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Effects of Valopro Win Feeding Duration in Different Nursery Diet Types on Nursery Pig Growth Performance and Fecal Dry Matter

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Julian Arroyave, Mike D. Tokach, Jason C. Woodworth, Joel M. DeRouchey, Robert D. Goodband, Katelyn N. Gaffield, and Jordan T. Gebhardt[1]

Summary

A total of 300 pigs (DNA, Line 241 × 600; initially 12.3 ± 1.04 lb), were used to evaluate the effects of Valopro Win (VLPW) feeding duration on pig performance and fecal dry matter. Valopro Win contains a purified source of coarse indigestible fiber, oat hulls, and yeast autolysate. At weaning, pigs were blocked by body weight (BW) and then randomly assigned to pens and allotted to one of six dietary treatments in a 2 × 3 factorial arrangement, with main effects of formulation strategy (low ABC-4 without ZnO or high ABC-4 with ZnO) and VLPW feeding duration (0, 10, or 24 d). There were five pigs per pen and 10 pens per treatment. Experimental diets were formulated in two dietary phases from d 0 to 10 and d 10 to 24, with a common post-treatment diet fed from d 24 to 42. Low ABC-4 diets were formulated to 200 and 250 meq/kg from d 0 to 10 and d 10 to 24, respectively. High ABC-4 diets were formulated to 493 and 470 meq/kg and contained 2,990 and 1,910 ppm of Zn from ZnO from d 0 to 10 and d 10 to 24, respectively. Diets containing VLPW were formulated by replacing 2.5% of the diet with VLPW without making any nutritional adjustments. No interactions were observed ($P > 0.10$) between VLPW feeding duration and formulation strategy on any response criteria. There was no significant effect ($P > 0.10$) of VLPW feeding duration on growth performance; however, on d 10, pigs fed VLPW diets had increased fecal dry matter ($P = 0.019$). During the experimental period (d 0 to 24), pigs fed low ABC-4 diets with no ZnO had decreased ($P < 0.001$) ADG, d 24 BW, and lower ADFI compared with pigs fed high ABC-4 with ZnO, but no significant differences ($P > 0.10$) were observed in the overall period (d 0 to 42). On d 24, pigs fed low ABC-4 without ZnO diets had greater ($P < 0.001$) fecal dry matter than those fed high ABC-4 with ZnO. In conclusion, even though pigs fed high ABC-4 diets containing ZnO had improved growth during the experimental feeding period, neither the use of VLPW nor the formulation strategies significantly affected overall nursery performance. However, fecal dry matter was increased on d 10 when pigs were fed VLPW and at d 24 when pigs were fed low ABC-4 diets without ZnO.

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Introduction

After weaning, pigs often experience difficulties adapting to a new diet and environment. Consequently, they may suffer from low feed intake and diarrhea, leading to dehydration, reduced nutrient digestibility, stunted growth, and, in severe cases, death.[2] The swine industry commonly uses pharmacological levels of Zn (primarily from zinc oxide, ZnO) to promote growth after weaning. However, some countries are limiting the use of pharmacological levels of Zn in swine diets due to potential environmental issues. This restriction increases the need to explore nutritional and management strategies that can maintain nursery performance without using pharmacological levels of Zn.[3]

Multiple studies have observed that dietary adjustments can be made to help replace ZnO in nursery diets. Lowering the diet acid binding capacity (ABC-4) using ingredients that help maintain the stomach's acidic condition can lead to better performance when no ZnO is used in the diet.[4] Using insoluble fiber (resistant to fermentation) increases the passage rate, prevents harmful bacterial growth, and improves intestinal morphology and microbial balance in the intestine.[5] The use of fiber in nursery diets has been shown to result in mixed effects regarding nursery performance, with the response depending on the basal diet's composition and the fiber's chemical and physical characteristics.[6]

Valopro Win (VLPW; MiXscience, Bruz, France) is a fiber ingredient for nursery pigs that contains a purified source of coarse indigestible fiber, oat hulls, and yeast autolysate. Studies conducted in Europe have shown that VLPW can improve feed intake and gut function, particularly in diets that do not contain ZnO. However, limited research has been conducted utilizing feeding strategies and ingredients commonly used in the U.S. Therefore, the aim of the present study was to evaluate the effect of VLPW feeding duration in two different dietary strategies (low ABC-4 without ZnO or high ABC-4 with ZnO) on pig performance and fecal dry matter.

Material and Methods

The Kansas State University Institutional Animal Care and Use Committee approved the protocol used in this experiment. The experiment was conducted in two indepen-

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[4] E. B. Stas, A. J. Warner, C. W. Hastad, M. D. Tokach, J. C. Woodworth, J. M. DeRouchey, R. D. Goodband, and J. T. Gebhardt. 2022. Effects of varying the acid-binding capacity-4 in diets utilizing specialty soy products with or without pharmacological levels of zinc on nursery pig performance. Kansas Agri. Exp. Station Research Reports: Vol. 8: Iss. 10. doi:10.4148/2378-5977.8370.

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[6] R. G. Hermes, F. Molist, M. Ywazaki, M. Nofrarías, A. Gomez de Segura, J. Gasa, and J. F. Pérez. 2009. Effect of dietary level of protein and fiber on the productive performance and health status of piglets. J Anim Sci. 87(11):3569-77. doi:10.2527/jas.2008-1241.

dent rooms located in the same barn at the Kansas State University Swine Teaching Center in Manhattan, KS. Each pen (4 × 5 ft) was equipped with a 6-hole dry feeder and nipple waterer to provide ad libitum access to feed and water.

Animals and diets

A total of 300 pigs (DNA, Line 241 × 600, Columbus, NE) initially 12.3 ± 1.04 lb were used in a 42-d study. The pigs were weaned at approximately 20 d of age and divided into five body weight blocks, each containing 20% of the pigs. The pigs were then randomly assigned to pens within BW block and pens were allotted to one of six dietary treatments. Each pen had five pigs, and there were 12 pens per BW block and 10 pens per dietary treatment. The two identical rooms in the research barn had an equal representation of dietary treatments and BW blocks.

Pigs were fed experimental diets for the first two phases, lasting 10 and 14 d, respectively. All pigs were then fed a common phase 3 diet for 18 d. The treatments were arranged in a 2 × 3 factorial with the main effects of formulation strategy (high or low ABC-4) and VLPW feeding duration (0, 10, or 24 d). Low ABC-4 diets were formulated to 200 and 250 meq/kg from d 0 to 10 and d 10 to 24, respectively, without pharmacological levels of ZnO. Pure lactose and AX3 digest (Proteka, Newport Beach, CA) were used in these diets as lactose and protein concentrate sources, respectively, along with fumaric and formic acid to lower pH. High ABC-4 diets were formulated to 493 and 470 meq/kg and contained 2,990 and 1,910 ppm of Zn from d 0 to 10 and 10 to 24, respectively. Spray-dried whey and HP300 (Hamlet protein, Findlay, OH) were used as lactose and specialty soy sources, respectively. Valopro Win inclusion was 2.5% of the diet, without any formulation adjustments to maintain the same chemical composition between diets. By design, this resulted in a dilution of approximately 2.5% in all the nutrients compared to the control diet (Table 1).

All dietary treatments were manufactured at the Kansas State University O.H. Kruse Feed Technology Innovation Center in Manhattan, KS. The first phase was fed in pellet form, and the remaining two phases were fed in meal form.

Pigs and feeders were weighed on d 10, 24, and 42 to determine ADG, ADFI, and F/G. Fecal samples were collected via rectal palpation from the same three pigs per pen on d 10 and 24 of the study. These samples were stored at 39.2°F (4°C) until fecal dry matter analysis was conducted. The samples were dried in a forced air oven for 48 h at 151°F (55°C).

Statistical analysis

Data were analyzed as a randomized complete block design in a 2 × 3 factorial arrangement. The lmer function was used from the lme4 package in RStudio [Version 4.0.2 (2020-06-22), R Core Team, R Foundation for Statistical Computing, Vienna, Austria] with pen serving as the experimental unit. The model incorporated formulation strategy, VLPW feeding duration, and the associated interaction as fixed effects. Room and BW block were considered random effects in the model, and for fecal dry matter, the pen was also considered a random effect in addition to the previous variables to account for the subsampling associated with multiple fecal samples collected and analyzed from each pen. For the period of 0 to 10 d post-weaning, when analyzing the performance and fecal dry matter data, the *P*-value associated with the VLPW feeding time only tested the effect of diets with and without VLPW. This is because the experimental groups with VLPW (10 and 24 d) were given the same diets from d 0 to 10. Differences between treatments were considered significant at $P \leq 0.05$ and marginally significant at $0.05 < P \leq 0.10$.

Results and Discussion

No significant interactions were observed ($P > 0.10$) between VLPW feeding duration and formulation strategy on growth measurements and fecal dry matter (Table 2).

For the main effect of VLPW feeding duration, there was no significant effect ($P > 0.10$) on growth performance. However, on d 10, pigs fed diets with added VLPW had increased fecal dry matter ($P = 0.019$) compared to those fed diets without VLPW. There was no evidence ($P = 0.952$) for differences in the fecal dry matter on d 24 between pigs fed diets with or without VLPW (Table 3).

An alternate interpretation of the VLPW data is that pigs fed VLPW performed similarly ($P > 0.10$) despite consuming diets with lower nutrient density. Because of the dilution effect, diets that included VLPW were 2.5% lower in all nutrients, except for fiber and its fractions.

For the main effect of diet ABC-4 level, from d 0 to 10, pigs fed diets with ZnO and high ABC-4 had increased ($P < 0.05$) ADG, d 10 BW, and ADFI compared with those fed low ABC-4 diets without ZnO, but there was no difference in feed efficiency. Similar responses were observed from d 10 to 24 and the experimental period (d 0 to 24), as pigs fed low ABC-4 diets without ZnO had decreased ($P < 0.001$) d 24 BW, ADG, and ADFI compared to those fed high ABC-4 diets with ZnO, but there were no differences in feed efficiency. There was no difference in fecal dry matter between formulation strategies on d 10; however, on d 24, pigs fed low ABC-4 diets without ZnO had greater ($P = 0.004$) fecal dry matter than those fed high ABC-4 diets with ZnO (Table 3).

In the common period (d 24 to 42), there was a marginal increased response ($P = 0.059$) for ADG for pigs previously fed diets with low ABC-4 without ZnO, which could be interpreted as compensatory gain. This change in ADG was responsible for no observed differences ($P = 0.332$) in d-42 BW despite a numerical difference of 0.8 lb between the two formulation strategies. There was no evidence ($P > 0.10$) of differences for ADFI and F/G between treatments. In the overall period (d 0 to 42), there were no differences ($P > 0.10$) observed between the two formulation strategies for ADG, ADFI, and F/G.

In summary, utilizing VLPW for 10 or 24 d did not impact nursery growth performance; however, fecal dry matter was increased on d 10 by including 2.5% VLPW in the diet. High ABC-4 diets with ZnO improved growth performance during the first 24 d, but not overall. On the other hand, low ABC-4 diets without ZnO had improved fecal dry matter on d 24.

Acknowledgments

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Table 1. Diet composition (as-fed basis)[1]

	Phase 1				Phase 2				
ABC-4:	Low		High		Low		High		
ZnO:	No	No	Yes	Yes	No	No	Yes	Yes	Phase
Item VLPW:	No	Yes	No	Yes	No	Yes	No	Yes	3
Ingredient, %									
Corn	50.76	49.49	48.23	47.03	57.17	55.74	55.17	53.79	68.06
Soybean meal	16.30	15.89	16.27	15.86	22.40	21.84	26.06	25.41	28.12
Crystalline lactose	15.00	14.63	----	----	7.50	7.31	----	----	----
Milk, whey powder	----	----	20.85	20.33	----	----	10.40	10.14	----
Spray-dried bovine plasma	2.50	2.44	2.50	2.44	----	----	----	----	----
Specialty soybean meal[2]	9.38	9.14	----	----	7.50	7.31	----	----	----
Enzymatically treated soybean meal[3]	----	----	7.75	7.56	----	----	4.00	3.90	----
Corn oil	2.00	1.95	2.00	1.95	1.00	0.98	1.00	0.98	----
L-Lys-HCl	0.44	0.43	0.36	0.35	0.49	0.47	0.45	0.44	0.55
DL-Met	0.19	0.18	0.16	0.16	0.19	0.19	0.19	0.19	0.21
L-Thr	0.19	0.19	0.14	0.13	0.21	0.20	0.19	0.19	0.23
L-Trp	0.05	0.05	0.03	0.03	0.05	0.05	0.04	0.04	0.05
L-Val	0.08	0.08	0.07	0.06	0.10	0.10	0.12	0.11	0.16
Limestone	0.35	0.34	0.33	0.32	0.51	0.50	0.52	0.51	0.75
Monocalcium phosphate	0.93	0.90	0.20	0.20	1.00	0.98	0.60	0.59	0.85
Salt	0.65	0.63	0.28	0.27	0.70	0.68	0.55	0.54	0.60
Trace mineral premix	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
Phytase[4]	0.06	0.05	0.06	0.05	0.06	0.05	0.06	0.05	0.03
Vitamin premix	0.25	0.24	0.25	0.24	0.25	0.24	0.25	0.24	0.25
Zinc oxide	----	----	0.40	0.39	----	----	0.25	0.24	----
Fumaric acid	0.38	0.37	----	----	0.38	0.37	----	----	----
Formic acid	0.36	0.35	----	----	0.36	0.35	----	----	----
VLPW[5]	----	2.50	----	2.50	----	2.50	----	2.50	----
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

continued

Table 1. Diet composition (as-fed basis)[1]

	Phase 1				Phase 2				
ABC-4:	Low		High		Low		High		
ZnO:	No	No	Yes	Yes	No	No	Yes	Yes	Phase
Item VLPW:	No	Yes	No	Yes	No	Yes	No	Yes	3
Calculated analysis									
SID AA,%									
Lys	1.36	1.33	1.36	1.33	1.35	1.32	1.35	1.32	1.30
Ile:Lys	56	56	58	58	58	58	58	58	53
Leu:Lys	116	116	118	118	116	116	115	115	113
Met:Lys	34	34	32	32	35	35	35	35	36
Met and Cys:Lys	56	56	56	56	56	56	56	56	57
Thr:Lys	63	63	63	63	63	63	63	63	63
Trp:Lys	20	20	20	20	20	20	20	20	19
Val:Lys	70	70	70	70	70	70	70	70	70
His:Lys	36	36	35	35	36	36	36	36	35
Total Lys, %	1.51	1.48	1.51	1.47	1.50	1.46	1.49	1.46	1.44
Metabolizable energy, kcal/lb	1,574	1,535	1,575	1,536	1,528	1,490	1,526	1,487	1,554
Net energy, Kcal/lb	1,179	1,149	1,183	1,154	1,134	1,106	1,135	1,106	1,111
SID Lys:NE, g/Mcal	5.23	5.23	5.21	5.21	5.40	5.27	5.41	5.27	5.31
Crude protein, %	21.05	20.52	21.03	20.51	21.34	20.80	21.22	20.69	19.98
Ca, %	0.50	0.49	0.49	0.48	0.59	0.57	0.59	0.58	0.64
P, %	0.53	0.51	0.52	0.50	0.56	0.56	0.56	0.56	0.56
STTD P, %[6]	0.46	0.45	0.46	0.45	0.46	0.45	0.46	0.45	0.43
Crude fiber, %	1.64	2.97	1.88	3.11	2.00	3.33	2.26	3.57	2.44
NDF, %[7]	5.96	7.70	6.09	6.52	7.05	8.75	7.35	9.05	8.51
ADF, %[8]	2.32	3.80	2.53	4.17	2.83	4.29	3.11	4.57	3.45
ADL, %[9]	0.34	2.23	0.33	2.22	0.43	2.32	0.46	2.35	0.53

[1] Phases 1, 2, and 3 were fed for 10, 14, and 18 d respectively.
[2] AX3 Digest (Proteka, Newport Beach, CA).
[3] HP 300 (Hamlet protein, Findlay, OH).
[4] Ronozyme Hiphos 2700 (dsm-firmenich, Parsippany, NJ) provided an estimated release of 0.14% STTD P in phases 1 and 2 and 0.12% STTD P in phase 3.
[5] Valopro Win (Mixscience, Bruz, France).
[6] Standardized total tract digestible phosphorus.
[7] Neutral detergent fiber.
[8] Acid detergent fiber.
[9] Acid detergent lignin.

Table 2. Effect of formulation strategy and Valopro Win on nursery performance and fecal dry matter[1]

Formulation type[2]:	Low ABC-4 without ZnO			High ABC-4 with ZnO				*P* =		
VLPW feeding duration, d[3]:	0	10	24	0	10	24	SEM	Formulation × VLPW	Formulation	VLPW
BW, lb										
d 0	12.3	12.3	12.3	12.3	12.3	12.3	1.04	0.992	0.957	0.998
d 10[3]	15.5	15.4		15.9	15.6		1.17	0.577	0.030	0.267
d 24	26.4	26.1	26.9	28.4	28.4	27.9	1.92	0.394	<0.001	0.901
d 42	50.6	50.9	51.2	51.7	51.4	51.9	3.04	0.947	0.332	0.883
Period 1 (d 0 to 10)[4]										
ADG, lb	0.32	0.31		0.36	0.33		0.026	0.582	0.033	0.276
ADFI, lb	0.38	0.36		0.41	0.40		0.017	0.777	0.001	0.163
F/G	1.22	1.18		1.22	1.21		0.071	0.712	0.575	0.560
Period 2 (d 10 to 24)										
ADG, lb	0.78	0.76	0.82	0.89	0.89	0.88	0.059	0.388	< 0.001	0.726
ADFI, lb	1.02	0.98	1.06	1.17	1.16	1.13	0.070	0.772	< 0.001	0.268
F/G	1.31	1.29	1.29	1.31	1.28	1.33	0.037	0.545	0.655	0.513
Experimental period (d 0 to 24)										
ADG, lb	0.59	0.57	0.61	0.67	0.66	0.65	0.041	0.487	< 0.001	0.808
ADFI, lb	0.75	0.72	0.77	0.85	0.84	0.83	0.047	0.722	< 0.001	0.316
F/G	1.29	1.26	1.27	1.28	1.26	1.31	0.039	0.512	0.612	0.389
Common diet (d 24 to 42)										
ADG, lb	1.34	1.38	1.35	1.29	1.28	1.33	0.068	0.513	0.059	0.795
ADFI, lb	1.92	1.95	1.92	1.90	1.82	1.91	0.101	0.362	0.134	0.739
F/G	1.43	1.41	1.43	1.47	1.42	1.43	0.026	0.690	0.313	0.304
Overall (d 0 to 42)										
ADG, lb	0.91	0.92	0.93	0.94	0.92	0.94	0.051	0.903	0.404	0.847
ADFI, lb	1.25	1.25	1.26	1.30	1.25	1.30	0.068	0.702	0.190	0.950
F/G	1.37	1.36	1.37	1.39	1.35	1.38	0.026	0.826	0.519	0.165
Fecal dry matter, %[5]										
d 10[3]	21.86	22.51		20.09	23.79		1.043	0.096	0.753	0.019
d 24	22.94	23.70	23.19	21.96	20.94	21.22	0.801	0.503	0.004	0.952

[1] A total of 300 pigs (Line 241 × 600, DNA, Columbus, NE, initially 12.3 ± 1.04 lb) were used in a 42-d growth study with five pigs per pen and 10 pens per treatment. Treatments were assigned in a randomized completed block design to compare the effect of the formulation type (Low ABC-4 without ZnO vs High ABC-4 with ZnO) and three feeding durations of Valopro Win (VLPW;0, 10, and 24 d) on nursery performance and fecal dry matter.

[2] Low ABC-4 diets were formulated to 200 and 250 meq/kg from d 0 to 10 and d 10 to 24, respectively. The lactose levels were reached using pure lactose, AX3 digest as a protein concentrate source, and fumaric and formic acid. High ABC-4 diets were formulated to 493 and 470 meq/kg, containing 2,990 and 1,910 ppm of Zn from d 0 to 10 and 10 to 24, respectively. Spray-dried milk whey powder and HP300 were used as lactose and soy-concentrated sources, respectively.

[3] Valopro Win (MiXscience, Bruz, France) is a fiber ingredient that combines a purified source of coarse indigestible fiber with oat hulls and yeast autolysate. Valopro Win was fed for 0, 10, or 24 d.

[4] For weight on d 10, period 1 performance, and fecal dry matter on d 10 only one value is displayed for 10 and 24 d VLPW feeding duration because all pigs received the same diet during this period. The *P*-value tests diets with and without lactose.

[5] Same three pigs per pen were sampled on days 10 and 24.

Table 3. Main effect of Valopro Win feeding duration and formulation type on nursery performance and fecal dry matter[1]

	Valopro Win feeding duration, d[2]					ABC-4:	Formulation type[3] Low	High		
Item	0	10	24	SEM	*P* =	ZnO:	No	Yes	SEM	*P* =
BW, lb										
d 0	12.3	12.3	12.3	1.04	0.998		12.3	12.3	1.04	0.957
d 10[4]	15.7	15.5		1.17	0.267		15.4	15.7	1.17	0.030
d 24	27.4	27.22	27.4	1.89	0.901		26.5	28.2	1.88	<0.001
d 42	51.1	51.2	51.6	2.97	0.883		50.9	51.7	2.94	0.332
Period 1 (d 0 to 10)[4]										
ADG, lb	0.34	0.32		0.026	0.276		0.31	0.34	0.025	0.033
ADFI, lb	0.4	0.38		0.017	0.163		0.37	0.4	0.016	0.001
F/G	1.22	1.2		0.071	0.560		1.19	1.21	0.068	0.575
Period 2 (d 10 to 24)										
ADG, lb	0.84	0.83	0.85	0.056	0.726		0.79	0.89	0.055	< 0.001
ADFI, lb	1.10	1.06	1.11	0.066	0.268		1.02	1.15	0.064	< 0.001
F/G	1.31	1.28	1.31	0.031	0.513		1.30	1.31	0.028	0.655
Experimental period (d 0 to 24)										
ADG, lb	0.63	0.62	0.63	0.038	0.808		0.59	0.66	0.037	< 0.001
ADFI, lb	0.80	0.77	0.80	0.044	0.316		0.75	0.84	0.043	< 0.001
F/G	1.28	1.26	1.29	0.035	0.389		1.27	1.28	0.034	0.612
Common diet (d 24 to 42)										
ADG, lb	1.32	1.33	1.34	0.064	0.795		1.36	1.30	0.062	0.059
ADFI, lb	1.91	1.88	1.92	0.096	0.739		1.93	1.87	0.094	0.134
F/G	1.45	1.42	1.43	0.021	0.304		1.42	1.44	0.020	0.313
Overall (d 0 to 42)										
ADG, lb	0.93	0.92	0.93	0.048	0.847		0.92	0.94	0.472	0.404
ADFI, lb	1.28	1.25	1.28	0.066	0.395		1.25	1.28	0.065	0.190
F/G	1.38	1.35	1.37	0.024	0.165		1.37	1.37	0.029	0.519
Fecal dry matter, %[5]										
d 10[4]	20.97	23.15		0.733	0.019		22.29	22.56	0.597	0.753
d 24	22.45	22.32	22.21	0.592	0.952		23.28	21.37	0.505	0.004

[1] A total of 300 pigs (Line 241 × 600, DNA, Columbus, NE, initially 12.3 ± 1.04 lb) were used in a 42-d growth study.
[2] Valopro Win (MiXscience, Bruz, France) is a fiber ingredient that combines a purified source of coarse indigestible fiber with oat hulls and yeast autolysate. Valopro Win was fed for 0, 10, or 24 d.
[3] Low ABC-4 diets were formulated to 200 and 250 meq/kg from d 0 to 10 and d 10 to 24, respectively. The lactose levels were reached using pure lactose, AX3 digest as a protein concentrate source, and fumaric and formic acid as acidifiers. High ABC-4 diets were formulated to 493 and 470 meq/kg, containing 2,990 and 1,910 ppm of Zn from ZnO from d 0 to 10 and 10 to 24, respectively. Spray-dried milk whey powder and HP300 were used as lactose and specialty soy sources, respectively.
[4] For weight on d 10, period 1 performance, and fecal dry matter on d 10 only one value is displayed for 10 and 24 d VLPW feeding duration because all pigs received the same diet during this period. The *P*-value tests diets with and without VLPW
[5] Same three pigs per pen were sampled on d 10 and 24.