USE OF WHEY PROTEIN CONCENTRATE, DRIED BUTTERMILK, AND PORCINE PLASMA PROTEIN TO REPLACE DRIED SKIM MILK IN DIETS FOR WEANLING PIGS

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Summary

One hundred thirty-two weanling pigs, with an average age of 19 d and average weight of 8.4 lb, were used in a 28-d growth assay to determine the effects of replacing dried skim milk (DSM) with dried whey protein concentrate (WPC), dried buttermilk (DBM), and spray-dried porcine plasma (SDPP). Treatments were 1) 20% DSM-20% dried whey-based control, 2) WPC used to replace the DSM of Diet 1, 3) DBM used to replace the DSM of Diet 1, and 4) SDPP and lactose used to replace the DSM of Diet 1. All diets were formulated to 1.4% lysine, 25% lactose, 5% fat, .9% Ca, and .8% P. These diets were fed from d 0 to 14 with a corn-soybean meal - dried whey - fish meal - based diet fed to all pigs from d 14 to 28. For d 0 to 14, pigs fed the alternative protein sources (WPC, DBM, and SDPP) had average daily gain (ADG), average daily feed intake (ADFI), and feed/gain (F/G) similar to pigs fed DSM. Pigs fed SDPP had the greatest ADG and ADFI but poorer F/G than pigs fed WPC and DBM. Pigs fed WPC had greater ADFI than pigs fed DBM. There were no differences among treatments for DM or N digestibilities. For d 14 to 28, there were no differences in ADG or ADFI among treatments. However, pigs fed WPC and DBM had numerically greater ADG than pigs fed SDPP (.99 vs .95 lb/d) corresponding closely with the 5% improvement in F/G. Overall (d 0 to 28), there were no differences in ADG among treatments. However, pigs fed SDPP consumed more feed and had poorer F/G compared to pigs fed WPC and DBM. Considering overall pig performance, WPC, DBM, and SDPP are acceptable substitutes for DSM in diets for early-weaned pigs.

(Key Words: Whey Protein Concentrate, Dried Buttermilk, Porcine Plasma, Skim Milk, Nursery.)

Introduction

Use of dried skim milk (DSM) in diets for early-weaned pigs has been a common practice during the last decade. It has allowed producers to reduce weaning age and maintain acceptable pig performance. However, DSM is expensive, and alternative protein sources are needed that reduce diet cost without loss of pig performance. With these concerns in mind, an experiment was conducted to determine the effects of replacing DSM with whey protein concentrate (WPC), dried buttermilk (DBM), and spray-dried porcine plasma (SDPP) in diets for weanling pigs.

Procedures

One hundred thirty-two weanling pigs, with an average age of 19 d and average weight of 8.4 lb, were used in a 28-d growth assay. Treatments were 1) 20% DSM-20% dried whey-based control, 2) WPC used to replace the DSM of Diet 1, 3) DBM used to replace the DSM of Diet 1, and 4) SDPP and lactose used to replace the DSM of Diet 1. These diets were formulated to 1.4% lysine, .9% Ca, and .8% P and fed in pelleted form (Table 1). For d 14 to 28, all pigs were given a corn-soybean meal-dried whey-fish meal-based diet formulated to 1.2% lysine, .8% Ca, and .7% P and fed in meal form.

Pigs were housed in 3.5 ft × 5 ft pens with rubber coated, expanded metal flooring. Room temperatures were 90, 86, 82, and 78°F for wk 1 to 4, respectively. Each pen had a self-feeder and nipple waterer to allow ad libitum consumption of feed and water. Pigs and feeders were weighed weekly to allow calculation of average daily gain (ADG), average daily feed intake (ADFI), and feed/gain (F/G). Fecal samples were collected on d 13 to allow calculation of apparent DM and N digestibilities.

Results and Discussion

Whey protein concentrate was similar to DSM for CP concentration (Table 2). However, lysine concentration (especially when expressed as a percentage of CP) was greater for WPC than DSM. Perhaps the most appealing characteristic of WPC was that its average cost was less than half the cost of DSM during the past year. Dried buttermilk was similar to DSM in CP and lysine concentrations, but had 6% milk fat, which should be readily utilized by weanling pigs. Spray-dried plasma protein had the greatest CP and lysine concentrations with only slightly lower lysine as a percentage of CP compared to WPC. Thus, the high cost of SDPP is deceiving because when 166 lb of spray-dried plasma protein was blended with 200 lb of lactose to replace DSM in the control diet, the cost was $1.05/lb for the blend.

For d 0 to 14, pigs fed the alternative protein sources (WPC, DBM, and SDPP) had similar ($P > .10$) ADG, ADFI, and F/G compared to pigs fed DSM (Table 3). Pigs fed SDPP had greater ADG ($P < .01$) and ADFI ($P < .001$) but poorer F/G ($P < .01$) than pigs fed WPC and DBM. These results are consistent with reports from Iowa State University, Kansas State University, Oklahoma State University, and others that indicate greater ADG and ADFI and only slight losses in efficiency of gain in weanling pigs fed SDPP. Pigs fed WPC had greater ADFI ($P < .06$) than pigs fed DBM. There were no differences ($P > .12$) among protein sources in DM and N digestibilities at d 13.

For d 14 to 28, there were no differences ($P > .10$) in ADG, ADFI, and F/G for DSM vs the alternative protein sources (WPC, DBM, and SDPP). However, within the alternative protein sources, pigs fed WPC and DBM tended to have the greatest ADG and had improved F/G ($P < .01$) compared to those fed SDPP.

Overall, ADG was similar among treatments. Pigs fed SDPP had greater overall ADFI ($P < .06$) resulting from greater appetite from d 0 to 14, and inferior F/G compared to pigs fed WPC and DBM ($P < .06$). The tendency for greater rates and efficiencies of growth during d 14 to 28 for pigs fed WPC and DBM vs DSM and SDPP from d 0 to 14 indicates carryover effects for the protein sources. Indeed, other research in this booklet indicates that choice of protein source from d 0 to 14 will determine if advantages from feeding SDPP from d 0 to 14 are lost or maintained. Such research to identify complementary protein sources (if any) for WPC and DBM is yet to be conducted.

In conclusion, WPC, DBM, and SDPP can effectively replace DSM in diets for the early-weaned pig. Furthermore, considering overall performance, WPC was a cost effective alternative to DSM when all pigs were changed to a corn-soybean meal-dried whey-fish meal-based diet for d 14 to 28 of the nursery phase.

Table 1. Diet Composition[a]

Item	DSM	WPC	DBM	SDPP
Corn	33.96	35.63	34.91	34.49
Soybean meal (48% CP)	19.85	19.85	19.85	19.85
Dried skim milk	20.00	—	—	—
Whey protein concentrate	—	16.15	—	—
Dried buttermilk	—	—	20.00	—
Spray-dried porcine plasma	—	—	—	8.30
Whey	20.00	20.00	20.00	20.00
Lactose	—	1.75	—	10.00
Lysine-HCl	—	—	.06	—
DL-methionine	—	—	—	.10
Soybean oil	3.00	2.70	2.00	3.00
Dicalcium phosphate	1.20	1.82	1.25	2.25
Limestone	.34	.45	.28	.36
Vitamins and minerals[b]	.65	.65	.65	.65
Antibiotic[c]	1.00	1.00	1.00	1.00
Total	100	100	100	100

[a]These diets were fed from d 0 to 14. All diets were formulated to 1.4% lysine, .9% Ca, and .8% P. All pigs were fed a corn-soybean meal-dried whey-fish meal-based diet from d 14 to 28 (formulated to 1.2% lysine, .8% Ca, and .7% P).

[b]KSU vitamin premix (.25%), KSU trace mineral premix (.15%), Se premix (.05%), copper sulfate (.10%), and chromic oxide (.10%).

[c]Day 0 to 14 antibiotic supplied 200 g furazolidone, 100 g oxytetracycline, and 90 g arsanilic acid per ton of diet. Day 14 to 28 antibiotic supplied 100 g chlortetracycline, 100 g sulfathiazole, and 50 g penicillin per ton of diet.

Table 2. Chemical Composition of Protein Sources

Item	Dried skim milk	Whey protein concentrate	Dried buttermilk	Spray-dried porcine plasma
Crude protein, %	33.3	34.5	32.0	70
Lysine, % of sample	2.54	3.12	2.28	6.10
Lysine, % of CP	7.6	9.0	7.1	8.7
Methionine, %	.62	.75	.55	.53
Fat, %	1.1	3.0	6.0	2.0
Lactose, %	52.0	52.6	51.5	—
Cost, $/cwt[a]	105	45	90	190

[a]Average cost for the last 12 months.

Table 3. Effects of Replacing DSM with Alternative Protein Sources[a]

	Protein sources (for d 0 to 14)				
Item	DSM[b]	WPC	DBM	SDPP	CV
d 0 to 14					
ADG, lb[d]	.53	.54	.50	.61	11.6
ADFI, lb[e,f]	.54	.55	.48	.66	9.4
F/G[d]	1.02	1.02	.96	1.08	5.9
Apparent digestibilities (d 13), %					
DM	89.8	90.3	90.1	88.8	2.1
N	84.8	84.5	85.5	81.6	5.0
d 14 to 28					
ADG, lb	.96	1.00	.98	.95	6.4
ADFI, lb	1.52	1.53	1.49	1.52	7.2
F/G[d]	1.58	1.53	1.52	1.60	2.9
d 0 to 28					
ADG, lb	.74	.77	.74	.78	7.6
ADFI, lb[c]	1.03	1.04	.98	1.09	7.0
F/G[c]	1.39	1.35	1.32	1.40	3.0

[a]132 weanling pigs with an average age of 19 d and average weight of 8.4 lb.
[b]DSM = dried skim milk, WPC = whey protein concentrate, DBM = dried buttermilk, and SDPP = spray-dried porcine plasma protein.
[cde]SDPP vs WPC and DBM ($P<.06$, $P<.01$ and $P<.001$, respectively).
[f]WPC vs DBM ($P<.06$).