBM	SDWG	5.0	2.5	CV, %
Day 0 to 14										
ADG, lb[c]	.64[e,f]	.59[f,g]	.57[f]	.67[e]	.68[e]	.65[e,g]	.60[f,g]	.63	.63	11.6
ADFI, lb[d]	.67	.59	.61	.68	.67	.66	.62	.64	.64	8.5
F/G[c]	1.04[e,g]	.99[f,g]	1.08[e]	1.01[f,g]	.98[f]	1.02[e,f,g]	1.02[e,f,g]	1.01	1.02	6.5
Day 14 to 26										
ADG, lb	1.03	1.06	.99	1.12	1.05	1.06	1.10	1.06	1.07	10.1
ADFI, lb[c]	1.43[g]	1.47[f,g]	1.46[f,g]	1.57[e]	1.49[f,g]	1.52[e,f]	1.48[f,g]	1.50	1.50	6.3
F/G	1.39	1.39	1.47	1.41	1.41	1.45	1.35	1.41	1.41	9.2
D 0 to 26										
ADG, lb[c]	.82[e,f,g]	.81[e,g]	.76[e]	.88[f]	.85[f,g]	.84[f,g]	.83[f,g]	.83	.83	8.8
ADFI, lb[c]	1.02[e,f,g]	.99[e]	1.00[e]	1.09[g]	1.05[f,g]	1.06[f,g]	1.02[e,f]	1.04	1.04	6.2
F/G	1.25	1.23	1.32	1.23	1.22	1.27	1.22	1.25	1.25	6.5

[a]Three hundred ninety pigs (initially 4.2 kg and 13 ± 2 d of age) were used with five pigs/pen and six pens/treatment.
[b]SDBM (spray-dried blood meal), SDEP (spray-dried egg), SMFM (select menhaden fish meal), ESPC (extruded soy protein concentrate), SDWG (spray-dried wheat gluten), SBM (soybean meal)
[c]Portein source main effect ($P < .05$).
[d]Interaction (protein source × plasma replacement level) $P < .05$.
[e,f,g,h]Means on the same row within control or protein source with different subscripts differ ($P < .05$).