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K-STATE Research and Extension

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Summary

A total of 4,100 weanling pigs (initially 12.9 ± 0.13 lb) were used in a 42-d study to determine the effect of two specialty corn protein products, Modified Corn Protein (MCP) and MOTIV (Cargill Starches, Sweeteners, & Texturizers, Blair, Nebraska), on growth performance and fecal dry matter (DM). At approximately 23 d of age, pigs were weaned and randomly placed in pens. Pens of pigs were then blocked by average pen weight and randomly allotted to one of four dietary treatments in a randomized complete block design with 50 and 52 pigs per pen and 20 replicate pens per treatment. The first dietary treatment contained 3.5% fish meal and 7.5% enzymatically treated SBM in phase 1 and 5% enzymatically treated SBM in phase 2 (high complexity). The second diet contained 5% enzymatically treated SBM, no fishmeal in phase 1 and 2.5% enzymatically treated SBM in phase 2 (medium complexity). This treatment diet contained approximately 6 and 3% more conventional SBM in phases 1 and 2 respectively than the high complexity diet. The final two treatment diets did not contain fishmeal or enzymatically treated SBM in phases 1 or 2, and those treatments were replaced by either 10% MCP or MOTIV in phase 1 and 5% in phase 2. The amount of L-Lys HCl was adjusted to achieve a similar level of conventional SBM as the high complexity diet in both phases. Diets were fed in three phases based on a feed budget with 4 and 12 lb/pig for phases 1 and 2, respectively. Phase 3 was a common diet fed to all pigs for the remainder of the study. Overall, pigs fed the medium complexity diets had a greater ($P < 0.05$) ADG and d 42 BW compared with pigs fed diets with MOTIV, while pigs fed the high complexity diets and those fed MCP intermediate diets showed intermediate results. Average daily feed intake was greater ($P < 0.05$) for pigs fed medium complexity diets compared with pigs fed diets containing MCP and MOTIV, while pigs fed high complexity diets were intermediate. No differences were observed for F/G among treatments. For fecal DM, pigs fed diets with MOTIV had increased ($P < 0.05$) fecal DM, compared to pigs fed medium complexity diets, with those fed the high

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complexity or MCP diets intermediate. There was no treatment effect on mortality or removals. In conclusion, the specialty corn protein products tested in this trial decreased ADG and ADFI in early nursery, which carried over to the overall performance. Additionally, increasing diet complexity in phase 1 and 2 diets did not improve performance compared to diets formulated to medium complexity.

Introduction

Highly digestible protein sources are commonly utilized in commercial nursery diets to aid the transition of weanling pigs from sow's milk to dry feed, as they provide readily digestible amino acids while minimizing the anti-nutritional factors typically associated with traditional soybean meal. Protein sources such as fish meal and enzymatically treated soybean meal are widely used due to their quality, but their relatively high cost drives the need for more economical alternatives to be identified that do not compromise pig growth performance. Recently, corn-derived protein products from the wet corn-milling process have emerged as potential alternative specialty protein sources. These products are derived from a corn manufacturing process where the starch, corn germ, and pericarp are removed from the corn kernel, leaving behind a protein-rich fraction with high levels of crude protein (> 69% CP, as-fed). However, limited data exist regarding their effects on nursery pig performance in commercial environments. For this reason, the present study aimed to evaluate the effects of two specialty corn protein-based products (MCP and MOTIV; Cargill Starches, Sweeteners, & Texturizers, Blair, Nebraska) on nursery pig growth performance and fecal dry matter compared to control diets formulated with increasing complexity.

Materials and Methods

The Kansas State University Institutional Animal Care and Use Committee approved the protocol used in this experiment. The study was conducted at the Swine Veterinary Center research facility located in St. Peter, MN. The experiment utilized two identical rooms that were completely enclosed, environmentally controlled, mechanically ventilated, and with totally slatted floors. Each pen contained a six-hole, dry self-feeder and a pan waterer to provide *ad libitum* access to feed and water. Feed additions were accomplished using a robotic feeding system (FeedPro, FeedLogic Corp., Wilmar, MN).

Animals and diets

A total of 4,100 weanling pigs (PIC line 42 × 337; initially 12.9 ± 0.13 lb) were used in a 42-d growth study. Pigs were weaned at approximately 23 d of age and randomly placed in pens and then pens were randomly allotted based on pen average weight to one of four dietary treatments in a randomized complete block design. A total of 80 pens were used with 50 to 52 pigs per pen (equal numbers of barrows and gilts in each pen) and 20 replications per treatment across two rooms. Daily feed additions to each pen were accomplished using a gravimetric robotic feeding system (FeedPro; Feedlogic Corp., Wilmar, MN) able to record feed weights delivered to individual pens.

Diets were fed in three phases (Table 1) based on feed budget: phase 1 was fed with 4 lb/pig which was from d 0 to approximately d 7, phase 2 was fed with 12 lb/pig from approximately d 7 to approximately d 20, and phase 3 was a common diet fed to all pigs for the reminder of the study. Treatments consisted of a high complexity diet which contained 3.5% fish meal and 7.5% enzymatically treated SBM in phase 1 and 5% enzymatically treated SBM in phase 2 (Table 1). The second treatment was a medium complexity diet which contained 5% enzymatically treated SBM and no fish

meal in phase 1 and 2.5% enzymatically treated SBM in phase 2. This diet contained greater amounts of conventional SBM than the high complexity diet. In the final two treatments, 10% MCP or MOTIV replaced fishmeal and enzymatically treated SBM in phase 1, and 5% MCP or MOTIV was added in phase 2. All phase 1 diets contained 2% plasma proteins and 15% whey permeate, and all phase 2 diets contained 7.5% whey permeate. The level of L-Lys HCl was adjusted to achieve a similar level of conventional SBM in the MCP and MOTIV diets, as the high complexity diet in both phases.

Pens of pigs were weighed 7 and 14 d post-placement and then biweekly until the end of the trial (approximately six weeks post-wean). While phase 2 was fed, fecal samples were collected on d 16 of the experiment from five randomly selected pigs from each pen to determine fecal dry matter percentage. Male and female pigs used for the sampling were balanced among treatments. Fecal samples were dried at 131°F (55°C) in a forced air oven, and the ratio of dried-to-wet fecal weight determined the fecal percentage dry matter.

Statistical analysis

Growth performance was analyzed as a randomized complete block design using the RStudio environment (Version 1.3.1093, RStudio, Inc., Boston, MA) using R programming language [Version 4.5.1 (2025-06-13), R Core Team, R Foundation for Statistical Computing, Vienna, Austria]. Pen was considered the experimental unit. The treatments were compared using a one-way ANOVA with treatment used as the fixed effect and block used as the random effect. For fecal DM, samples were analyzed using the pig as the experimental unit, treatment was used as a fixed effect, and block and pen were used as random effects. Results were considered significant with $P \leq 0.05$ and were considered marginally significant with $P \leq 0.10$.

Results and Discussion

From d 0 to 7, pigs fed medium complexity diets had greater ($P < 0.05$) ADG and d 7 body weight (BW) compared to pigs fed the high complexity diet, and both had greater ($P < 0.05$) ADG than the pigs fed MCP and MOTIV diets. Pigs fed the high and medium complexity diets both had greater ($P < 0.05$) ADFI than pigs fed either the diet with MCP or MOTIV, which were not different. Feed efficiency was improved ($P < 0.05$) for the pigs fed the medium complexity diet compared to the pigs fed the MOTIV diet, with the others intermediate.

From day 7 to 14 there were no differences in ADG or F/G. A treatment effect for ADFI was observed ($P = 0.044$), but treatment means did not separate. Day 14 BW was greater ($P < 0.05$) for pigs fed either the high or medium complexity diets compared to those fed either the MCP or MOTIV diets.

From day 14 to 28, there were no differences in ADG, but pigs fed the medium complexity diet had greater ($P < 0.05$) ADFI compared to pigs fed either the diet with MCP or MOTIV, with pigs fed the high complexity diet intermediate. This resulted in poorer ($P < 0.05$) F/G for pigs fed the medium complexity diet compared to those fed the diet with MOTIV, with the other treatments intermediate. On day 28, pigs fed the high and medium complexity diets had greater ($P = 0.001$) BW compared to pigs fed diets containing MCP or MOTIV, which did not differ.

From day 28 to 42, when only a common diet was fed, ADG and ADFI were not affected by previous treatment. But F/G was improved ($P < 0.05$) for pigs previously

fed MCP compared to those fed the high or medium complexity diets, with those fed the MOTIV intermediate.

Overall, pigs fed the medium complexity diet had the greater ($P < 0.05$) ADG compared to those fed the diets with MOTIV, with the others intermediate. Average daily feed intake was greater ($P < 0.05$) for pigs fed the medium complexity diet compared to either the diet with MCP or MOTIV, with the high complexity diet intermediate. There was no overall effect on F/G. Final BW was greater ($P < 0.05$) for pigs fed the medium complexity diets in phases 1 and 2 compared to those fed diets with MOTIV, with the other treatments intermediate.

Pigs fed diets with MOTIV had increased ($P < 0.05$) fecal DM compared to pigs fed the medium complexity diet, while pigs fed the MCP and high complexity diets were intermediate. No differences were observed among treatments for mortality, removals and total mortality, and removals during this study with mortality and removals being very low — less than 0.5% and 1.5%, respectively.

These data suggest that the specialty corn protein products used in this study decreased ADG and ADFI in early nursery, which carried over to the overall performance. Pigs fed the diets with MOTIV had the highest fecal DM, but all treatments resulted in fecal DM within a range typically observed with relatively healthy pigs, which was also confirmed with the low mortality and removal rates. Pigs fed with medium complexity diet had the best growth performance, including greater ADG, ADFI, and BW compared to pigs fed the high complexity diet.

Table 1. Phase 1 diet composition (as-fed basis)

Item	High complexity	Medium complexity	MCP	MOTIV
Ingredient. %				
Corn	47.76	46.48	48.61	48.39
Soybean meal, (47.7% CP)	19.09	25.63	19.10	19.08
Modified Corn Protein[1]	---	---	10.00	---
MOTIV[1]	---	---	---	10.00
Enzymatically treated SBM[2]	7.50	5.00	---	---
Bovine plasma	2.00	2.00	2.00	2.00
Fish meal	3.50	---	---	---
Whey permeate	15.00	15.00	15.00	15.00
Choice white grease	2.00	2.00	2.00	2.00
Calcium carbonate	0.35	0.55	0.60	0.60
Monocalcium phosphate (21% P)	0.80	1.20	1.10	1.05
Salt	0.40	0.40	0.10	0.23
L-Lys-HCl	0.32	0.37	0.22	0.46
DL-Met	0.18	0.21	0.13	0.08
L-Thr	0.18	0.20	0.19	0.19
L-Trp	0.03	0.02	0.06	0.06
L-Val	0.05	0.09	0.05	0.03
Trace mineral premix	0.15	0.15	0.15	0.15
Choline chloride 60%	0.05	0.05	0.05	0.05
Zinc oxide	0.40	0.40	0.40	0.40
Vitamin premix w/phytase[3]	0.25	0.25	0.25	0.25
Total	100.00	100.00	100.00	100.00

continued

Table 1. Phase 1 diet composition (as-fed basis)

Item	High complexity	Medium complexity	MCP	MOTIV
Calculated analysis				
SID AA, %				
Lys	1.35	1.35	1.35	1.35
Ile:Lys	58	58	58	58
Leu:Lys	117	115	164	159
Met:Lys	36	36	34	32
Met & Cys:Lys	58	58	58	58
Thr:Lys	65	65	65	65
Trp:Lys	20.0	20.0	20.0	20.0
Val:Lys	70	70	70	70
His:Lys	37	37	35	36
Total Lys, %	1.52	1.50	1.55	1.51
ME, kcal/lb	1,571	1,555	1,605	1,605
SID Lys:ME, g/Mcal	3.90	3.94	3.81	3.82
Na, %	0.40	0.40	0.40	0.40
Cl, %	0.71	0.71	0.50	0.63
CP, %	22.0	21.5	22.2	22.7
Ca, %	0.68	0.69	0.66	0.65
P, %	0.67	0.68	0.64	0.63
STTD P, %	0.57	0.57	0.57	0.57
Ca:P	1.03	1.03	1.03	1.03

[1] Cargill Starches, Sweeteners, & Texturizers, Blair, Nebraska.
[2] Enzymatically treated soybean meal, (HP300, Hamlet Protein, Findlay, OH).
[3] Quantum Blue (AB Vista) provided an assumed 0.12% release of STTD P.

Table 2. Phases 2 and 3 diet composition (as fed- basis)

	Phase 2				Phase 3
Item	**High complexity**	**Medium complexity**	**MCP**	**MOTIV**	**Common diet**
Ingredient, %					
Corn	55.03	54.22	55.33	55.20	66.18
Soybean meal (47.7% CP)	26.45	29.76	26.45	26.43	30.24
Modified Corn Protein[1]	---	---	5.00	---	---
MOTIV[1]	---	---	---	5.00	---
Whey permeate	7.50	7.50	7.50	7.50	---
Enzymatically treated SBM[2]	5.00	2.50	0.00	---	---
Choice white grease	2.00	2.00	2.00	2.00	---
Calcium carbonate	0.70	0.70	0.73	0.73	0.83
Monocalcium P (21% P)	1.10	1.10	1.05	1.05	0.85
Salt	0.60	0.60	0.45	0.50	0.60
L-Lys-HCl	0.43	0.42	0.34	0.46	0.42
DL-Met	0.21	0.21	0.17	0.15	0.18
L-Thr	0.21	0.21	0.20	0.20	0.19
L-Trp	0.03	0.03	0.05	0.05	0.04
L-Val	0.09	0.10	0.08	0.07	0.08
Trace mineral premix	0.15	0.15	0.15	0.15	0.15
Zinc oxide	0.26	0.26	0.26	0.26	---
Vitamin premix with phytase[3]	0.25	0.25	0.25	0.25	0.25
Total	100.00	100.00	100.00	100.00	100.00

continued

Table 2. Phases 2 and 3 diet composition (as fed- basis)

	Phase 2				Phase 3
Item	High complexity	Medium complexity	MCP	MOTIV	Common diet
Calculated analysis					
SID AA, %					
Lys	1.30	1.30	1.30	1.30	1.25
Ile:Lys	58	58	58	58	58
Leu:Lys	116	116	142	139	121
Met:Lys	37	37	36	35	36
Met & Cys:Lys	58	58	58	58	58
Thr:Lys	65	65	65	65	65
Trp:Lys	19.8	20.0	20.0	20.0	20.0
Val:Lys	70	70	70	70	70
His:Lys	37	37	36	37	38
Total Lys, %	1.44	1.44	1.46	1.45	1.39
ME, kcal/lb	1,541	1,537	1,562	1,562	1,490
SID Lys:ME, g/Mcal	3.83	3.84	3.77	3.78	3.81
Na, %	0.35	0.35	0.35	0.35	0.28
Cl, %	0.65	0.64	0.54	0.60	0.48
CP, %	20.9	21.0	21.4	21.6	20.6
Ca, %	0.71	0.72	0.70	0.70	0.69
P, %	0.63	0.63	0.62	0.62	0.57
STTD P, %	0.52	0.52	0.52	0.52	0.45
Ca:P	1.13	1.13	1.13	1.13	1.22

[1] Cargill Starches, Sweeteners, & Texturizers, Blair, Nebraska.
[2] Enzymatically treated soybean meal, HP300, Hamlet protein, Findlay, OH.
[3] Quantum Blue (AB Vista) provided an assumed 0.12% release of STTD P.

Table 3. Effects of two specialty corn protein products and diet complexity on nursery pig growth performance and fecal dry matter[1]

	High complexity	Medium complexity	MCP	MOTIV	SEM	*P* =
Initial BW, lb						
d 0	12.92	12.91	12.92	12.91	0.130	---
d 7	16.07[b]	16.26[a]	15.56[c]	15.52[c]	0.330	< 0.001
d 14	20.04[a]	19.99[a]	19.29[b]	19.22[b]	0.323	< 0.001
d 28	33.84[a]	33.84[a]	32.82[b]	32.84[b]	0.648	0.001
d 42	52.09[ab]	52.33[a]	51.24[ab]	51.09[b]	0.877	0.019
d 0 to 7						
ADG, lb	0.45[b]	0.48[a]	0.38[c]	0.37[c]	0.029	< 0.001
ADFI, lb	0.39[a]	0.41[a]	0.34[b]	0.34[b]	0.024	< 0.001
F/G	0.92[ab]	0.87[b]	0.99[ab]	1.05[a]	0.062	0.032
d 7 to 14						
ADG, lb	0.56	0.53	0.53	0.53	0.002	0.329
ADFI, lb	0.81	0.79	0.76	0.76	0.024	0.044
F/G	1.44	1.53	1.46	1.45	0.054	0.410
d 14 to 28						
ADG, lb	0.94	0.95	0.93	0.94	0.025	0.590
ADFI, lb	1.33[ab]	1.36[a]	1.29[b]	1.30[b]	0.029	0.006
F/G	1.42[ab]	1.43[a]	1.40[ab]	1.39[b]	0.013	0.024
d 28 to 42						
ADG, lb	1.40	1.42	1.42	1.40	0.021	0.638
ADFI, lb	2.13	2.16	2.12	2.12	0.047	0.474
F/G	1.52[a]	1.52[a]	1.50[b]	1.51[ab]	0.013	0.016
d 0 to 42 (Overall)						
ADG, lb	0.94[ab]	0.94[a]	0.92[ab]	0.91[b]	0.018	0.018
ADFI, lb	1.33[ab]	1.35[a]	1.30[b]	1.30[b]	0.027	0.003
F/G	1.42	1.43	1.41	1.42	0.006	0.140
Fecal DM, %2	23.6[ab]	22.8[b]	24.2[ab]	24.7[a]	0.42	0.015
Mortality, %	0.35	0.35	0.52	0.52	0.019	0.850
Removals, %	1.46	1.27	1.37	0.98	0.004	0.782
Mortality and removals, %	1.86	1.66	1.96	1.57	0.004	0.904

[a, b, c] Means within a row with different superscripts differ (P < 0.05).

[1] A total of 4,100 pigs (PIC line 42 × 337; initially 12.9 ± 0.13 lb) were used with 50 to 52 pigs per pen and 20 replicates per treatment. Diets were fed in three phases based on feed budget with phase 1 provided at 4 lb/pig from day 0 to approximately d 7, phase 2 provided at 12 lb/pig from approximately d 7 to approximately d 20, and phase 3 fed for the remainder of the study. The high complexity diet contained 3.5% fish meal and 7.5% enzymatically treated SBM in phase 1 and 5% enzymatically treated SBM in phase 2. The medium complexity treatment had no fish meal and 5% enzymatically treated SBM in phase 1 and 2.5% enzymatically treated SBM in phase 2. The MCP and MOTIV treatments had no fishmeal or enzymatically treated SBM in phases 1 or 2 and were included at 10% in phase 1 and 5% in phase 2, with the level of L-Lys HCl adjusted to achieve a similar level of conventional SBM as the high complexity treatment in both phases. Phase 3 was a common diet fed to all pigs.

[2] Fecal collections occurred on day 16 of the experiment while phase 2 feed was being fed for the determination of fecal dry matter.