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Effects of ValoproWin and Formulation Strategy on Nursery Pig Performance and Fecal Dry Matter

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Effects of ValoproWin and Formulation Strategy on Nursery Pig Performance and Fecal Dry Matter

Julian Arroyave, Mike D. Tokach, Jason C. Woodworth, Joel M. DeRouchey, Robert D. Goodband, Katelyn N. Gaffield, Jordan T. Gebhardt,[1] Pau Salgado-López,[2] David Guillou,[3] and Noëmie Lemoine[3]

Summary

A total of 335 pigs (initially 12.3 ± 1.91 lb) were used to evaluate the effect of ValoproWin (VLPW) level and formulation strategy on nursery growth performance and fecal dry matter (DM). ValoproWin is a fiber ingredient that contains a purified source of coarse indigestible fiber, oat hulls, and yeast autolysate. At weaning, pigs were randomly assigned within two body weight (BW) blocks to one of the five dietary treatments in a generalized randomized block design. There were four or five pigs per pen and 14 replicate pens per treatment. Experimental diets were fed for 23 d, and then pigs were fed a common diet for 22 d. Dietary treatments were arranged in a 2 × 2 + 1 factorial design, with the main effects of added VLPW (2.5 or 5%) and formulation strategy (diluted or adjusted). An additional control treatment, which contained no VLPW, was included for comparison. In the diluted diets, VLPW was added at the expense of the complete diet without further adjustments to the formulation, resulting in nutrient dilution proportional to the VLPW inclusion. In contrast, adjusted diets were reformulated to maintain a similar nutrient composition to the control diet, regardless of VLPW addition. No significant interactions between VLPW inclusion or formulation strategy were observed for any of the performance criteria or periods. For the experimental period (d 0 to 23), pigs fed the diluted diets tended ($P = 0.091$) to have greater ADFI than those fed the adjusted diets. No differences were observed in ADG between formulation strategies. Consequently, pigs fed the adjusted diets tended ($P = 0.084$) to have improved F/G compared with those fed diluted diets. No significant main effects of VLPW level were observed for ADG and ADFI; however, pigs fed diets containing 5% of VLPW tended ($P = 0.056$) to have worse F/G compared with those fed diets containing 2.5% of VLPW. Also, increasing VLPW from 0 to 5% tended ($P = 0.051$) to linearly worsen F/G in the diluted diets but not in the adjusted diets. For the overall period (d 0 to 45), no main effects of the formulation strategy were observed for any of the performance parameters. However, pigs fed diets with 5% of VLPW during the

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experimental period tended ($P = 0.059$) to have poorer F/G compared with those fed diets with 2.5% VLPW. No significant effect of formulation strategy was observed for fecal DM. However, fecal DM linearly increased ($P < 0.001$) on d 10 as VLPW inclusion increased, independent of formulation strategy. At d 24, fecal DM tended to linearly increase ($P = 0.098$) as VLPW inclusion increased in the adjusted formulation strategy. In conclusion, the effect of added VLPW was independent of the formulation strategy. Increasing dietary VLPW improved fecal DM, particularly on d 10; however, F/G tended to worsen as VLPW level increased during both experimental and overall periods. During the experimental period, pigs fed the diluted diets had greater ADFI and poorer F/G than those fed the adjusted diets, although these differences were not maintained overall.

Introduction

Fiber plays a critical role in nursery pig nutrition by supporting gut health and digestive function during the post-weaning period. The inclusion of both soluble and insoluble fibers has been shown to stimulate gut development, enhance microbial diversity, and promote immune modulation.[4] Soluble fiber can serve as a fermentable substrate for beneficial bacteria, while insoluble fiber helps to regulate intestinal transit and reduce the colonization of pathogenic microbes.[5] Despite these benefits, the effects of dietary fiber on growth performance remain inconsistent. Variations in outcomes are likely influenced by fiber type, inclusion level, and interaction with other dietary components.

ValoproWin (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. Previous studies conducted at Kansas State University suggest that the use of 2.5% of VLPW in the first two dietary phases led to an improvement of fecal DM, but no responses were observed in growth performance. A follow-up experiment focused on the estimation of the optimum inclusion level of VLPW in a corn-soybean meal-based diet concluded that increasing VLPW from 0 to 5% linearly increased fecal DM at d 10 and 24: however, ADG and G:F tended to decrease with increasing VLPW.

The lack of response in the previous studies on performance could be related to the formulation strategy utilized. In both cases, the VLPW was included on top of the existing diet without adjusting nutrient levels, which led to a dilution in all nutrients proportional to the VLPW inclusion. Therefore, the objective of the present study was to evaluate the effect of increasing VLPW and two formulation strategies on performance and fecal DM in nursery pigs.

Materials and Methods

The Kansas State University Institutional Animal Care and Use Committee approved the protocol used in this experiment. The experiment was conducted in an environmentally controlled facility at the Kansas State University Swine Teaching and Research

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[4] G. F. Silva, B. A. N. Silva, D. Sanglard, R. L. Domingos, M. F. Gonçalves, H. M. C. Cardoso, L. A. Cardoso, T. S. B. Pereira, B. C. A. Maia, S. K. Brito, L. T. S. Martins, A. L. Miranda, L. A. Haupenthal, S. Hirtenlehner, and M. L. T. Abreu. 2023. Performance and gut permeability of post-weaned piglets are influenced by different sources of lignocellulose fiber. Livest. Sci. 274:105274. doi:10.1016/j.livsci.2023.105274.

[5] Li, Q., E. R. Burrough, N. K. Gabler, C. L. Loving, O. Sahin, S. A. Gould, and J. F. Patience. 2019. A soluble and highly fermentable dietary fiber with carbohydrases improved gut barrier integrity markers and growth performance in F18 ETEC challenged pigs. J. Anim. Sci. 97:2139–2153. doi:10.1093/jas/skz093.

Center in Manhattan, KS. Each pen (5 × 5 ft) was equipped with a six-hole dry feeder and a nipple drinker to provide *ad libitum* access to feed and water.

Animals and diets

A total of 335 pigs (Line 241 × 600, DNA, Columbus, NE; initially 12.3 ± 1.91 lb) were used in a 45-d study. The pigs were weaned at approximately 19 d of age and divided into two body weight (BW) categories. Pigs were then randomly assigned to pens within the BW categories, and pens were allotted to one of five dietary treatments. Each pen had four or five pigs, and there were 14 replicate pens per treatment.

Pigs were fed experimental diets for the first two dietary phases, lasting 10 and 13 d, respectively. From d 23 to 45 of the experiment, all pigs were fed a common phase 3 diet. All dietary treatments were manufactured at the Kansas State University O.H. Kruse Feed Technology Innovation Center in Manhattan, KS. The first two phases were fed in pellet form, and the common phase was fed in meal form. Feed samples by phase were collected during the bagging process. Samples were collected from every other bag for phases 1 and 2 and from every five bags for phase 3.

Dietary treatments were arranged in a 2 × 2 + 1 factorial with the main effects of VLPW (2.5 or 5%) and formulation strategy (diluted or adjusted). An additional control treatment, which contained no VLPW and was not diluted, was included for comparison. In the diluted diets, VLPW was added at the expense of the complete diet without further adjustments to the formulation, resulting in nutrient dilution proportional to the VLPW inclusion. In contrast, adjusted diets were reformulated to maintain a similar nutrient composition to the control diet, regardless of VLPW level (Table 1). Thus, the adjusted diets contained increasing soybean meal and monocalcium phosphate to maintain amino acid and phosphorus levels across diets as VLPW increased.

Pigs and feeders were weighed on d 10, 17, 23, 31, 38, and 45 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 until fecal DM analysis was conducted. The samples were dried in a forced-air oven for 48 h at 151°F for the determination of fecal DM.

Statistical analysis

Data were analyzed as a generalized randomized block design. 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. For performance data, the model utilized treatment as a fixed effect and BW block as a random effect. For fecal dry matter, data were analyzed as repeated measures, considering the two sampling days. In addition to the parameters previously mentioned, the model incorporated pen as a random effect to account for the subsampling associated with multiple individual pigs analyzed from each pen.

Contrast coefficients were set to evaluate the main effect of VLPW inclusion (2.5 or 5%), formulation strategy (diluted or adjusted), and their interaction. The linear and quadratic effects of increasing the VLPW inclusion (0, 2.5, or 5%) within each formulation strategy on performance and fecal DM were evaluated. Contrast coefficients were established based on the VLPW concentration. Results were considered significant with $P \leq 0.05$ and marginally significant with $P \leq 0.10$.

Results and Discussion

No significant interactions between the VLPW inclusion or formulation strategy were observed for any of the performance criteria or periods (Table 2).

For period 1 (d 0 to 10), pigs that were fed adjusted diets tended ($P = 0.093$) to have worse F/G compared with those fed diluted diets. However, no significant effects of formulation strategy were observed for d 10 BW, ADG, and ADFI. Similarly, no significant main effects of VLPW inclusion were observed for any of the performance parameters during this period. No significant linear or quadratic interactions or main effects were observed for ADG and ADFI. However, F/G linearly worsened ($P = 0.043$) as VLPW inclusion increased in the adjusted formulation strategy.

For period 2 (d 10 to 23), pigs fed diluted diets had greater feed intake ($P = 0.043$) than those fed adjusted diets. However, no differences were observed in d 23 BW and ADG between formulation strategies. As a result, pigs fed adjusted diets had improved ($P = 0.012$) F/G compared with those fed diluted diets. No significant main effects of VLPW inclusion level were observed for any performance criteria during this period. Similarly, no significant linear or quadratic interactions or main effects were observed for any performance parameters.

For the experimental period (d 0 to 23), pigs fed diluted diets tended ($P = 0.091$) to have greater ADFI than those fed adjusted diets. No differences were observed in ADG between formulation strategies. Consequently, pigs fed adjusted diets tended ($P = 0.084$) to have improved F/G compared with those fed diluted diets. No significant main effects of VLPW inclusion level were observed for ADG and ADFI; however, pigs fed diets containing 5% VLPW tended ($P = 0.056$) to have worse F/G compared with those fed diets containing 2.5% VLPW. No significant linear or quadratic interactions or main effects were observed for ADG and ADFI. However, a tendency for a linear interaction ($P = 0.084$) was observed for F/G, where F/G tended to linearly increase ($P = 0.051$) as VLPW inclusion increased in the diluted diets but not in the adjusted diets.

When pigs were fed a common diet during period 3 (d 23 to 45), no significant main effect of formulation strategy was observed for any of the performance criteria. Pigs fed diets with 5% VLPW during the experimental period tended ($P = 0.063$) to have greater ADFI than those fed 2.5% VLPW; however no significant effect of VLPW level was observed for d 45 BW, ADG, and F/G. No significant linear or quadratic interactions or main effects were observed for ADFI. However, ADG tended to linearly increase ($P = 0.097$) as VLPW inclusion increased during the experimental period in the diluted formulation strategy, whereas F/G tended to linearly worsen ($P = 0.091$) with increasing VLPW inclusion in the adjusted formulation strategy.

For the overall period (d 0 to 45), no significant main effect of formulation strategy was observed for any of the performance criteria. Pigs fed diets with 5% VLPW during the experimental period tended ($P = 0.059$) to have poorer F/G compared with those fed 2.5% VLPW, however no significant effect of VLPW level was observed for ADG and ADFI. No significant linear or quadratic interactions or main effects were observed for any of the performance criteria.

For fecal DM, no significant interactions between sampling day and dietary treatment or a significant main effect of the sampling day ($P = 0.109$) were observed. Similarly, no significant interactions or main effects of the formulation strategy or VLPW inclusion were observed for d 10 and 23 fecal DM. However, fecal DM linearly increased ($P < 0.001$) on d 10 as VLPW inclusion increased, independent of formulation strategy. On d 24, fecal DM tended to linearly increase ($P = 0.098$) as VLPW inclusion increased in the adjusted formulation strategy.

In conclusion, the effect of VLPW level was independent of formulation strategy. Increasing dietary VLPW inclusion improved fecal DM, particularly on d 10; however, F/G tended to worsen as VLPW level increased during both experimental and overall periods. During the experimental period, no significant effects of formulation strategy were observed for BW or ADG. However, pigs fed diluted diets had greater ADFI and poorer F/G than those fed adjusted diets, although these differences were not maintained overall.

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The authors would like to thank MiXscience, France, for providing the VLPW for this study.

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

	Phase 1					Phase 2					Phase 3
Formulation:		Diluted		Adjusted			Diluted		Adjusted		---
VLPW, %:	**0**	**2.5**	**5.0**	**2.5**	**5.0**	**0**	**2.5**	**5.0**	**2.5**	**5.0**	---
Ingredient, %											
Corn	50.54	49.27	48.01	46.59	42.43	55.97	54.57	53.17	51.77	47.65	68.05
Soybean meal, 47.7% CP	17.35	16.91	16.48	17.67	18.11	25.35	24.72	24.09	25.94	26.37	28.12
Lactose	15.00	14.63	14.25	15.00	15.00	7.50	7.31	7.13	7.50	7.50	---
Microbial enhanced SBM[2]	7.50	7.31	7.13	7.50	7.50	5.50	5.36	5.23	5.50	5.50	---
Spray-dried plasma	3.25	3.17	3.09	3.25	3.25	---	---	---	---	---	---
Soybean oil	2.00	1.95	1.90	3.09	4.28	1.00	0.98	0.95	2.15	3.28	---
Calcium carbonate	0.33	0.32	0.31	0.31	0.30	0.48	0.46	0.45	0.45	0.43	0.75
Monocalcium phosphate, 21%	0.91	0.89	0.87	0.95	0.96	0.97	0.94	0.92	0.97	1.00	0.85
Sodium chloride	0.77	0.75	0.73	0.77	0.78	0.80	0.78	0.76	0.81	0.81	0.6
L-Lys-HCl	0.44	0.43	0.42	0.43	0.43	0.49	0.47	0.46	0.47	0.46	0.55
DL-Met	0.25	0.24	0.24	0.25	0.26	0.23	0.22	0.22	0.24	0.26	0.21
L-Thr	0.18	0.18	0.17	0.19	0.20	0.21	0.20	0.19	0.21	0.22	0.23
L-Trp	0.04	0.04	0.04	0.04	0.04	0.05	0.05	0.05	0.05	0.05	0.05
L-Val	0.09	0.08	0.08	0.10	0.10	0.11	0.10	0.10	0.11	0.12	0.16
Trace mineral premix	0.15	0.15	0.14	0.15	0.15	0.15	0.15	0.14	0.15	0.15	0.15
Vitamin premix	0.25	0.24	0.24	0.25	0.25	0.25	0.24	0.24	0.25	0.25	0.25
Phytase[3]	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.03
Fumaric acid	0.50	0.49	0.48	0.50	0.50	0.50	0.49	0.48	0.50	0.50	---
Formic acid[4]	0.40	0.39	0.38	0.40	0.40	0.40	0.39	0.38	0.40	0.40	---
ValoproWin[5]	---	2.50	5.00	2.50	5.00	---	2.50	5.00	2.50	5.00	---
Total	100.00	100.00	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					Phase 3
Formulation:		Diluted		Adjusted			Diluted		Adjusted		---
VLPW, %:	**0**	**2.5**	**5.0**	**2.5**	**5.0**	**0**	**2.5**	**5.0**	**2.5**	**5.0**	---
Calculated analysis											
Standardized ileal digestible amino acids, %											
Lys	1.36	1.33	1.30	1.36	1.36	1.35	1.32	1.29	1.35	1.35	1.30
Ile:Lys	56	56	56	56	56	58	58	58	59	59	53
Leu:Lys	115	115	115	113	112	115	115	115	114	113	113
Met:Lys	38	38	38	38	38	38	38	38	38	39	36
Met & Cys:Lys	56	56	56	56	56	55	55	55	55	56	57
Thr:Lys	63	63	63	63	64	63	63	63	63	64	63
Trp:Lys	20	21	21	21	20	20	20	20	20	21	19
Val:Lys	70	70	70	70	70	70	70	70	70	70	70
His:Lys	36	36	36	36	35	36	36	36	36	36	35
NE, kcal/lb	1,173	1,150	1,126	1,172	1,173	1,125	1,103	1,081	1,125	1,125	1,111
CP, %	21.05	20.63	20.21	21.00	20.98	21.45	21.02	20.59	21.48	21.47	19.98
Lactose, %	15.00	14.63	14.25	15.00	15.00	7.50	7.31	7.13	7.50	7.50	---
Ca, %	0.49	0.48	0.46	0.49	0.49	0.57	0.56	0.55	0.57	0.57	0.64
P, %	0.52	0.51	0.50	0.52	0.52	0.55	0.54	0.53	0.55	0.55	0.56
STTD P, %	0.47	0.46	0.45	0.47	0.47	0.46	0.45	0.45	0.46	0.47	0.43
Crude fiber, %	2.20	3.52	4.84	3.51	4.81	2.48	3.79	5.10	3.79	5.10	2.44
NDF, %	7.49	9.18	10.88	9.04	10.58	8.25	9.93	11.60	9.80	11.34	8.51
ADF, %	3.10	4.56	6.01	4.54	5.97	3.49	4.93	6.38	4.93	6.36	3.45
Lignin, %	0.42	0.89	1.37	0.89	1.37	0.51	0.98	1.45	0.98	1.46	0.53

[1] Phases 1, 2, and 3 were fed from d 0 to 10, 10 to 23, and 23 to 45, respectively.
[2] ME-PRO (Aquatech, Brookings, SD).
[3] Ronozyme Hiphos 2400 (dsm-firmenich, Parsippany,NJ) provided 907 FTU/lb for phases 1 and 2 and 368 FTU/lb in phase 3 with an assumed release of 0.14% STTD P in phases 1 and 2 and 0.12% STTD P in phase 3.
[4] Phormasil NA (Hawkins, Roseville, MN).
[5] ValoproWin (MiXscience, Bruz, France).

Table 2. Effect of VLPW and formulation strategy on growth performance and fecal dry matter in nursery pigs[1]

Formulation:[2]		Diluted		Adjusted			*P* =[4]		
VLPW, %:[3]	0.0	2.5	5.0	2.5	5.0	SEM	Formulation × VLPW	Formulation	VLPW
BW, lb									
d 0	12.3	12.3	12.3	12.3	12.3	1.91	0.968	0.856	0.676
d 10	14.4	14.5	14.3	14.2	13.9	2.24	0.829	0.163	0.347
d 23	26.8	27.5	26.7	26.4	26.5	3.70	0.299	0.203	0.485
d 45	59.2	59.8	60.3	58.9	59.0	6.08	0.806	0.213	0.726
Period 1 (d 0 to 10)									
ADG, lb	0.21	0.22	0.20	0.19	0.16	0.037	0.818	0.130	0.208
ADFI, lb	0.28	0.29	0.29	0.28	0.25	0.040	0.341	0.175	0.470
F/G	1.20	1.38	1.25	1.50	1.65	0.165	0.376	0.093	0.952
Period 2 (d 10 to 23)									
ADG, lb	0.95	0.99	0.95	0.94	0.97	0.114	0.132	0.526	0.973
ADFI, lb	1.13	1.17	1.15	1.08	1.12	0.132	0.349	0.043	0.735
F/G	1.18	1.19	1.21	1.16	1.16	0.016	0.412	0.012	0.460
Experimental period (d 0 to 23)									
ADG, lb	0.62	0.65	0.62	0.61	0.62	0.079	0.425	0.402	0.605
ADFI, lb	0.75	0.78	0.77	0.73	0.74	0.091	0.807	0.091	0.936
F/G	1.21	1.20	1.25	1.20	1.20	0.014	0.121	0.084	0.056
Period 3 (d 23 to 45)									
ADG, lb	1.47	1.47	1.53	1.48	1.48	0.109	0.202	0.370	0.250
ADFI, lb	2.19	2.19	2.29	2.21	2.27	0.180	0.723	0.950	0.063
F/G	1.49	1.49	1.50	1.49	1.54	0.020	0.332	0.254	0.165
Overall (d 0 to 45)									
ADG, lb	1.04	1.05	1.06	1.04	1.04	0.093	0.667	0.392	0.622
ADFI, lb	1.45	1.46	1.51	1.45	1.49	0.134	0.836	0.578	0.137
F/G	1.40	1.40	1.42	1.40	1.43	0.015	0.848	0.569	0.059
Fecal dry matter, %[5]									
d 10	22.0	25.1	26.0	25.4	26.8	1.38	0.109	0.516	0.192
d 24	23.2	24.2	25.2	23.5	25.3		0.619	0.718	0.123

[1] A total of 335 pigs (Line 241 × 600, DNA, Columbus, NE; initially 12.3 ± 1.91 lb) were used in a 45-d growth study with four or five pigs per pen and 14 replicate pens per treatment. Dietary treatments were assigned in a 2 × 2 + 1 factorial experiment, with main effects of VLPW inclusion (2.5 or 5.0%) and formulation strategy (diluted or adjusted), and an extra treatment was included where no VLPWs were included in the formulation.

[2] In the diluted formulation strategy, the VLPW was included without any nutritional adjustments in the diet, which resulted in a dilution of all nutrients as the VLPW inclusion increased. In the adjusted formulation strategy, the chemical composition of the diet was adjusted to the values of the diets without VLPW.

[3] VLPW = ValoproWin (MiXscience, Bruz, France), is a fiber source that contains a purified source of coarse indigestible fiber with oat hulls and yeast autolysate.

[4] The *P*-value associated with formulation compares the diluted and adjusted formulation strategy when VLPW was included at 2.5 or 5.0%. Linear and quadratic effects of increasing the VLPW (0, 2.5, or 5%) within each formulation strategy and their interaction were evaluated. No significant linear or quadratic interactions or main effects ($P > 0.10$) were observed for most performance criteria. However, in period 1, F/G linearly worsened ($P = 0.043$) as VLPW inclusion increased under the adjusted formulation strategy. In the experimental period, a tendency for the linear interaction ($P = 0.084$) was observed for F/G, where F/G tended to linearly increase ($P = 0.051$) as VLPW inclusion increased in the diluted diets but not in the adjusted diets. During period 3, ADG tended to linearly increase ($P = 0.097$) as the VLPW inclusion increased in the diluted formulation strategy, while F/G tended to linearly worsen ($P = 0.091$) with increasing VLPW inclusion in the adjusted formulation strategy.

[5] Fecal samples were collected from the same three pigs per pen on d 10 and 24. Data were analyzed as repeated measurements. No significant interactions ($P = 0.269$) between sampling day and dietary treatment or significant main effect of sampling day ($P = 0.109$) were observed. Linear and quadratic effects of increasing the VLPW (0, 2.5, or 5%) within each formulation strategy were evaluated. At d 10, fecal DM linearly increased ($P < 0.001$) as the VLPW inclusion increased, independent of the formulation strategy. At d 24, fecal DM tended to linearly increase ($P = 0.098$) as VLPW inclusion increased in the adjusted formulation strategy.