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EFFECT OF DIETARY ENZYME ON PERFORMANCE OF WEANLING PIGS

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Summary
The current study was conducted to determine the effect of enzyme addition to a simple diet on the performance of weanling pigs. A total of 180 pigs were weaned at approximately 21 ± 3 days of age and allotted by weight and sex to 60 pens (3 pigs/pen). Pens were randomly allotted to dietary treatments, which included a complex diet or a simple diet with 0, 250, 500, 750, or 1000 mg of enzyme/kg of feed. The pelleted prestarter and starter diets were fed for 14 and 21 days (48 pens were fed the starter for 21 days and 12 pens for 14 days), respectively. The simple diet consisted primarily of corn, soybean meal, and whey. The addition of rolled oats and blood meal to partially replace corn and soybean meal and a higher percentage of whey and fish meal were incorporated to formulate the complex diet. Experimental diets were formulated to be iso-energetic, iso-lysinic, and contain a similar amino acid profile relative to lysine. Enzyme addition to the simple diet linearly increased feed intake during the prestarter phase. However, the increased feed intake did not affect daily bodyweight gain or efficiency of feed utilization during the prestarter phase. Pigs consuming the complex diet had a higher daily bodyweight gain and greater efficiency of feed utilization during the starter phase than pigs consuming the simple diet or the simple diet with enzyme addition. Overall, pigs consuming the complex diet had a higher daily body weight gain than pigs consuming the simple diet without enzyme addition and had a greater efficiency of feed utilization than pigs fed the simple diet or the simple diet with enzyme addition. Thus, enzyme addition to the simple diet increased feed intake during the prestarter phase but did not subsequently increase daily bodyweight gain or efficiency of feed utilization of weanling pigs.

Materials and Methods
Seventy-two barrows and seventy-two gilts weighing approximately 7.6 kg were weaned at 21 ± 3 days of age and allocated by weight and sex to 48 pens (3 pigs/pen). Pigs were randomly allotted by pen to a complex diet or simple diet with 0, 250, 500, 750, or 1000 mg of enzyme/kg of feed. Pigs were fed the appropriate pelleted prestarter and starter for 14 d and 21 d, respectively. An additional group of 36 pigs were weaned and allocated as mentioned previously with the exception that the starter was fed for 14 d. Five pigs were removed from the experiment due to inadequate performance during the first week of the experiment. Pigs were allowed ad libitum access to feed and water for the duration of the study. Pigs were weighed individually and feed disappearance was determined every
7 d.

Experimental diets were formulated to be iso-energetic, iso-lysinic, and contain a similar amino acid profile relative to lysine (Table 1). The simple diet consisted primarily of corn, soybean meal, whey, plasma protein, and fish meal to provide sufficient substrate for the enzyme. The enzyme was added to the simple diet to obtain appropriate enzyme concentrations. Rolled oats and blood meal partially replaced corn and soybean meal in the complex diet, which also contained a higher percentage of whey and fish meal than the simple diet.

Data were analyzed by a randomized complete block design using the GLM procedure of SAS. The data represent 10 replications during the entire prestarter phase and the first two weeks of the starter phase. Furthermore, the third week and average of the starter phase as well as the average of all time periods represent 8 replications because the second group of pigs was fed the starter diet for 14 d instead of 21 d. Pen was the experimental unit. Contrasts were performed for the simple diet without enzyme addition vs. complex diet, simple diet vs. simple diet with enzyme addition, and simple diet with enzyme addition vs. complex diet. Regression analysis was also performed on the simple diet plus 0, 250, 500,750, and 1000 mg of enzyme/ kg of feed. Least square means and standard errors of the means have been reported. Significant differences were considered at P 0.05.

Table 1. Composition of the experimental diets

	Prestarter		Starter	
	Complex	**Simple**	**Complex**	**Simple**
Corn	27.29	42.88	53.03	53.01
Rolled oats	15.00	0	0	0
Soybean meal (48%)	18.76	31.61	29.01	39.12
Fat	5.12	5.33	4.38	4.39
Whey	20.00	10.00	6.25	0
Plasma protein	4.00	4.00	0	0
Fish meal	6.00	3.00	2.50	0
Blood meal	1.50	0	2.00	0
Dicalcium phosphate	0.18	0.95	0.76	1.33
Limestone	0.52	0.60	0.73	0.80
Vitamin and minerals	0.25	0.25	0.25	0.25
Salt	0.25	0.25	0.40	0.40
Antibiotic[1]	0.50	0.50	0.50	0.50
Copper sulfate	0.089	0.089	0.089	0.089
Zinc oxide	0.35	0.35	0	0
Lysine-HCl	0.026	0.031	0.006	0.043
DL-methionine	0.177	0.155	0.084	0.067
Calculated composition				
ME	3500	3500	3500	3500
Crude protein	24.00	24.89	22.35	23.09
Crude fat	8.46	8.34	7.60	7.60
Calcium	0.8	0.8	0.75	0.75
Available P	0.40	0.40	0.33	0.33
ID Lysine[2]	1.35	1.35	1.13	1.13
ID Methionine	0.51	0.48	0.40	0.37
ID Threonine	0.83	0.82	0.68	0.67
ID Tryptophan	0.26	0.26	0.22	0.23
ID Sulfur amino acids	0.76	0.76	0.68	0.68

[1] Tylan-sulfa was included in prestarter diets at 100g/ton and Mecadox was included at 50 g/ton in starter diets. Different phases were fed for 2 weeks and 3 weeks, respectively. Enzyme was supplemented to the simple diets at 0, 250, 500, 750, and 1,000 mg/kg of feed.
[2] Apparent ileal digestible

Results

The overall feed intake and growth rate of pigs were above the average of past performance observed at our research facility. Furthermore, the coefficient of variation is similar to past experiments conducted at our facility under similar conditions. The high variation during the first week post-weaning is to be expected as pigs adjust from sow's milk to solid feed. Therefore, we are satisfied that our procedure is sufficient to determine differences in the performance of weanling pigs.

performance during the prestarter phase

Feed intake of the simple and complex diet was similar during the prestarter phase (Table 2). Furthermore, the complex diet did not result in a higher average daily gain or efficiency of feed utilization than the simple diet or the simple diet with enzyme addition. However, enzyme addition to the simple diet had a quadratic effect (P 0.06) on feed intake during the first week of the prestarter phase. Furthermore, feed intake during the second week of the prestarter phase increased linearly ($P < 0.05$) as enzyme concentration increased. The magnitude of this effect in the second week was sufficient to observe this linear relationship when feed intake was averaged over the entire prestarter phase. Although enzyme addition to the simple diet increased feed intake, enzyme addition did not affect growth rate or the efficiency of feed utilization.

Table 2. Pig performance during the prestarter phase[a].

		Enzyme, mg/kg						Regression[b]				Contrasts[c]		
Criteria	**Simple**	**250**	**500**	**750**	**1000**	**Complex**	**SEM**	**L**	**Q**	**C**	**QR**	**C1**	**C2**	**C3**
Feed Intake, g														
Week 1	180	197	230	203	202	201	13	0.24	0.06	0.81	0.15	0.27	0.06	0.64
Week 2	394	422	440	448	443	409	18	0.04	0.28	0.95	0.98	0.58	0.04	0.15
Average	287	309	335	326	322	305	13	0.04	0.08	0.94	0.46	0.33	0.02	0.21
ADG, g/d														
Week 1	137	165	164	167	165	170	17	0.29	0.39	0.66	0.79	0.18	0.15	0.79
Week 2	371	365	415	397	390	359	19	0.27	0.32	0.47	0.22	0.67	0.34	0.14
Average	254	265	290	282	277	265	15	0.17	0.24	0.83	0.50	0.59	0.14	0.41
Gain:Feed, g/ kg														
Week 1	683	840	737	784	807	816	67	0.38	0.65	0.28	0.32	0.17	0.16	0.76
Week 2	940	871	951	887	880	878	34	0.34	0.88	0.40	0.08	0.20	0.27	0.61
Average	883	856	863	868	862	865	28	0.73	0.70	0.62	0.89	0.64	0.50	0.94

[a]Prestarter diet was fed for 14 d post-weaning.
[b]Regression of simple plus 0, 250, 500, 750, and 1000 mg of enzyme/kg of feed.
[c]Contrasts: C1=simple vs. complex, C2=simple vs. enzyme, and C3=enzyme vs. complex.

performance during the starter phase

Enzyme addition to the simple diet did not affect feed intake during the starter phase (Table 3). Pigs fed the complex diet had a greater daily bodyweight gain than the simple diet without enzyme during the second week of the starter phase ($P < 0.01$) and a greater efficiency of feed utilization ($P < 0.05$) than pigs fed the simple diet or the simple diet with enzyme addition during the first week of the starter phase. Furthermore, pigs consuming the complex diet had a higher rate of bodyweight gain and greater efficiency of feed utilization than pigs consuming the simple diet or the simple diet with enzyme addition when averaged over the entire starter phase ($P < 0.05$). Therefore, the complex diet improved daily bodyweight gain and efficiency of feed utilization during the starter period compared to the simple diet or the simple diet with enzyme addition.

Table 3. Pig performance during the starter phase[a].

	Enzyme, mg/kg							Regression[b]				Contrasts[c]		
Criteria	Simple	250	500	750	1000	Complex	SEM	L	Q	C	QR	C1	C2	C3
Feed Intake, g														
Week 3	670	690	665	646	670	673	31	0.66	0.91	0.37	0.95	0.94	0.96	0.89
Week 4	828	891	924	854	872	894	30	0.59	0.10	0.21	0.31	0.12	0.09	0.78
Week 5	1104	1144	1074	1119	1074	1085	46	0.56	0.76	0.88	0.29	0.77	0.98	0.73
Weeks 3 and 4	749	791	788	750	771	784	22	0.96	0.36	0.14	0.65	0.27	0.30	0.73
Average	847	892	871	855	841	865	27	0.57	0.27	0.43	0.76	0.64	0.55	0.99
ADG, g/d														
Week 3	450	464	488	427	430	494	23	0.31	0.23	0.46	0.21	0.18	0.93	0.11
Week 4	578	617	608	634	632	669	23	0.10	0.58	0.78	0.46	0.01	0.09	0.08
Week 5	752	744	731	741	755	751	27	0.97	0.52	0.91	0.83	0.98	0.77	0.80
Weeks 3 and 4	514	540	548	530	531	581	17	0.66	0.24	0.49	0.74	0.01	0.22	0.03
Average	590	615	614	603	605	648	17	0.74	0.39	0.47	0.95	0.02	0.32	0.05
Gain:Feed, g/ kg														
Week 3	681	695	748	684	673	773	29	0.77	0.13	0.88	0.19	0.03	0.57	0.03
Week 4	699	690	672	744	728	748	19	0.07	0.29	0.20	0.10	0.07	0.65	0.07
Week 5	683	650	706	661	725	700	35	0.40	0.50	0.86	0.21	0.74	0.95	0.72
Weeks 3 and 4	690	686	704	710	697	748	19	0.27	0.46	0.24	0.78	0.01	0.44	0.01
Average	698	690	711	705	725	751	15	0.15	0.61	0.94	0.40	0.02	0.57	0.01

[a]Starter diet was fed for 21 d after the prestarter diet.
[b]Regression of simple plus 0, 250, 500, 750, and 1000 mg of enzyme/kg of feed.
[c]Contrasts: C1=simple vs. complex, C2=simple vs. enzyme, and C3=enzyme vs. complex.

overall performance

Overall feed intake of pigs during the study was not affected by dietary treatment (Tables 4 and 5). However, pigs consuming the complex diet had a heavier final bodyweight ($P < 0.05$) and a higher rate of bodyweight gain ($P < 0.05$) than pigs consuming the simple diet without enzyme and a greater ($P < 0.05$) efficiency of feed utilization than pigs consuming the simple diet or simple diet with enzyme addition. These data indicate that the complex diet improved the performance of weanling pigs compared to the simple diet or the simple diet with enzyme addition, most notably during the starter phase. Enzyme addition to the simple diet increased feed intake during the prestarter phase, however, daily bodyweight gain or efficiency of feed utilization of weanling pigs were not affected.

Table 4. Cumulative pig performance during the entire trial[a].

		Enzyme, mg/kg						Regression[b]				Contrasts[c]		
Criteria	**Simple**	**250**	**500**	**750**	**1000**	**Complex**	**SEM**	**L**	**Q**	**C**	**QR**	**C1**	**C2**	**C3**
Feed Intake, g														
Weeks 1-2	287	309	335	326	322	304	13	0.04	0.08	0.94	0.46	0.33	0.02	0.21
Weeks 1-3	415	436	445	432	438	428	15	0.35	0.33	0.49	0.69	0.23	0.15	0.52
Weeks 1-4	518	550	560	538	547	544	15	0.33	0.16	0.25	0.55	0.21	0.07	0.78
Weeks 1-5	626	660	651	643	632	646	20	0.94	0.25	0.51	0.77	0.46	0.35	0.99
ADG, g/d														
Weeks 1-2	254	265	290	282	277	265	15	0.17	0.24	0.83	0.50	0.59	0.14	0.41
Weeks 1-3	319	331	356	330	328	341	14	0.69	0.13	0.79	0.24	0.26	0.26	0.75
Weeks 1-4	384	403	419	406	404	423	12	0.27	0.13	0.72	0.53	0.03	0.09	0.28
Weeks 1-5	458	477	482	475	472	501	14	0.55	0.30	0.70	0.93	0.04	0.24	0.14
Gain:Feed, g/ kg														
Weeks 1-2	884	856	863	867	861	865	28	0.73	0.70	0.62	0.89	0.64	0.50	0.94
Weeks 1-3	775	767	804	773	759	808	20	0.69	0.29	0.65	0.25	0.25	0.97	0.16
Weeks 1-4	744	735	763	758	744	780	10	0.43	0.26	0.15	0.27	0.01	0.57	0.01
Weeks 1-5	734	724	751	740	751	776	13	0.23	0.92	0.73	0.24	0.03	0.62	0.03

[a]Experimental diets were fed for 35 d.
[b]Regression of simple plus 0, 250, 500, 750, and 1000 mg of enzyme/kg of feed.
[c]Contrasts: C1=simple vs. complex, C2=simple vs. enzyme, and C3=enzyme vs. complex.

Table 5. Overall pig performance[a].

		Enzyme, mg/kg						Regression[b]				Contrasts[c]		
Criteria	**Simple**	**250**	**500**	**750**	**1000**	**Complex**	**SEM**	**L**	**Q**	**C**	**QR**	**C1**	**C2**	**C3**
Starting BW, kg	7.63	7.64	7.61	7.65	7.59	7.64	0.03	0.47	0.51	0.57	0.23	0.84	0.88	0.68
Final BW, kg	23.71	24.36	24.51	24.32	24.16	25.19	0.48	0.61	0.33	0.75	0.96	0.04	0.25	0.12
Feed Intake, g	626	660	651	643	632	646	20	0.94	0.24	0.51	0.77	0.46	0.35	0.99
ADG, g/d	458	477	482	475	472	501	14	0.55	0.30	0.70	0.93	0.04	0.24	0.14
Gain:Feed, g/ kg	734	723	751	740	751	776	13	0.23	0.92	0.73	0.24	0.03	0.62	0.03

[a]Results are the reported as the least squares mean of the 14 d prestarter and 21 d starter phase.
[b]Regression of simple plus 0, 250, 500, 750, and 1000 mg of enzyme/kg of feed.
[c]Contrasts: C1=simple vs. complex, C2=simple vs. enzyme, and C3=enzyme vs. complex.