Effects of AV-E Digest and XFE Liquid Energy on Nursery Pig Performance[1]

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Summary

A total of 347 nursery pigs (PIC 1050, initially 11.0 lb) were used in a 44-d trial. Pens of pigs were balanced by initial BW and randomly allotted to 1 of 8 dietary treatments with 9 replications per treatment. Pigs were fed in 3 dietary phases (Phase 1, d 0 to 9; Phase 2, d 9 to 23; and Phase 3, d 23 to 44). The 8 dietary treatments included: (1) control diet containing no specialty protein sources; (2) 7.1% PEP2+ in Phase 1 and no specialty protein sources in Phase 2 or Phase 3; (3) 7.1% PEP2+ and 3.75% spray-dried animal plasma (SDAP) in Phase 1, 3.8% PEP2+ in Phase 2, and no specialty protein sources in Phase 3; (4) 7.1% PEP2+, 3.75% SDAP, and 3% liquid energy in Phase 1; 3.8% PEP2+ and 3% liquid energy in Phase 2; and 3% liquid energy but no specialty protein sources in Phase 3; (5) 7.1% PEP2+, 3.75% SDAP, and 3% choice white grease (CWG) in Phase 1; 3.8% PEP2+ and 3% CWG in Phase 2; and 3% CWG but no specialty protein sources in Phase 3; (6) 12.5% AV-E Digest (AV-E) and 2.5% spray-dried blood cells (SDBC) in Phase 1, 7.5% AV-E in Phase 2, and 2.5% AV-E in Phase 3; (7) 12.5% AV-E, 2.5% SDBC, and 3% liquid energy in Phase 1; 7.5% AV-E and 3% liquid energy in Phase 2; and 2.5% AV-E and 3% liquid energy in Phase 3; and (8) 12.5% AV-E, 2.5% SDBC, and 3% CWG in Phase 1; 7.5% AV-E and 3% CWG in Phase 2; and 2.5% AV-E and 3% CWG in Phase 3.

From d 0 to 9, pigs fed diets containing liquid energy tended ($P < 0.08$) to have improved ADG compared with pigs fed diets without liquid energy. No other differences between protein or energy sources were found. From d 9 to 23, pigs fed diets containing AV-E had greater ADG ($P < 0.04$) and tended to have improved F/G ($P < 0.10$) compared with pigs fed diets containing PEP2+. Pigs fed CWG had better ($P < 0.01$) F/G than pigs fed liquid energy. From d 23 to 44, ADG and F/G were improved ($P < 0.01$) from feeding CWG. Also, pigs fed CWG tended ($P < 0.07$) to have greater ADG and better ($P < 0.001$) F/G than pigs fed liquid energy. Overall (d 0 to 44), pigs fed CWG had increased ADG and final BW ($P < 0.02$) and better F/G ($P < 0.001$) than pigs fed diets without an additional energy source. Also, pigs fed diets containing CWG had better ($P < 0.001$) F/G than pigs fed liquid energy. In conclusion, adding CWG to nursery diets improved performance, but liquid energy did not. Pigs fed AV-E had performance equal to pigs fed other specialty protein sources.

Key words: AV-E Digest, choice white grease, liquid energy, nursery pig

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Introduction

Increasing dietary energy from added fat consistently has been shown to improve ADG and feed efficiency during the middle to late nursery period, but increased cost of added fat means that alternatives are being sought to increase energy density at a lower cost. A recent product made available for swine producers, XFE Liquid Energy (XFE Products, Des Moines, IA), is an alcohol-based liquid product that is believed to have the potential to increase the dietary energy level economically. Recent studies at Kansas State University have found mixed results for liquid energy improving ADG but have not shown improvements in feed efficiency (Ying et al., 2011[3]). Further research is needed to determine if an energy response from liquid energy can be found in nursery pigs.

High-quality specialty protein sources are continually sought for starter diets to lower feed cost and replace common protein sources such as fish meal. Previous research has demonstrated that addition of PEP2+ (porcine intestinal mucosa that is co-dried with vegetable proteins; TechMix, LLC, Stewart, MN) as a specialty protein source had improved growth performance in Phase 2 nursery diets (Myers et al., 2009[4]) compared with those fed fishmeal. In addition, high-quality, low-ash poultry meal can be used as an animal protein replacement in nursery diets (Keegan et al., 2004[5]). Another specialty product, AV-E Digest (XFE Products, Des Moines, IA), a poultry-based co-product, has potential to be used as an alternative animal protein source for nursery pigs, but research is lacking. The objectives of this experiment were to: (1) compare the effects of choice white grease (CWG) and XFE Liquid Energy, and (2) evaluate AV-E Digest as a specialty protein source for nursery pigs.

Procedures

All experimental procedures were approved by the K-State Animal Care and Use Committee.

A total of 347 nursery pigs (PIC 1050, initially 11.0 lb) were used in 44-d trial. Pigs were randomly allotted to 1 of 8 treatments with 5 pigs per pen and 9 pens per treatment. The study was conducted at the K-State Segregated Early Weaning facility in Manhattan, KS. Each pen (5 ft × 5 ft) contained a 4-hole dry self-feeder and a 1-cup waterer to provide ad libitum access to feed and water.

The 8 dietary treatments included: (1) control diet containing no specialty protein sources; (2) 7.1% PEP2+ in Phase 1 and no special protein sources in Phase 2 or Phase 3; (3) 7.1% PEP2+ and 3.75% spray-dried animal plasma (SDAP) in Phase 1, 3.8% PEP2+ in Phase 2, and no specialty protein sources in Phase 3; (4) 7.1% PEP2+, 3.75% SDAP, and 3% liquid energy in Phase 1; 3.8% PEP2+ and 3% liquid energy in Phase 2; and 3% liquid energy but no specialty protein sources in Phase 3; (5) 7.1% PEP2+, 3.75% SDAP, and 3% choice white grease (CWG) in Phase 1; 3.8% PEP2+ and 3% CWG in Phase 2; and 3% CWG but no specialty protein sources in Phase 3; (6) 12.5% AV-E Digest (AV-E) and 2.5% spray-dried blood cells (SDBC) in Phase 1; 7.5% AV-E in Phase 2; and 2.5% AV-E in Phase 3; (7) 12.5% AV-E, 2.5% SDBC and 3% liquid

[3] Ying et al., Swine Day 2011. Report of Progress 1056, pp. 129–137.
[4] Myers et al., Swine Day 2009. Report of Progress 1020, pp. 90–95.
[5] Keegan, T. P., J. M. DeRouchey, J. L. Nelssen, M. D. Tokach, R. D. Goodband, and S. S. Dritz. 2004. The effects of poultry meal source and ash level on nursery pig performance. J. Anim. Sci. 82:2750–2756.

energy in Phase 1; 7.5% AV-E and 3% liquid energy in Phase 2; 2.5% AV-E and 3% liquid energy in Phase 3; and (8) 12.5% AV-E, 2.5% SDBC, and 3% CWG in Phase 1; 7.5% AV-E and 3% CWG in Phase 2; and 2.5% AV-E and 3% CWG in Phase 3. Diets were formulated to the recommended standardized ileal digestible (SID) lysine:ME ratios for respective pig weights (Tables 1, 2, and 3). The ME of liquid energy used in diet formulation was equal to that of CWG (3.62 Mcal/lb). Spray-dried whey was included at 25% and 10% in all Phase 1 and 2 diets, respectively. Phase 1 diets were fed in pelleted form and manufactured at the K-State Grain Science Feed Mill, and Phase 2 and 3 diets were fed in meal form and manufactured at the K-State Animal Science Feed Mill.

Pigs were weighed and feed disappearance was determined on d 0, 5, 9, 16, 23, 33, and 44 to calculate ADG, ADFI, and F/G.

Data were analyzed using the MIXED procedure in SAS (SAS Institute, Inc., Cary, NC), with pen as the experimental unit for analysis. Contrast statements were used to test the main effect of liquid energy (treatments 3 and 6 vs. 4 and 7), CWG (treatments 3 and 6 vs. 5 and 8) or AV-E (treatments 3, 4, and 5 vs. 6, 7, and 8), and to make comparison between liquid energy and CWG (treatments 4 and 7 vs. 5 and 8). Differences between treatments were determined by using least squares means. Results were considered significant at $P \leq 0.05$ and considered a trend at $P \leq 0.10$.

Results and Discussion

From d 0 to 9, pigs fed liquid energy tended ($P < 0.08$) to have improved ADG compared with pigs fed diets without liquid energy (Table 4). Pigs fed PEP2+ as the only specialty protein source had lower ($P < 0.05$) ADG than pigs fed the diet with a combination of PEP2+, SDAP, and liquid energy and the diet containing AV-E, SDBC, and CWG. Pigs fed no specialty protein sources or PEP2+ as the only specialty protein source had worse ($P < 0.05$) F/G than pigs fed the diet with a combination of PEP2+, SDAP, and liquid energy and the diet containing AV-E, SDBC, and CWG. Pigs fed the combination of PEP2+ and SDAP had worse ($P < 0.05$) F/G than pigs fed combinations of PEP2+, SDAP, and liquid energy. No differences between protein source regime (SDAP-PEP2+ vs. Av-E-SDBC) or energy (CWG vs. liquid energy) source were found.

From d 9 to 23, pigs fed diets containing AV-E had greater ADG ($P < 0.04$) and tended to have improved F/G ($P < 0.10$) compared with pigs fed diets containing PEP2+. Pigs fed CWG had better ($P < 0.01$) F/G than that of pigs fed liquid energy. Pigs fed combinations of AV-E and CWG had greater ($P < 0.05$) ADG than pigs fed PEP2+ or pigs previously fed PEP2+ in Phase 1 and the control diet in Phase 2. Pigs fed AV-E-CWG had better ($P < 0.05$) F/G than pigs fed diets containing PEP2+, PEP2+-liquid energy, or AV-E-liquid energy.

From d 23 to 44, there was improvement ($P < 0.01$) in ADG and F/G from feeding CWG compared with pigs fed diets without an additional energy source. Also, pigs fed diets containing CWG tended ($P < 0.07$) to have greater ADG and better ($P < 0.001$) F/G than pigs fed diets containing liquid energy. Pigs fed diets containing CWG or AV-E-CWG had better ($P < 0.05$) ADG than pigs previously fed PEP2+ in Phase 2

and control diet in Phase 3. Pigs fed control diet for all 3 phases had greater ($P < 0.05$) ADFI than pigs fed CWG or pigs fed PEP2+ in Phase 2 and the control diet in Phase 3. Pigs fed CWG had improved ($P < 0.05$) F/G compared with pigs fed all other treatments except the treatment containing AV-E and CWG, which was intermediate. Also, pigs fed AV-E and CWG together had improved ($P < 0.05$) F/G compared with pigs fed the control (regardless of previous phase diet), AV-E, or AV-E-liquid energy diets. Finally, pigs fed the control diet in all three phases had worse ($P < 0.05$) F/G then all other treatments except those fed AV-E-liquid energy.

Overall (d 0 to 44), pigs fed diets with CWG had improved ADG ($P < 0.02$), final BW ($P < 0.02$) and F/G ($P < 0.001$) compared with pigs fed diets without an additional energy source. Also, pigs fed diets containing CWG had better ($P < 0.001$) F/G than pigs fed liquid energy. Pigs fed diets with a combination of AV-E and CWG had greater ($P < 0.05$) ADG and final BW than pigs fed diets containing PEP2+ in Phase 1, 2, and no specialty protein source in Phase 3. Pigs fed the control diet for all 3 phases had greater ($P < 0.05$) ADFI than pigs fed diets containing PEP2+ in Phase 1 and 2 and no specialty protein source in Phase 3. Pigs fed diets containing a combination of AV-E and CWG had better ($P < 0.05$) F/G than other treatments, except pigs fed PEP2+-CWG. Pigs fed the PEP2+-liquid energy treatment series or AV-E in each phase with no added energy source had better ($P < 0.05$) F/G than pigs fed control diets for all 3 phases.

For overall energy source conclusions, feeding nursery pigs CWG improved ADG and F/G as expected; however, growth performance was not affected by feeding liquid energy. Although the actual energy value of liquid energy is unknown, these data along with previous research shows that liquid energy cannot substitute for fat in nursery pig diets and maintain similar performance.

For overall protein source conclusions, these data indicate that AV-E is a potential replacement for other animal specialty proteins sources such as PEP2+ or fish meal (based on previous research indicating PEP2+ is comparable to fish meal) in nursery diets. More research is needed to validate AV-E as an SDAP replacement in Phase 1 diets.

Table 1. Composition of Phase 1 diets (as-fed basis)[1]

	Treatment							
	1	2	3	4	5	6	7	8
Item	Control	7.1% PEP2+[2]	7.1% PEP2+, 3.75% SDAP[3]	7.1% PEP2+, 3.75% SDAP, 3% liquid energy[4]	7.1% PEP2+, 3.75% SDAP, 3% CWG[5]	12.5% AV-E[6], 2.5% SDBC[7]	12.5% AV-E, 2.5% SDBC, 3% liquid energy	12.5% AV-E, 2.5% SDBC, 3% CWG
Ingredient, %								
Corn	39.80	41.20	45.75	40.80	40.80	41.10	37.70	37.70
Soybean meal, 46.5% CP	31.60	23.25	15.15	17.00	17.00	15.15	17.00	17.00
PEP2+	--	7.10	7.10	7.10	7.10	--	--	--
AV-E Digest	--	--	--	--	--	12.50	12.50	12.50
Spray-dried animal plasma	--	--	3.75	3.75	3.75			
Spray-dried blood cells	--	--	--	--	--	2.50	2.50	2.50
Spray-dried whey	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00
Choice white grease	--	--	--	--	3.00	--	--	3.00
Liquid energy	--	--	--	3.00	--	--	3.00	--
Monocalcium P, 21% P	0.88	0.80	0.58	0.58	0.58	0.10	0.10	0.10
Limestone	0.70	0.78	0.93	0.93	0.93	0.43	0.40	0.40
Salt	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35
Zinc oxide	0.415	0.415	0.415	0.415	0.415	0.415	0.415	0.415
Vitamin premix	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Trace mineral premix	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
L-lysine HCl	0.35	0.25	0.225	0.25	0.25	0.175	0.20	0.20
DL-methionine	0.215	0.205	0.185	0.21	0.21	0.16	0.19	0.19
L-threonine	0.155	0.125	0.09	0.11	0.11	0.10	0.12	0.12
L-valine	0.04	--	--	--	--	--	--	--
Phytase[8]	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

continued

Table 1. Composition of Phase 1 diets (as-fed basis)[1]

	Treatment							
	1	2	3	4	5	6	7	8
Item	Control	7.1% PEP2+[2]	7.1% PEP2+, 3.75% SDAP[3]	7.1% PEP2+, 3.75% SDAP, 3% liquid energy[4]	7.1% PEP2+, 3.75% SDAP, 3% CWG[5]	12.5% AV-E[6], 2.5% SDBC[7]	12.5% AV-E, 2.5% SDBC, 3% liquid energy	12.5% AV-E, 2.5% SDBC, 3% CWG
Calculated analysis								
Standard ileal digestible (SID) amino acids								
Lysine, %	1.41	1.40	1.41	1.47	1.47	1.40	1.46	1.46
Isoleucine:lysine, %	59	60	55	55	55	55	55	55
Methionine:lysine, %	36	36	33	34	34	34	35	35
Met & cys:lysine, %	58	58	58	58	58	58	58	58
Threonine:lysine, %	64	64	64	64	64	64	64	64
Tryptophan:lysine, %	17	18	18	18	18	17	17	17
Valine:lysine, %	65	65	66	65	65	77	75	75
Total lysine, %	1.56	1.54	1.55	1.61	1.61	1.53	1.59	1.59
ME, kcal/lb	1,479	1,470	1,481	1,542	1,542	1,471	1,533	1,533
SID lysine:ME, g/Mcal	4.32	4.32	4.32	4.32	4.32	4.32	4.32	4.32
CP, %	21.7	21.9	21.4	21.9	21.9	22.8	23.3	23.3
Ca, %	0.73	0.74	0.74	0.74	0.74	0.74	0.74	0.74
P, %	0.69	0.68	0.66	0.65	0.65	0.63	0.63	0.63
Available P, %	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55

[1] A total of 347 nursery pigs were used in a 44-d study with 5 pigs per pen and 9 replications per treatment. Phase 1 diets were fed from d 0 to 9.
[2] TechMix, LLC, Stewart, MN, and Midwest Ag Enterprises, Marshall, MN.
[3] SDAP: spray-dried animal plasma (AP920; APC, Inc., Ames, IA).
[4] XFE Products, Des Moines, IA.
[5] CWG: choice white grease.
[6] AV-E: AV-E Digest (XFE Products, Des Moines, IA).
[7] SDBC: spray-dried blood cells.(AP302G APC, Inc., Ames, IA).
[8] Phyzyme 600 (Danisco, Animal Nutrition, St. Louis, MO), providing 231 phytase units (FTU)/lb, with a release of 0.10% available P.

Table 2. Composition of Phase 2 diets (as-fed basis)[1]

	Treatment							
	1	2	3	4	5	6	7	8
Item	Control	Control	3.8% PEP2+[2]	3.8% PEP2+, 3% liquid energy[3]	3.8% PEP2+, 3% CWG[4]	7.5% AV-E[5]	7.5% AV-E, 3% liquid energy	7.5% AV-E, 3% CWG
Ingredient, %								
Corn	54.60	54.60	53.80	48.60	48.60	50.90	45.75	45.75
Soybean meal, 46.5% CP	31.85	31.85	29.05	31.20	31.20	27.55	31.20	31.20
PEP2+	--	--	3.80	3.80	3.80	--	--	--
AV-E Digest	--	--	--	--	--	7.50	7.50	7.50
Spray-dried whey	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
Choice white grease	--	--	--	--	3.00	--	--	3.00
Liquid energy	--	--	--	3.00	--	--	3.00	--
Monocalcium P, 21% P	0.95	0.95	0.88	0.85	0.85	0.45	0.43	0.43
Limestone	0.80	0.80	0.83	0.83	0.83	0.58	0.58	0.58
Salt	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35
Zinc oxide	0.275	0.275	0.275	0.275	0.275	0.275	0.275	0.275
Vitamin premix	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Trace mineral premix	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
L-lysine HCl	0.35	0.35	0.25	0.255	0.255	0.175	0.185	0.185
DL-methionine	0.165	0.165	0.15	0.17	0.17	0.09	0.11	0.11
L-threonine	0.15	0.15	0.11	0.12	0.12	0.075	0.09	0.09
Phytase[6]	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

continued

Table 2. Composition of Phase 2 diets (as-fed basis)[1]

	Treatment							
	1	2	3	4	5	6	7	8
Item	Control	Control	3.8% PEP2+[2]	3.8% PEP2+, 3% liquid energy[3]	3.8% PEP2+, 3% CWG[4]	7.5% AV-E[5]	7.5% AV-E, 3% liquid energy	7.5% AV-E, 3% CWG
Calculated analysis								
Standard ileal digestible (SID) amino acids								
Lysine, %	1.33	1.33	1.33	1.38	1.38	1.33	1.39	1.39
Isoleucine:lysine, %	60	60	62	62	62	66	66	66
Methionine:lysine, %	34	34	34	35	35	32	32	32
Met & Cys:lysine, %	58	58	58	58	58	58	58	58
Threonine:lysine, %	64	64	64	64	64	64	64	64
Tryptophan:lysine, %	17.2	17.2	18.1	18.1	18.1	18.4	18.3	18.4
Valine:lysine, %	65	65	68	68	68	75	73	73
Total lysine, %	1.47	1.47	1.47	1.53	1.53	1.47	1.53	1.53
ME, kcal/lb	1,493	1,493	1,489	1,551	1,551	1,491	1,551	1,553
SID lysine:ME, g/Mcal	4.04	4.04	4.05	4.04	4.04	4.05	4.05	4.05
CP, %	21.2	21.2	21.9	22.5	22.5	23.2	23.8	23.8
Ca, %	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68
P, %	0.64	0.64	0.64	0.63	0.63	0.63	0.62	0.62
Available P, %	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46

[1] A total of 347 nursery pigs were used in a 44-d study with 5 pigs per pen and 9 replications per treatment. Phase 2 diets were fed from d 9 to 23.
[2] TechMix LLC, Stewart, MN, and Midwest Ag Enterprises, Marshall, MN.
[3] XFE Products, Des Moines, IA.
[4] CWG: choice white grease.
[5] AV-E: AV-E Digest (XFE Products, Des Moines, IA).
[6] Phyzyme 600 (Danisco, Animal Nutrition, St. Louis, MO), provided 231 phytase units (FTU)/lb, with a release of 0.10% available P.

Table 3. Composition of Phase 3 diets (as-fed basis)[1]

	Treatment							
	1	2	3	4	5	6	7	8
Item	Control	Control	Control	3% liquid energy[2]	3% CWG[3]	2.5% AV-E[4]	2.5% AV-E, 3% liquid energy	2.5% AV-E, 3% CWG
Ingredient, %								
Corn	65.45	65.45	65.45	60.70	60.70	65.35	60.45	60.45
Soybean meal, 46.5% CP	31.05	31.05	31.05	32.80	32.80	28.95	30.85	30.85
AV-E Digest	--	--	--	--	--	2.50	2.50	2.50
Choice white grease	--	--	--	--	3.00	--	--	3.00
Liquid energy	--	--	--	3.00	--	--	3.00	--
Monocalcium P, 21% P	1.05	1.05	1.05	1.05	1.05	0.90	0.90	0.90
Limestone	0.90	0.90	0.90	0.88	0.88	0.83	0.80	0.80
Salt	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35
Vitamin premix	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Trace mineral premix	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
L-lysine HCl	0.36	0.36	0.36	0.375	0.375	0.34	0.35	0.35
DL-methionine	0.14	0.14	0.14	0.16	0.155	0.125	0.14	0.14
L-threonine	0.14	0.14	0.14	0.15	0.15	0.125	0.14	0.14
Phytase[5]	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

continued

Table 3. Composition of Phase 3 diets (as-fed basis)[1]

	Treatment							
	1	2	3	4	5	6	7	8
Item	Control	Control	Control	3% liquid energy[2]	3% CWG[3]	2.5% AV-E[4]	2.5% AV-E, 3% liquid energy	2.5% AV-E, 3% CWG
Calculated analysis								
Standard ileal digestible (SID) amino acids								
Lysine, %	1.26	1.26	1.26	1.31	1.31	1.26	1.31	1.31
Isoleucine:lysine, %	60	60	60	59	59	61	60	60
Methionine:lysine, %	34	34	34	34	34	34	34	34
Met & Cys:lysine, %	58	58	58	58	58	58	58	58
Threonine:lysine, %	63	63	63	63	63	63	63	63
Tryptophan:lysine, %	17.0	17.0	17.0	17.0	17.0	17.0	17.0	17.0
Valine:lysine, %	67	67	67	66	66	69	68	68
Total lysine, %	1.39	1.39	1.39	1.44	1.44	1.39	1.44	1.44
ME, kcal/lb	1,505	1,505	1,505	1,567	1,567	1,504	1,566	1,566
SID lysine:ME, g/Mcal	3.80	3.80	3.80	3.79	3.79	3.80	3.79	3.79
CP, %	20.5	20.5	20.5	21.0	21.0	20.8	21.3	21.3
Ca, %	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66
P, %	0.62	0.62	0.62	0.62	0.62	0.61	0.61	0.61
Available P, %	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42

[1] A total of 347 nursery pigs were used in a 44-d study with 5 pigs per pen and 9 replications per treatment. Phase 3 diets were fed from d 23 to 44.
[2] XFE Products, Des Moines, IA.
[3] CWG: choice white grease.
[4] AV-E: AV-E Digest (XFE Products, Des Moines, IA).
[5] Phyzyme 600 (Danisco Animal Nutrition, St. Louis, MO), providing 231 phytase units (FTU)/lb, with a release of 0.10% available P.

Table 4. The effects of AV-E Digest and XFE Liquid Energy on nursery pig performance[1]

	Treatment												
	1	2	3	4	5	6	7	8					
d 0 to 9:	Control	7.1% PEP2+	7.1% PEP2+, 3.75% SDAP[2]	7.1% PEP2+, 3.75% SDAP, 3% liquid energy	7.1% PEP2+, 3.75% SDAP 3% CWG[3]	12.5% AV-E[4], 2.5% SDBC[5]	12.5% AV-E, 2.5% SDBC, 3% liquid energy	12.5% AV-E, 2.5% SDBC, 3% CWG					
d 9 to 23:	Control	Control	3.8% PEP2+	3.8% PEP2+, 3% liquid energy	3.8% PEP2+, 3% CWG	7.5% AV-E	7.5% AV-E, 3% liquid energy	7.5% AV-E, 3% CWG					
										Probability, *P*<			
Item d 23 to 44:	Control	Control	Control	3% liquid energy	3% CWG	2.5% AV-E	2.5% AV-E +3% liquid energy	2.5% AV-E +3% CWG	SEM	AV-E[6]	Liquid energy[7]	CWG[8]	Liquid energy vs. CWG[9]
d 0 to 9													
ADG, lb	0.24^{ab}	0.23^{a}	0.24^{ab}	0.32^{c}	0.27^{ac}	0.27^{ac}	0.27^{ac}	0.30^{bc}	0.04	0.93	0.08	0.23	0.55
ADFI, lb	0.26	0.25	0.24	0.28	0.26	0.27	0.26	0.27	0.04	0.59	0.44	0.55	0.85
F/G	1.16^{a}	1.09^{ab}	1.00^{ab}	0.87^{b}	1.01^{ab}	0.98^{ab}	1.01^{ab}	0.93^{b}	0.06	0.82	0.41	0.66	0.70
d 9 to 23													
ADG, lb	0.73^{ab}	0.68^{a}	0.64^{a}	0.72^{ab}	0.69^{ab}	0.75^{ab}	0.71^{ab}	0.79^{b}	0.05	0.04	0.59	0.21	0.48
ADFI, lb	1.06	1.02	0.99	1.10	1.02	1.08	1.07	1.10	0.05	0.17	0.21	0.53	0.52
F/G	1.46^{ab}	1.51^{ab}	1.54^{a}	1.54^{a}	1.48^{ab}	1.45^{ab}	1.54^{a}	1.40^{b}	0.06	0.10	0.26	0.17	0.01
d 23 to 44													
ADG, lb	1.16^{ab}	1.16^{ab}	1.11^{a}	1.15^{ab}	1.19^{b}	1.13^{ab}	1.13^{ab}	1.19^{b}	0.03	0.93	0.43	0.01	0.07
ADFI, lb	1.91^{a}	1.84^{ab}	1.76^{b}	1.79^{ab}	1.78^{b}	1.79^{ab}	1.82^{ab}	1.80^{ab}	0.05	0.45	0.48	0.80	0.65
F/G	1.66^{a}	1.59^{b}	1.58^{b}	1.56^{bc}	1.49^{d}	1.59^{b}	1.61^{ab}	1.51^{cd}	0.02	0.19	0.95	0.001	0.001

continued

Table 4. The effects of AV-E Digest and XFE Liquid Energy on nursery pig performance[1]

	Treatment												
	1	2	3	4	5	6	7	8					
d 0 to 9:	Control	7.1% PEP2+	7.1% PEP2+, 3.75% SDAP[2]	7.1% PEP2+, 3.75% SDAP, 3% liquid energy	7.1% PEP2+, 3.75% SDAP 3% CWG[3]	12.5% AV-E[4], 2.5% SDBC[5]	12.5% AV-E, 2.5% SDBC, 3% liquid energy	12.5% AV-E, 2.5% SDBC, 3% CWG					
d 9 to 23:	Control	Control	3.8% PEP2+	3.8% PEP2+, 3% liquid energy	3.8% PEP2+, 3% CWG	7.5% AV-E	7.5% AV-E, 3% liquid energy	7.5% AV-E, 3% CWG					
										Probability, *P*<			
Item d 23 to 44:	Control	Control	Control	3% liquid energy	3% CWG	2.5% AV-E	2.5% AV-E +3% liquid energy	2.5% AV-E +3% CWG	SEM	AV-E[6]	Liquid energy[7]	CWG[8]	Liquid energy vs. CWG[9]
d 0 to 44													
ADG, lb	0.83[ab]	0.82[ab]	0.78[a]	0.84[ab]	0.84[ab]	0.83[ab]	0.82[ab]	0.88[b]	0.03	0.26	0.27	0.02	0.19
ADFI, lb	1.30[a]	1.25[ab]	1.20[b]	1.26[ab]	1.22[ab]	1.25[ab]	1.27[ab]	1.26[ab]	0.04	0.28	0.30	0.63	0.57
F/G	1.57[a]	1.54[ab]	1.53[ac]	1.50[bcd]	1.45[de]	1.51[bc]	1.54[ab]	1.44[e]	0.03	0.91	0.98	0.001	0.001
BW, lb													
d 0	11.0	11.0	11.0	11.0	11.0	10.9	10.9	10.9	0.1	0.33	0.80	0.55	0.72
d 44	47.5[ab]	46.9[ab]	45.6[a]	48.1[ab]	48.1[ab]	47.5[ab]	47.1[ab]	49.7[b]	1.6	0.31	0.29	0.02	0.21

[a, b, c, d, e] Means within the same row with different superscripts differ ($P < 0.05$).

[1] A total of 347 pigs (initially 11.0 lb) were used with 5 pigs per pen and 9 pens per treatment.

[2] SDAP: spray-dried animal plasma (AP 920, APC, Inc., Ames, IA).

[3] CWG: choice white grease.

[4] AV-E: AV-E Digest (XFE Products, Des Moines, IA.).

[5] SDBC: spray-dried blood cells (AP302G, APC, Inc., Ames, IA).

[6] AV-E = Treatments 3, 4, and 5 vs. 6, 7, and 8.

[7] Liquid energy (XFE Products, Des Moines, IA.); Treatments 3 and 6 vs. 4 and 7.

[8] CWG = Treatments 3 and 6 vs. 5 and 8.

[9] Liquid energy vs. CWG = Treatments 4 and 7 vs. 5 and 8.