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FEEDING MANAGEMENT STRATEGIES FOR EARLY WEANED PIGS USING SPRAY DRIED PORCINE PLASMA AND PELLETED DIETS FOLLOWING TREATMENT FOR *S. SUIS* INFECTION

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ABSTRACT

Three-hundred-seventy-eight, 18-21 day-old, pigs were used to evaluate subsequent weanling pig performance, during the second and third dietary phases, following initial phase 1 exposure to a commercial pelleted starter (CS) diet or farm processed wheat/barley/dried whey based starter diets prepared with, or without, spray dried porcine plasma (PPLS). One-half of the pigs in each treatment also received penicillin and *S. suis* antiserum as a preventative procedure for *S. suis* infection.

Experiment 1. Pigs were fed a 3-phase starter program as follows: phase 1 = 7 days, phase 2 = 7 days, and phase 3 = 14 days. Numerical differences were measured for ADG, feed intake and gain to feed ratio. Pigs fed the control starter consumed more (P<.05) feed/pound of gain than the CS group. When PPLS replaced fish meal, pig response was intermediate. Feed cost/pound of gain favored the control group. Progression through the 3 phases in this first experiment was too rapid for the immature digestive systems of young pigs.

Experiment 2. Feeding periods for the dietary phases were changed to the following: phase 1 = 7 days, phase 2 = 14 days and phase 3 = 7 days. Phase 1 ADG and feed intake for the pelleted CS and PPLS were similar, and greater (P<.05) than the control, however, feed efficiencies were similar. Phase 1 feed costs were lowest for the

control, and highest for the CS group. Subsequent performance in phases 2 and 3 favored the pelleted CS, in which, ADG, feed intake and feed cost/pound of gain were better than either the control or PPLS supplemented starters. Compared to the control, pig gain for the 28-day period translated into 27.7% and 16.8% heavier pigs in the CS and PPLS groups, but cost more to achieve.

Experiment 3. Phase lengths were adjusted a third time as follows: Phase 1 = 14 days and phases 2 and 3 were fed for 7 days each. For pigs receiving the CS in phase 1, ADG tended to be greater, and the feed to gain ratio was significantly (P<.05) lower. In the 2nd and 3rd phases following CS in phase 1, where meal diets were fed, ADG and feed intake were higher (P<.05) when preceded by the CS. In addition, there was a trend toward lower feed:gain ratio, but feed cost/pound of gain was higher (P<.05) for the CS. For the 28-day period, using pelleted CS resulted in faster ADG, increased feed intake and improved feed efficiency, but when the higher cost for CS used in phase 1 was included, feed cost/pound of gain was higher(P<.05) than the control, and equal to the PPLS group. Compared to the control and PPLS groups, CS pigs were 23.2% and 26.3% heavier, respectively, at the end of the study.

Pig response in phases 2 and 3 were strong indicators of weaning transition success and nursery acclimitization that occurred in the first phase. Consistently better pig performance was obtained when the nutrient-dense, pelleted, CS preceded phase 2 meal diets that were fed longer (14 vs. 7 days). Cost is obviously important. Control starters were more economical to feed with respect to feed cost/per pound of gain, however, the pigs were lighter at the end of the 28 day period. Pelleted starters helped promote quick, strong gains that are essential in developing early weaned pigs.

Pre-treatment with penicillin and *S. suis* antiserum injections did not improve pig performance, suggesting that the low grade infection was not of sufficient magnitude to affect pig growth.

INTRODUCTION

Matching feeding management methods to the growth curve of young swine (18-21 days) can have a pronounced effect on post weaning growth and feeding economics. Physical form, dietary protein quality and energy are criteria that, when in proper balance, will allow pigs to grow at or near their genetic potential.

A review of the scientific literature reveals spray-dried porcine plasma and dried whey to be important ingredients for young weanling pigs. Pelleting, as well, is a beneficial processing method. Evaluated in numerous experiments, pelleting has repeatedly been shown to enhance growth performance. Factors attributed to improved performance include reduced feed waste, increased diet digestibility, improved growth rate and feed efficiency (Patience and Thacker, 1989). Greatest response to pelleting occurs when fibrous basal grains, like barley, are pelleted.

Animal protein supplements (porcine plasma, dried whey, dried skim milk, caesin, lactose/starch, porcine blood, bovine plasma and meat extract) have been evaluated in the diets of early-weaned pigs by Hansen and co-workers (1993). Of the supplement sources tested, porcine plasma (10.3%) fed in conjunction with dried whey (20%) and added lactose (10%) resulted in significantly higher average daily gain (ADG) and average daily feed intake, during the first two weeks after weaning, and for the entire 35 day post weaning period.

1. Beneficial responses from dietary dried whey by young pigs has been known for some time. The trend toward earlier weaning of pigs has resulted in a greater reliance on whey in starter diets. Mahan et al. (1993) summarized the impact of dried whey and lysine inclusion in early-weaned pig diets, and concluded that good quality whey enhanced growth rates, feed intakes and gain:feed response.

   A common practice among hog producers is to start freshly weaned pigs on a pelleted commercial weaning ration containing high levels of dried whey followed by switching to farm processed rations after the first 7 to 14 days. Since porcine plasma and dried whey are important ingredients in the initial diets of early-weaned pigs, and pelleting has repeatedly been shown to improve performance, feeding management strategies were evaluated around nutrient dense diets containing a full compliment of dried whey and 4% spray dried porcine plasma.

   Objectives in this piglet feeding management investigation included:

1. Evaluate the subsequent impact on weanling pig performance during the second and third dietary phases following initial exposure to a commercial pelleted diet and farm processed wheat/barley/dried whey based starter diets prepared with and without spray-dried porcine plasma.
2. Evaluate pig response by phase and overall performance when the length of phase feeding time varied in a

three phase feeding system.

3. To evaluate the effect on piglet performance following application of a *S. suis* prevention regime that included administration of a synthetic penicillin, amoxicillin, and *S. suis* antiserum.

MATERIALS AND METHODS

Three hundred seventy-eight (378) weanling pigs (18-21 days) were randomly allotted to three dietary treatments in three triple replicated experiments of 126 pigs each.

Experiment 1. A farm processed (**FP**) wheat/barley/dried whey based control diet was compared to a similar diet containing 4% spray dried porcine plasma (**PPLS**), and a pelleted commercial starter (**CS**) diet also containing dried whey and spray dried porcine plasma. The farm processed diets and nutrient analysis of all diets are shown in table 1.

Pigs used in each experiment were transferred immediately after weaning, weighing and vaccination (3-way vaccine; Schering-Plough) to a confinement nursery building and allotted to experimental treatments. Seven pigs were allotted per pen, and there were three replicates per treatment. Pen served as the experimental unit. The nursery building used is a modular 12'x54' structure equipped with stainless steel pens (16 sq. ft.) and feeders, Filter-eze[R] flooring, "pull plug" type self contained manure pits, positive ventilation and computer modulated ventilation and heat control.

Initial nursery room temperature was 85^{o}F. A computer ramping feature in the facilities environ-mental control system was set to lower room tem-perature one-half degree daily from 85^{o}F to 75^{o}F.

The pelleted **CS** diet (Vigorstart 120 C - Med) was purchased from Vigortone Ag Products' local retailer, Steffan Feeds, Dickinson, ND 58601. The **FP** diets were prepared using a New Holland 355 grinder/mixer equipped with electronic scale and 1/8" screen. The experimental diets were weighed into each pen and self-fed. Pigs and feed were weighed at the beginning and at the end of each dietary phase change.

Experiments 2 and 3. Diets and handling procedures in the second and third experiments were the same as those in experiment 1 except the length of time each phase was fed varied. Variations in phase length are shown in table 2.

Determining whether using a preventative treatment with an antibiotic and *S. suis* antiserum would reduce the influence of *S. suis* infection on performance was accomplished by adding an additional set of replicates to each treatment in the three experiments. Each piglet assigned to the additional treatment replicates received 1cc (15mg.) of amoxicillin and 1cc of *S. suis* antiserum subcutaneously in the neck when weaned.

Pigs in all treatments were fed for four seven day periods for a total feeding period of 28 days.

All data were analyzed using the GLM procedures of SAS (1985). Pen was the experimental unit. Main effects, production variables and all possible interactions were tested.

RESULTS AND DISCUSSION

Experiment 1. Control, plasma supplemented and pelleted commercial post-weaning starter diets were offered to 126 (14-15 pound) pigs during the first 7 days post-weaning. After an initial seven day exposure to the starter diets, the pigs were switched to a common farm processed phase 2 diet for seven days and a phase 3 diet for 14 days. Combined growth, antibiotic /antiserum treatment and piglet response to initial starter diet types and subsequent response to dietary phase changes are shown in table 3. No differences were measured between the starters for ADG, feed/head/day, and feed to gain ratio during the first seven days after weaning. Control feed cost/pound of gain was considerably less than the CS and PPLS groups. In the second phase, also fed for seven days, pigs that received the control and CS diets during phase 1 gained faster (P<.05) than the group supplemented with porcine plasma. Pigs offered common phase 2 diets that had previously received CS consumed less phase 2 feed/day (P<.05), and tended toward better feed and gain efficiency. When the common phase 3 diet was fed, no difference in ADG or feed efficiency was measured. Pig response for the combined 28-day period was variable depending on the criteria considered. There was no difference in ADG between treatments, but pigs started on pelleted CS consumed less feed/pound of gain compared to the control group, and tended to be more efficient when compared to the plasma diet. Feed cost/pound of gain favored the control starter. Feed costs/pound of gain were $.21, $.22, and $.23 for the control, commercial starter pellet, and plasma supplement, respectively, which translates into feed costs/pig of $3.86, $3.96, and $4.14 for the control, PP, and pelleted CS groups.

Experiment 2. Data for experiment 2 is shown in table 4. In this experiment, feeding time for common phase 2 and 3 diets was reversed. Following exposure to phase 1 diets for seven days, phase 2 was fed for 14 days and phase 3 for 7 days. In phase 1, ADG and feed/head/day for the CS and PP were similar and greater (P<.05) than the control diet, however, feed efficiency was similar. Feed cost/pound of feed for the short 7 day period was considerably lower (P<.05) for the control group. Subsequent performance in phase 2 and 3 following phase 1 experimental starters favored the pelleted CS , in which ADG, feed intake and gain cost efficiency were better than either the control or plasma supplemented starters. For the full 28-day period, gain and feed consumption were higher for the pelleted CS pigs compared to the control starter. Performance of plasma supplemented pigs was intermediate. Gain performance for the 28 days translated into pigs that were 27.7% and 16.8% heavier for the CS and PPLS pigs, respectively. Economic efficiency favored the control group. Gain costs were $3.66, $4.58, and $5.28 for the control, PPLS, and pelleted CS, respectively.

Experiment 3. In the third experiment, phase 1 feeding time was extended to 14 days and phases 2 and 3 were 7 days each. Data has been summarized in table 5. Average daily gain in phase 1 tended to be slightly greater for the pelleted CS, but the feed to gain ratio was significantly better (P<.05). Feed cost/pound of gain for the CS was much higher (P<.05). Subsequent growth during phases 2 and 3 were remarkably good for all starter types. Pelleted starter groups had faster gains (P<.05), though, and consumed less daily feed in phase 2, but in phase 3 consumption was higher. Significant differences in feed efficiency were not measured during phases 2 and 3, however, a trend toward improved feed efficiency following the CS was recorded. Feed cost/pound of gain also tended to favor the pelleted starter, but was not of sufficient magnitude to offset the cost of feeding the pellet for 14 days in phase 1. For the 28-day nursery period, the pelleted CS resulted in faster ADG, increased feed consumption, improved feed efficiency and higher cost/pound of gain (P<.05). Compared to the pelleted CS, the control and plasma supplemented pigs were 23.2% and 26.3% lighter, respectively. Feed cost/pound of gain favored the control pigs that cost $.05 less/pound of gain than either the PPLS or pelleted CS. Gain costs were $4.03, $4.70, and $6.38 for the control, PPLS, and pelleted CS groups.

The penicillin/*S. suis* antiserum treatment administered at weaning did not improve performance in any of the experiments, as shown in Tables 3, 4 and 5, suggesting that the low grade infection present was not of sufficient magnitude to affect pig growth.

Dietary phase changes reduce nutrient density provided by highly digestible ingredients, and subsequently, feed cost. In an effort to reduce the amount of time high cost diets were fed in experiment 1, the progression through the first two phases was accelerated. Compared to the performance of pigs in experiments 2 and 3, where feeding periods for phases 1 and 2 were longer, these data suggest that length of time the early phases were fed was too short for the immature digestive systems of young pigs in transition, and experiencing weaning stress.

Spray-dried porcine plasma was added at 4% of the diet as a replacement for nearly all of the fish meal. Hansen et al. (1993) found a progressive improvement over control pigs with each plasma addition from 2 to 10% of the diet. Kats et al. (1994) found that adding porcine plasma at levels greater than 4% of the diet did not improve gain to feed ratios. Since the 4% level was a practically priced level, and had been determined to be a pivotal level in other swine nursery research, it was selected to replace fish meal at the 4% level in these experiments. Adding 4% plasma supported pig responses that were equal to, or slightly better than, the control diets, but were more costly/pound of gain.

IMPLICATIONS

Pig response in phases 2 and 3 were strong indicators of weaning transition success and nursery acclimitization that occurred in the first phase. Consistently better pig performance was obtained when the nutrient-dense, pelleted, CS preceded phase 2 meal diets that were fed 14 days. Cost is obviously important. Control starters were more economical to feed, with respect to feed cost/per pound of gain, however, the pigs were lighter at the end of the 28 day period. Pelleted starters helped promote quick, strong gains that are essential in developing early weaned pigs. here.

Table 1. Weanling pig diet composition fed during phase 1 and common diet formulations

fed across treatments during phases 2 and 3.

	EXPERIMENTAL DIET COMPOSITION (%)				
	PHASE I			PHASE II	PHASE III
	CTRL	CTRL + PLASMA	COMMERCIAL STRTR.		
Spr. Wheat	24 .3	24.3		41.8	35.4
Barley	19.1	18.9		21.3	38.8
Whey	24.2	24.2		7.42	0.0
SBOM	19.2	19.2		17.8	18.0
Fish Meal	5.9	1.9		3.96	0.0
Soybean Oil	4.0	4.0		3.95	3.46
Tr. Mineral	1.45	1.45		1.7	2.0
Lysine	0.33	0.25		0.4	0.6
Vit B Comp.	0.164	0.164		0.197	0.166
Vit A,D&E	0.05	0.05		0.05	0.05
Copper Sulf.	0.08	0.08		0.08	0.05
Porcine Plasma	0.0	4.0		0.0	0.0
Mecadox Med.	1.22	1.22		0.62	0.62
Analysis (%):					
Dry Matter	89.6	89.6	89.6	89.4	89.0

C. Protein	20.7	21.3	20.0	19.9	18.3
C. Fat	5.7	5.4	7.5	5.6	4.9
C. Fiber	3.0	3.0	2.5	3.5	4.2
Calcium	0.81	0.70	---	0.88	0.71
Total Phos.	0.78	0.73	---	0.68	0.58
Avail. Phos.	0.54	0.42	---	0.44	0.31
Lysine	1.50	1.50	1.50	1.38	1.29
Met. En (kcal)	3234	3253	---	3246	3179
Cost/lb., $	.1915	.2777	.3600	.1309	.0939

Table 2. Feeding intervals evaluated in objective 2.

FEEDING INTERVALS (Days)

PHASE: PHASE I PHASE II PHASE III

Expt. 1 7 7 14

Expt. 2 7 14 7

Expt. 3 14 7 7

Table 3 Combined growth and antibiotic/antiserum treatment on performance and piglet

response to dietary phase changes [Expt.1] Phase Lengths: Phase 1 = 7 Da, Phase 2 = 7 Da, Phase 3 = 14 Da

COMBINED PERFORMANCE

Item	Control	Pellet	Plasma	SEM
Starting Wt.	15.1	14.4	14.5	--
End Wt.	33.5	33.2	31.7	--
Gain	18.4	18.8	17.2	--
ADG	.66	.67	.61	.030
Fd/Hd/Da	1.22^{a}	1.13^{ab}	1.05^{b}	.040
Fd:Gain	1.87^{a}	1.68^{b}	1.74^{ab}	.058
Fd Cost/Hd/Da	$.14	$.15	$.14	.005
Fd Cost:Gain	$.21	$.22	$.23	.006

COMBINED PERFORMANCE - ANTIBIOTIC/ANTISERUM

	WITH	**WITHOUT**	**SEM**
ADG	.63	.66	.30
Fd/Hd/Da	1.12	1.15	.493
Fd:Gain	1.80	1.74	.403
Fd Cost/Hd/Da	$.14	$.14	.668

Fd Cost:Gain	$.22	$.21	.195

PHASE PERFORMANCE										
DAYS FED	**PHASE 1**			**PHASE 2**			**PHASE 3**			SEM
	7			**7**			**14**			
Item	**Ctrl**	**Pel**	**Plas**	**Ctrl**	**Pel**	**Plas**	**Ctrl**	**Pel**	**Plas**	
ADG	.35	.41	.41	.75^{a}	.70^{a}	.57^{b}	.76	.79	.73	.034
Fd/Hd/Da	.50	.50	.61	1.13^{a}	.95^{b}	.91^{b}	1.63^{a}	1.53^{a}	1.35^{b}	.033
Fd:Gain	1.42	1.22	1.68	1.52	1.35	1.67	2.17	1.95	1.87	.127
Fd Cost/Hd/Da	$.10^{a}	$.18^{b}	$.17^{b}	$.15^{a}	$.12^{b}	$.12^{b}	$.15^{a}	$.14^{ab}	$.13^{b}	.006
Fd Cost : Gain	$.27^{a}	$.44^{b}	$.47^{b}	$.20	$.18	$.22	$.20	$.18	$.18	.023
a,b,c Values in same row with different superscripts differ (P<.05).										

Table 4. Combined growth and antibiotic/antiserum treatment on performance and piglet response to dietary phase changes [Expt.2] Phase Lengths: Phase 1 = 7 Da, Phase 2 = 14Da, Phase 3 = 7

COMBINED PERFORMANCE

Item	Control	Pellet	Plasma	SEM
Starting Wt.	15	15.7	15.2	
End Wt.	30.9	37.7	33.5	
Gain	15.9	22.0	18.3	
ADG	$.56^{a}$	$.79^{b}$	$.65^{ab}$	.032
Fd/Hd/Da	$.99^{a}$	1.31^{c}	1.18^{b}	.036
Fd:Gain	1.79	1.68	1.81	.052
Fd Cost/Hd/Da	$\$.13^{a}$	$\$.19^{c}$	$\$.16^{b}$	.005
Fd Cost:Gain	$.23	$.24	$.25	.011

COMBINED PERFORMANCE - ANTIBIOTIC/ANTISERUM			
	WITH	WITHOUT	SEM
ADG	.63	.70	.091
Fd/Hd/Da	1.12^{a}	1.21^{b}	.044
Fd:Gain	1.79	1.74	.416
Fd Cost/Hd/Da	$\$.15^{a}$	$\$.17^{b}$	.047
Fd Cost:Gain	$.25	$.24	.504

PHASE PERFORMANCE										
	PHASE 1 7			**PHASE 2** 14			**PHASE 3** 7			SEM
Item	**Ctrl**	**Pel**	**Plas**	**Ctrl**	**Pel**	**Plas**	**Ctrl**	**Pel**	**Plas**	
ADG	.35[a]	.47[ab]	.51[b]	.63[a]	.88[b]	.68[a]	.64[a]	.91[b]	.74[a]	.035
Fd/Hd/Da	.5[a]	.62[ab]	.71[b]	1.03[a]	1.37[b]	1.16[a]	1.43[a]	1.89[c]	1.68[b]	.038
Fd:Gain	1.49	1.32	1.42	1.66	1.56	1.73	2.34	2.09	2.28	.107
Fd Cost/Hd/Da	$.10[a]	$.23[c]	$.20[b]	$.14[a]	$.18[b]	$.15[a]	$.13[a]	$.18[b]	$.16[c]	.007
Fd Cost : Gain ADG	$.28[a]	$.48[c]	$.39[b]	$.22	$.20	$.23	$.22	$.20	$.21	.016
a,b,c Values in same row with different superscripts differ (P<.05).										

Table 5. Combined growth and antibiotic/antiserum treatment on performance and piglet response to dietary phase changes [Expt.3] Phase Lengths: Phase 1=14 Da, Phase 2=7 Da, Phase 3=7 Table

COMBINED PERFORMANCE

Item	**Control**	**Pellet**	**Plasma**	**SEM**
Starting Wt.	12.2	12.1	11.9	
End Wt.	29.7	34.9	28.7	

Gain	17.5	22.8	16.8	
ADG	.62[a]	.81[b]	.60[a]	.024
Fd/Hd/Da	1.06a	1.26[b]	1.03[a]	.035
Fd:Gain	1.71[a]	1.55[b]	1.72[a]	.035
Fd Cost/Hd/Da	$.14[a]	$.22[b]	$.17[a]	.005
Fd Cost:Gain	$.23[a]	$.28[b]	$.28[b]	.006

COMBINED PERFORMANCE - ANTIBIOTIC/ANTISERUM			
	WITH	**WITHOUT**	**SEM**
ADG	.68	.68	.776
Fd/Hd/Da	1.10	1.13	.456
Fd:Gain	1.63	1.68	.167
Fd Cost/Hd/Da	$.18	$.18	.34
Fd Cost:Gain	$.26	$.27	.07

PHASE PERFORMANCE				
	PHASE 1	**PHASE 2**	**PHASE 3**	

Days Fed	14			7			7			SEM
Item	**Ctrl**	**Pel**	**Plas**	**Ctrl**	**Pel**	**Plas**	**Ctrl**	**Pel**	**Plas**	
ADG	.43	.53	.43	.69^{a}	.99^{b}	.66^{a}	.95^{a}	1.21^{b}	.88^{a}	.042
Fd/Hd/Da	.64	.68	.68	1.22^{a}	1.58^{b}	1.13^{a}	1.74^{a}	2.11^{b}	1.64^{a}	.042
Fd:Gain	1.52^{b}	1.29^{a}	1.57^{b}	1.80	1.60	1.75	1.85	1.74	1.90	.042
Fd Cost/Hd/Da	\$.12^{a}	\$.25^{c}	\$.19^{b}	\$.16^{a}	\$.21^{b}	\$.15^{a}	\$.16^{a}	\$.20^{b}	\$.15^{a}	.042
Fd Cost : Gain	\$.29^{a}	\$.47^{c}	\$.43^{b}	\$.23	\$.21	\$.23	\$.17	\$.16	\$.18	.042
a,b,c Values in same row with different superscript letters differ (P<.05).										

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