Dietary supplementation of CJ xylanase on growth performance, digesta viscosity, nutrient digestibility, and gut health of newly weaned pigs

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*** This article is based on the research carried out by North Carolina State University, USA. As the data are not published yet, this article is just to introduce the key results.**

Abstract

This experiment was conducted to investigate the effects of endo-β-1,4-xylanase (0, 900, 1,800, 3,600, 7,200 U/kg feed) on growth performance, nutrients utilization and digesta viscosity in nursery pigs. For the study, corn-soybean meal based diets with corn DDGS (distillers dried grains with solubles) were formulated using sixty newly weaned pigs in a randomized complete block design for 5 treatments. The performance was monitored weekly. On 38 days, jejunal digesta and mucous membranes were collected for viscosity and gut health measurement, respectively. Additionally, ileal digesta were obtained for determination of the apparent ileal digestibility (AID). The supplemental xylanase tended to increase ADG ($P = 0.057$) and significantly reduced digesta viscosity ($P < 0.05$). Furthermore, the supplementation of xylanase significantly improved AID of ADF, NDF, and malondialdehyde (MDA; $P < 0.05$).

Introduction

Recently, the cost of feed ingredients such as corn/maize, sorghum were drastically increased worldwide. The increasing cost of cereal grains has pressured the feed industry to find ways to use alternative cost-effective feed ingredients including the use of co-products such as wheat, barley, palm kernel meal, and DDGS. However, these substitutions contain high amounts of anti-nutritional factors (ANF) which could negatively affect growth performance, feed efficiency, and gut health in pig. Due to the ANF including non starch polysaccharides (NSP), the use of these alternative feedstuffs as feed materials is limited. (Raza at al., 2019; Teymouri et al., 2018; Al-Harthi, 2017; Waititu et al., 2018; Munyaka et al., 2016).

Arabinoxylan is a polysaccharide composed of β-1,4-linked xylose units with side branches of arabinose. Among the many types of heteroxylans, arabinoxylan is most abundant in major plant feedstuffs. The composition of arabinoxylan accounts for 5-29% (DM basis) of typical feed grains. To be specific, it ranges from to 3.1-4.8% in corn, 5.9-8.1% in wheat, 10-17% in DDGS, 21-29% in wheat bran (DM basis). The arabinoxylans are mostly located in the bran (aleurone, testa, and pericarp) and some of soluble arabinoxylans are located in cell walls of endosperm. Therefore, DDGS, a co-product from bioethanol industry, contains 3-3.5 times more arabinoxylans than that is present in the parent grain, corn. (Jaworski et al., 2015; Pedersen et al., 2014; Englyst, 1989; Knudsen, 1997; Tiwari et al., 2018).

Arabinoxylan acts as ANF, causing negative effect on growth performance, digestibility of nutrients, detrimental impacts on gut health by giving rise to digesta viscosity (Bach Knudsen, 2014; Anderson and Simsek, 2018).

In this experiment, it was hypothesized that supplementary xylanase would depolymerize arabinoxylan, reduce viscosity of jejunal digesta, increase AID of nutrients, and improve gut health (as indicated by reduced oxidative stress). Therefore, the objective of this study was to evaluate the effects of CJ xylanase on viscosity, digestibility, intestinal health, and growth performance in nursery pigs fed corn-soybean meal diet with DDGS.

Material and Methods

The experimental protocol was approved by the Institutional Animal Care and Use Committee of North Carolina State University. At 21 days of age, sixty newly weaned pigs (30 barrows and 30 gilts) were allocated to 5 dietary treatments based on a randomized complete block design with initial BW and sex as blocks. The dietary treatments were varying levels of the CJ xylanase (Table 1). The activity of CJ xylanase was 30,000 U/g. The experimental diets were formulated using corn, soybean meal, corn DDGS and met the nutrients requirements of the pigs (NRC, 2012). The experimental period was 38 d, which was divided into 3 dietary phases: phase 1 (d 1 to d 10), phase 2 (d 10 to d 24), and phase 3 (d 24 to d 38). Calculated composition of arabinoxylan gradually increased as the phase changed.

Sample collection for measuring GI parameters was performed at 38 d of feeding. Pigs were enuthazied by captive bolt method. A section of the jejunum (5 cm) was taken at 3 m after the duodenojejunal junction. Digesta sample was also collected from jejunum and ileum.

All the data were analyzed based on a randomized block design using the SAS 9.4 software (SAS Inc., Cary, NC, USA). Dietary treatments were defined as fixed effects and the random effects were blocks. The experimental unit was the pig, as they were individually housed and fed. Statistical differences were considered significant with $P < 0.05$ and tendency with $0.05 \leq P < 0.10$.

Table 1. Composition of experimental diets

Groups	Treatments
Control	Basal diet
Xyl 900	Basal diet + xylanase 900 U/kg feed (30 g/ton)
Xyl 1800	Basal diet + xylanase 1,800 U/kg feed (60 g/ton)
Xyl 3600	Basal diet + xylanase 3,600 U/kg feed (120 g/ton)
Xyl 7200	Basal diet + xylanase 7,200 U/kg feed (240 g/ton)

*The activity of CJ Xylanase: 30,000 U/g

Measured Parameters

1. Growth performance (ADG, ADFI): The pigs and the feed disappearance were individually weighed weekly to determine growth performance parameters.
2. Digesta viscosity: Digesta viscosity was measured with the viscometer and the viscosity values were recorded as apparent viscosity in millipascal seconds (mPa.s).
3. AID of crude protein (CP), ether extract (EE), neutral detergent fiber (NDF) and acid detergent fiber (ADF): Titanium dioxide (0.4%) was added in the diets as an indigestible external marker to determine the digestibility. The AID of ADF, NDF and CP, and EE were calculated using the following equation.

$$\text{AID (\%)} = \left(1 - \frac{Ti_{feed} \times N_{digesta}}{Ti_{digesta} \times N_{feed}}\right) \times 100$$

*Ti_{feed} and $Ti_{digesta}$: the titanum concentation in the feed and the ileal digesta, respectivly
**N_{feed} and $N_{digesta}$: the nutrient concentation in the feed and the ileal digesta, respectivly

4. Oxidative stress as measured by Protein carbonyl and MDA are indicators of cell damage and/or as oxidative stress markers. The concentrations of total protein, protein carbonyl, MDA were measured by the colorimetric method using commercially available kits according to instructions of the manufacturers.

RESULTS

1. Growth Performance

The supplementation of increasing levels of xylanase in piglet diets tended impacted ADG ($P<0.10$) and increased ADFI ($P<0.05$) during the experimental period. The supplementary xylanase tended to increase the ADG by 25% compared to control group, from d 31 to d 38 ($P = 0.057$). Supplementation with increasing levels of xylanase significantly increased the ADFI up to 19% compared to control group from d 31 to d 38 ($P < 0.05$; Figure 1). Futhermore, the treatment of xylanase tended to increase the ADFI from d 24 to d 38 ($P = 0.057$).

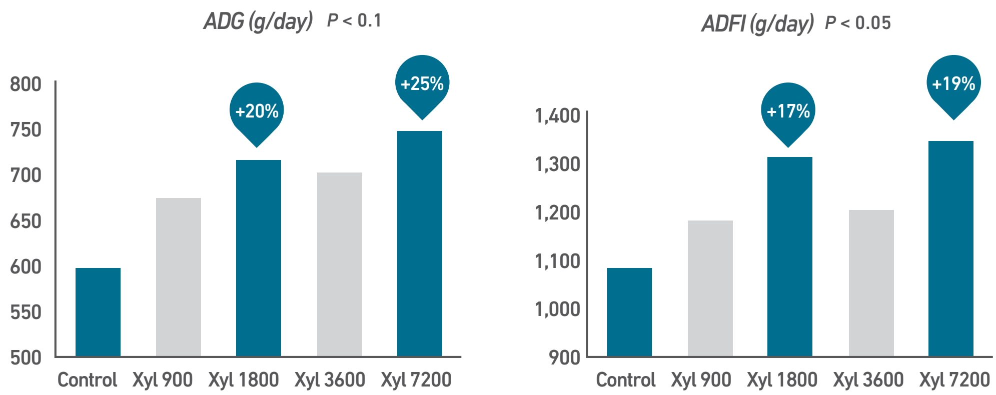

Figure 1. Effects of increasing level of CJ xylanase on growth performance of nursery pigs (d31 - d 38)

2. Digesta viscosity

The jejunal digesta viscosity was significantly reduced by increasing level of supplementary xylanase in the diets ($P < 0.05$). The viscosity values expressed in millipascal (mPa.s), levels decreased 13% and 23% in treatment group of xylanase 900 and 7200 U/kg feed,respectively, compared to control group (Figure 2).

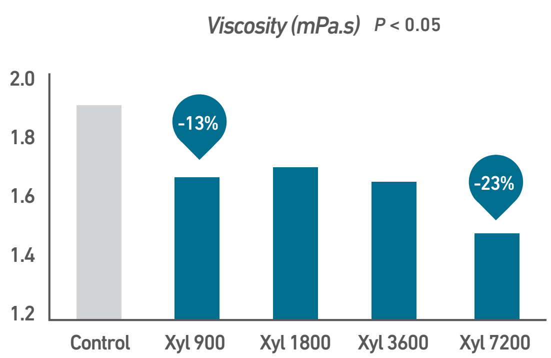

Figure 2. Viscosity of jejunum digesta of nursery pigs fed diets with increasing levels of xylanase

3. Apparent ileal digestibility

The increasing level of supplementary xylanase in the diets increased the AID of EE ($P < 0.05$) and tended to increase the AID of CP ($P = 0.058$). When it compared to the control group, the groups of xylanase supplementation showed higher level of the AID of EE and CP up to 6% and 7%, respectively.

The AID of NDF and ADF were significantly increased by incresing level of supplemention of xylanase in the diets ($P < 0.05$). The xylanase supplemented group had higher AID of NDF and ADF up to 7% and 10% respectively, when it compared to the control group (Figure 3).

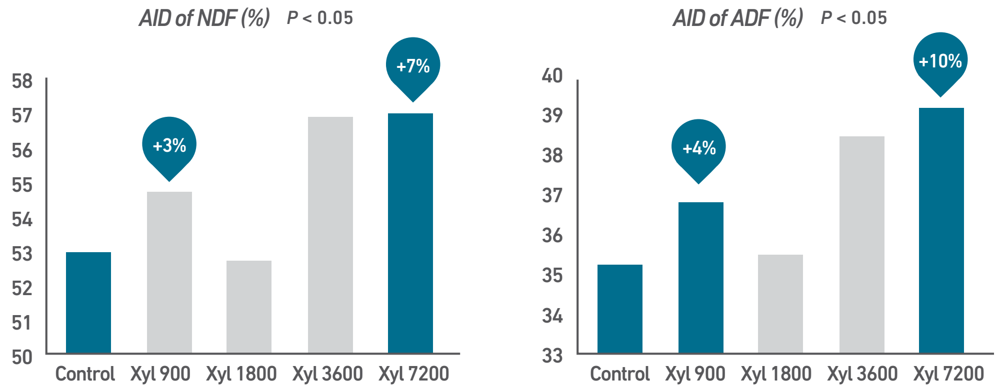

Figure 3. AID of NDF and ADF in piglet fed diets with increasing levels of xylanase

4. Oxidative stress status

The increasing level of supplementary xylanase in the diets reduced the concentration of MDA up to 22% ($P < 0.05$) and tended to reduce in a quadratic manner the concentration of protein carbonyl in the jejunal mucosa ($P = 0.059$; Figure 4).

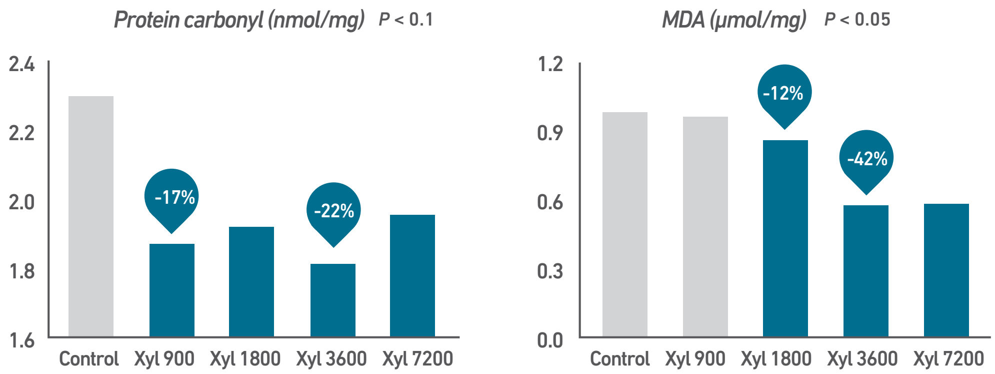

Figure 4. Oxidative stress of nursery pigs fed diets with increasing levels of xylanase

CONCLUSION

This study was designed to investigate the effects of xylanase on parameters of growth performance, viscosity, AID, and gut health. The results indicate that supplementation of xylanase increased ADG and ADFI, and increased AID of CP, EE, ADF, and NDF. The results also reveal that the supplementation of xylanase reduced digesta viscosity and oxidative stress status in the mucous membrane of jejunum. It was confirmed that the intake of 900-1800 U/kg feed (30-60 g/ton) is the optimized dosage for growth and gut health of nursery pigs, which is the current CJ recommended range.

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