Growth performance and nutrient digestibilities in nursery pigs receiving varying doses of xylanase and β-glucanase blend in pelleted wheat- and barley-based diets

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ABSTRACT: In 2 experiments, dose response efficacy of a xylanase and β-glucanase blend (XB) on growth performance and ileal nutrient digestibility was investigated in nursery pigs fed pelleted wheat (*Triticum aestivum*)- and barley (*Hordeum vulgare*)-based diets. A basal diet (meeting NRC [1998] specifications for 6 to 30 kg BW, except for 5% lower DE) was supplemented with XB to give 4 diets (0, 50, 100, and 200 g/t). The xylanase and β-glucanase blend was formulated to contain guaranteed activity of 12,200 and 1520 units/g, respectively. In Exp.1, 192 nursery pigs (initial BW of 6.5 kg) were randomly assigned to 4 diets to give 12 pens (4 pigs/pen) per diet to study growth performance for 42 d. In Exp. 2, apparent ileal digestibility (AID) of energy and AA was evaluated in 4 individually housed ileal-cannulated barrows (21 kg BW) according to a 4 × 4 Latin square design. In Exp. 1, XB linearly and quadratically increased ($P < 0.05$) G:F compared with control. Adding 200 g/t increased overall G:F by 20% compared with control. In Exp. 2, XB linearly increased ($P < 0.05$) AID of DM, CP, energy, and AA. In conclusion, supplemental xylanase and β-glucanase in nursery pelleted wheat- and barley-based diets deficient in DE increased energy and nutrient use, resulting in better G:F. In conclusion, an enzyme product containing a combination of xylanase and β-glucanase allowed young pigs to derive more nutrients and energy in a wheat- and barley-based diet deficient in energy.

Key words: digestibility, pigs, xylanase and β-glucanase

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INTRODUCTION

The choice of ingredients for a piglet diet must primarily fit its digestive capacity and maintain gut health and nutrient requirements. By virtue of ingredients available and the economics of feeding, weaned pig diets normally contain cereals and their coproducts and legume and oil seed meals in which nonstarch polysaccharides (**NSP**) content can be important. Indigestible NSP reduce feed intake and nutrient use in nonruminants. Supplemental carbohydrases such as β-glucanase and xylanase can overcome limitations of NSP in feedstuffs (e.g., Kiarie et al., 2007; Owusu-Asiedu et al. 2010). However, studies with carbohydrases have produced varied growth performance responses in pigs (e.g., Zijlstra et al., 2010). The reasons for varied responses has not been fully defined; however, in most studies, matching the carbohydrases with the diverse NSP in the feedstuffs is often not considered, and where multicarbohydrase blends are used, specific proportions of the individual carbohydrases were poorly defined (Owusu-Asiedu et al. 2010). Furthermore, most trials were not always accompanied with digestibility (ileal) or balance assays to validate observed responses (Zijlstra et al., 2010). The current studies investigated the dose response of β-glucanase and xylanase blend on growth performance and nutrient use in weaned pigs fed wheat- and barley-based diets.

MATERIALS AND METHODS

All animals and experimental procedures were approved by the University of Manitoba Animal Care Committee and followed the principles established by the Canadian Council on Animal Care (CCAC, 2009). In Exp. 1, a wheat–barley basal diet formulated to meet or exceed the NRC (1998) nutrient requirements for pigs was used (6.0 to 25.0 kg BW, except for DE, which was 5% less; Table 1). The basal diet was prepared for a 2-phase feeding program: 6.0 to 12.5 kg BW in

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phase I and 12.5 to 25.0 kg BW in phase II. For each phase, 3 other diets were prepared by adding xylanase and β-glucanase blend (**XB**; Danisco Animal Nutrition, Marlborough, Wiltshire, UK) at 50, 100, or 200 g/t to the basal diet. The guaranteed minimum activities of the xylanase and β-glucanase were 12,200 and 1520 units/g, respectively. Titanium dioxide (0.3%) was added to the phase II diets as an indigestible marker in Exp. 2. In Exp. 1, 192 (6.3 ± 0.9 kg BW) Landrace pigs were assigned to 48 pens (n = 4 pigs/pen) in a randomized complete block design to give 12 pens/treatment. Pigs had free access to feed and water throughout the study and were weighed at days 0, 15, and 42. Feed disappearance and BW were measured. In Exp. 2, 4 barrows (21.5 kg BW) were fitted with a T-cannula at the distal ileum. The 4 phase II diets were allotted according to a 4 × 4 Latin square design and were supplied in a daily amount of 4% BW. Each experimental period lasted for 7 d; digesta was collected for 12 h on days 6 and 7. Diets and digesta were analyzed for DM, GE, CP, and AA (AOAC, 1990). Titanium was measured using Lomer et al. (2000) procedures. Apparent ileal digestibility (**AID**) values were calculated using standard procedures. Data were analyzed using a mixed model (diet as fixed and other factors were random) procedures of SAS (version 9.1; SAS Institute, Cary, NC). Contrast coefficients from unequally spaced treatments were generated using the interactive matrix language procedure of SAS (Exp. 1). A P-value ≤ 0.05 was considered significant.

Table 1. Ingredient and nutrient composition of the basal diets, Exp. 1[1]

Item	Phase I	Phase II
Ingredient, %		
Barley	20.8	28.9
Wheat	34.9	38.2
Oat (*Avena sativa*) groats	4.00	–
Soybean (*Glycine max*) meal, 45%	27.4	18.0
Canolal meal	–	2.00
Field pea (*Pisum sativum*)	–	7.50
Dried whey	7.70	–
Limestone	1.00	1.00
Dicalcium phosphate	1.50	1.18
Canola oil	0.70	1.30
Salt	0.25	0.25
Vitamin–mineral premix[2]	1.00	1.00
L-Lys	0.30	0.30
DL-Met	0.05	–
L-Thr	0.10	0.05
Titanium dioxide	–	0.30
Calculated provisions (as-fed)		
DE, kcal/kg	3,247	3,237
CP	21.7	19.8
SID[3] Lys	1.16	1.00
SID Met + Cys	0.61	0.49
SID Thr	0.74	0.58
SID Trp	0.23	0.19
Ca	0.90	0.76
Total P	0.73	0.63
Available P	0.41	0.32

[1]Xylanase and β-glucanase activity guaranteed at 12,200 and 1520 units/g, respectively.

[2]Provided per kilogram of diet: vitamin A, 8255 IU; vitamin D_3, 1000 IU; vitamin E, 10.9 IU; vitamin B_{12}, 0.115 mg; vitamin K, 1.1 mg; niacin, 36.8 mg; choline chloride, 781.2 mg; biotin, 0.25 mg; folic acid, 0.75 mg; Mn, 55 mg as MnO; Zn, 50 mg as ZnO; Fe, 80 mg as $FeSO_4.H_2O$; Cu, 5 mg as CuO; Se, 0.1 mg as $NaSeO_3$; and I, 0.28 mg as Ca $(IO_3)_2$.

[3]SID = standardized ileal digestible.

RESULTS AND DISCUSSION

In Exp. 1, overall (days 0 to 42), XB supplementation linearly and quadratically affected ($P < 0.05$) ADFI and G:F (Table 2). Pigs fed diet with XB (200 g/t) had the lowest ADFI and highest G:F resulting in a 12.8% lower ADFI and 20% higher G:F than pigs fed control. In Exp. 2, adding XB linearly increased ($P \leq 0.01$) AID of DM, energy, and AA (Table 2). Relative to pigs fed the control diet, the AID of DM, energy, and CP and average of indispensable AA in pigs fed XB (200 g/t) was higher by 2.4, 4.1, 3.3, and 6.6% units, respectively. The present paradigm is that supplemental carbohydrase in piglet diets partially or completely breakdown target dietary NSP and thus enhance nutrient digestion and absorption (Bedford and Schulze, 1998). Therefore, an expected benefit of supplemental carbohydrases is increased G:F. In Exp. 1, XB increased G:F, which is consistent with the expected benefits from enzyme supplementation and was confirmed by the increased nutrient digestibility in Exp. 2. The decline in ADFI seen in the present study due to enzyme addition is plausible and even more so when the added enzyme increased nutrient digestibility thereby increasing availability of substrates for endogenous enzymes in the intestinal lumen. The presence of nutrients in the intestinal lumen stimulates the release of peptides such as gastric inhibitory protein, glucagon-like peptide-1, glucagon-like peptide-2, and oxyntomodulin, which through a range of mechanisms initiate meal cessation (Maljaars et al., 2008). Thus, pigs fed the control diet in Exp. 1 might have experienced increased digesta flow that might have necessitated them to consume more feed to obtain enough nutrients. In contrast, enzyme supplementation counteracted deleterious effects of NSP with the potential to slow intestinal digesta flow (lowered ADFI) and therefore better ileal nutrient digestibility as evidenced in Exp. 2. In conclusion, the enzyme product containing β-glucanase and xylanase activities allowed young pigs to derive more nutrients and energy in wheat- and barley-based diet limiting in DE.

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Table 2. Enzyme supplementation on growth performance and apparent ileal nutrient digestibility

	XB[1], g/t				SEM	*P*-value	
Item, %	0	50	100	200		Linear	Quadratic
Growth performance[2]							
ADG, kg	0.50	0.50	0.51	0.52	0.020	0.40	0.84
ADFI, kg	0.83	0.74	0.73	0.73	0.030	0.02	0.04
G:F	0.60	0.68	0.70	0.72	0.020	<0.01	0.03
Apparent ileal digestibility[3], %							
DM	66.0	67.2	67.8	68.4	0.55	0.01	0.32
GE	64.0	67.3	66.7	68.6	0.74	<0.01	0.42
CP	76.1	77.2	78.5	79.4	0.76	0.01	0.45
Indispensable amino acids							
Arg	59.8	61.3	62.4	65.4	1.69	0.310	0.968
His	69.2	70.8	70.1	72.6	1.68	0.207	0.881
Ile	68.7	74.6	77.0	78.0	0.93	0.001	0.003
Leu	68.8	72.3	74.1	75.1	1.05	0.001	0.082
Lys	66.2	67.6	67.4	69.9	1.68	0.153	0.875
Met	62.9	64.8	65.1	66.4	1.48	0.135	0.679
Phe	69.9	71.8	73.1	74.9	1.33	0.019	0.600
Thr	80.8	81.6	81.3	83.0	0.65	0.039	0.632
Val	80.3	82.1	82.4	82.8	0.46	0.004	0.065
Average	69.6	71.9	72.6	74.2	1.01	0.008	0.466

[1]XB = xylanase and β-glucanase blend; activity guaranteed at 12,200 and 1520 units/g, respectively.
[2]Growth performance (days 0 to 42); n, replicates pens/treatment = 12 (4 pigs/pen), Exp. 1.
[3]Digestibility trial; n, replicates pigs/treatment = 4, Exp. 2.

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