



## EFFECT OF XYLANASE ADDED TO A RYE-BASED DIET ON NUTRIENT UTILIZATION IN PIGS

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### ABSTRACT

The effect of enzyme xylanase derived from *Trichoderma longibrachiatum* supplemented to a rye-based diet on apparent ileal digestibility of amino acids and non-starch polysaccharides constituting sugars was studied. Enzymes supplementation at 200 mg.kg<sup>-1</sup> increased ( $P<0.05$ ) the digestibility of total amino acids from 67.1 to 70.8. When the dietary concentration of enzyme increased from 0 to 100 mg.kg<sup>-1</sup>, the ileal digestibility of the NSP constituents gradually increased as well. No further increase was observed with the supplementation level of 200 mg.kg<sup>-1</sup>. The improvement in the digestibility of arabinose and xylose (685%,  $P<0.05$ ) was much higher in comparison with remaining sugars (110%,  $P<0.05$ ). The apparent ileal digestibility of galactose was positively influenced by xylanase but it remained negative in all dietary treatments, presumably due to the high concentration of galactose in endogenous secretions. It is concluded that xylanase effectively degrades non-starch polysaccharides in upper digestive tract and marginally improves amino acid availability in young pigs.

**Keywords:** ileal digestibility; xylanase; NSP; piglets

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## INTRODUCTION

The basic diets containing cereals supplemented with enzymes acting on non-starch polysaccharides (NSP) improves nutrient utilization and animal growth intensity. Arabinoxylans are considered as primary antinutritional sources in the rye, wheat and triticale (Englyst *et al.*, 1989). Physical and chemical properties of NSP effect many processes associated with digestion and absorption of nutrients. Moreover the effect of enzymes depends on various factors such as their stability, optimum pH, dosage levels and the status of microbial populations in the gut. The effect of supplemental enzymes in compound feed for pigs is less knowledge than for poultry. Better results were obtained with young pigs (Nyachoti *et al.*, 2003), probably because of their immature digestive system and limited ability to hydrolyze the NSP. The aim of the experiment was to study the effect of the enzyme complex derived from *Trichoderma longibrachiatum* with the predominant activity of endo-1,4-beta-xylanase to improve digestibility of essential nutrients and amino acids in pigs fed by rye-based diets.

## MATERIAL AND METHODS

Together we used 11 young female pigs (Large White) from a herd APRC, weaned after 30 days. The experiment was conducted in two parts, in the first part there were 5 pigs and in the second 6 pigs. When the pigs reached body weight 10-15 kg, they were surgically fitted with ileal T-cannula in terminal ileum. After 12-day recovery period the gilts were individually weighed and placed in metabolic cages. Their average initial weight in the first and the second part of the experiment was 12.4 and 17.0 kg, respectively. During the four experimental periods each animal received successively each of the four tested diets. Gilts were weighted at the beginning and at the end of each balance period. All the essentials of the experiment were reviewed and approved by the Ethical Committee APRC.

Component composition of basal diet and the results of chemical analysis are given in Table 1. As the main source of energy and protein has been used rye (variety Fernando, harvest 2003). Chromium oxide was used as an indigestible marker. Adding the enzyme complex corresponding to 50, 100 and 200 mg.kg<sup>-1</sup> basal diet, we created three experimental diets (diet X50, X100 and X200). Not-been-supplemented diet (X0) served as controls. Pigs were fed twice daily at 6.00 and 16.00 h. in two equal doses, in daily amount of 90 g.kg<sup>0.75</sup>. Water was available *ad libitum*. Each balance period consisted of 6-days feeding period

followed by a 24-hours collection period. The ileal digesta samples were collected and stored at -20 ° C for later analysis. The content of dry matter, organic matter, total nitrogen, fat, fiber, neutral detergent fiber (NDF) and acido detergent fiber (ADF) was determined in accordance with standard procedures of **AOAC (1990)**. Amino acid composition of diets and the ileal digesta was determined using ion-exchange chromatography (AAA Ingos, Prague) according to manufacturer's recommendations. Chromium oxide was determined by atomic adsorption spectroscopy (**Williams et al., 1962**). Arabinoxylans and total non-starch polysaccharides were analyzed using the method of **Englyst and Cummings (1984)**.

**Table 1** Ingredient and chemical composition of the basal diet ( $g \cdot kg^{-1}$ , air-dry basis)

<i>Ingredients</i>	<i>g.kg<sup>-1</sup></i>
Rye cv. Fernando <sup>1</sup>	958.0
Sunflower oil	9.0
Monocalcium phosphate	11.0
Limestone	13.0
Salt	3.0
Chromic oxide	3.0
Premix <sup>2</sup>	3.0
<b>Chemical analyses</b>	
Dry matter	900.3
Organic matter	953.7
Crude protein	136.7
Ether extract	26.3
Crude fibre	28.6
NDF	287.1
ADF	38.9

<sup>1</sup>Contained g/kg air-dry: DM, 897; CP, 138; crude fibre, 23.3; ether extract, 15.1; ash, 17; Ca, 0.46; P, 1.8; lysine, 4.6

<sup>2</sup>Supplied per kg of diet: vit. A, 7200 IU; vit. D3, 1350 IU;  $\alpha$ -tocopherol 18 mg; vit. B1, 0.54 mg; vit. B2, 3.6 mg; vit. B6 19.5 mg; Ca-pantothenate, 10.5 mg; niacin, 15 mg; vit. K3, 0.54 mg; biotin, 0.06 mg; cyanocobalamin, 0.021 mg; choline, 102 mg; betaine, 51 mg; Fe, 60 mg; Zn, 90 mg; Mn, 42 mg; Cu, 21 mg; I, 0.42 mg; Co, 0.54 mg; Se, 0.21 mg.

The obtained data were subjected to analysis of variance (ANOVA) and differences between values were compared using Fisher's LSD test.

## RESULTS AND DISCUSSION

Animals in both parts of the experiment were in good health, with one exception and the served food they consumed without the major problems. One animal fed by diet X100 have taken only about 65% of their daily intake during the balance period of the first period and the data from this period have not been loaded into the calculations.

Mean values for ileal digestibility (IS) of dry matter, organic matter, nitrogen, fat, crude fiber, NDF and ADF are summarized in Table 2.

**Table 2** Effect of xylanase supplementation on the apparent ileal digestibility of nutrients and energy (%).

Diet	X0	X50	X100	X200	Pooled SEM
N	11	11	10	11	
Dry matter	62.7 <sup>a</sup>	64.7 <sup>ab</sup>	65.9 <sup>b</sup>	66.3 <sup>b</sup>	0.9
Organic matter	66.1 <sup>a</sup>	67.6 <sup>a</sup>	68.8 <sup>a</sup>	69.1 <sup>a</sup>	0.9
Nitrogen	60.5 <sup>a</sup>	62.9 <sup>a</sup>	61.9 <sup>a</sup>	63.3 <sup>a</sup>	1.5
Ether extract	63.7 <sup>a</sup>	65.6 <sup>a</sup>	65.1 <sup>a</sup>	64.2 <sup>a</sup>	2.5
Crude fibre	14.9 <sup>a</sup>	17.0 <sup>a</sup>	19.6 <sup>a</sup>	21.4 <sup>a</sup>	2.2
NDF	57.8 <sup>a</sup>	60.6 <sup>ab</sup>	64.5 <sup>bc</sup>	64.8 <sup>c</sup>	1.5
ADF	24.3 <sup>a</sup>	27.5 <sup>a</sup>	26.9 <sup>a</sup>	27.5 <sup>a</sup>	2.0

<sup>a,b</sup> Means within a column followed by the different superscript are significantly different (P<0.05)

The adding of enzyme complex in the feed had a positive effect on the digestibility of all nutrients, the largest increase was observed in the levels of 100 and 200 mg.kg<sup>-1</sup>. The relative improvement compared with the control group ranged from 3.0% (fat) and 43.6% (crude fiber). Significant effect of added enzyme on digestibility was observed for NDF and dry matter. Insignificant difference was found between levels 100 and 200 mg.kg<sup>-1</sup>. Arabinoxylans, the main component of the endosperm of the rye, produce highly viscous aqueous solutions. In studies with poultry **Choct and Annison (1992)** found a significant negative correlation between the viscosity of ileal digesta and digestibility of nutrients. In pigs, the viscosity of ileal digesta is much lower compared to poultry. **Bedford *et al.* (1992)** mentioned that the effect of viscosity is less significant in pigs than in poultry. **Bartelt *et al.* (2002)** based on their experiments with carboxymethylcellulose in pigs clearly concluded that the viscosity of the ileal digesta does not affect the digestibility of nutrients. An alternative hypothesis is based on the assumption that the intact cell walls containing nutrients are for digestion and absorption available in the small intestine **Hesselman (1983)** and **Barrera *et al.***

(2004). By adding exogenous enzymes capable of degrading the cell wall structure may be released encapsulated nutrients, thereby facilitating their digestion.

The apparent ID of the arabinoxylans and total NSP are shown in Table 3. Digestibility of both components was gradually increased with enzyme concentration in the feed from 0 to 100 mg.kg<sup>-1</sup>. Adding of the higher level, 200 mg enzyme per kg of feed, resulted in a slight decrease in digestibility.

**Table 3** Effect of xylanase supplementation on the apparent ileal digestibility of arabinoxylans and total NSP (%)

<b>Diet</b>	<b>X0</b>	<b>X50</b>	<b>X100</b>	<b>X200</b>	<b>Pooled SEM</b>
N	11	11	10	11	
Arabinoxylans	2.6 <sup>a</sup>	7.9 <sup>ab</sup>	18.8 <sup>b</sup>	15.0 <sup>b</sup>	4.2
Total NSP	11.3 <sup>a</sup>	18.2 <sup>ab</sup>	27.6 <sup>b</sup>	25.8 <sup>b</sup>	3.2

<sup>a,b</sup> Means within a column followed by the different superscript are significantly different (P<0.05)

The higher digestibility of total NSP compared with digestibility of arabinoxylans was detected in all diets, indicating a low degradation of arabinoxylans in the small intestine. This phenomenon underlines the importance of added enzymes degrading arabinoxylans to diets containing rye, triticale and wheat. Digestibility of essential amino acids has increasing tendency with increasing concentration of enzymes in diets (Table 4). Except of arginine, improvement of the individual amino acids was not significant. However, there is a conclusive increase (P <0.05) digestibility of total amino acids in the diet with an enzyme of 200 mg.kg<sup>-1</sup>.

**Table 4** Effect of xylanase on apparent ileal digestibility of amino acids (%)

	Xylanase (mg. kg <sup>-1</sup> )				SEM
	0	50	100	200	
Arginine	78.3 <sup>a</sup>	80.6 <sup>b</sup>	81.7 <sup>b</sup>	82.1 <sup>b</sup>	0.8
Histidine	69.3 <sup>a</sup>	72.1 <sup>a</sup>	72.0 <sup>a</sup>	73.3 <sup>a</sup>	1.2
Isoleucine	58.4 <sup>a</sup>	62.2 <sup>a</sup>	62.0 <sup>a</sup>	66.8 <sup>a</sup>	4.8
Leucine	77.4 <sup>a</sup>	80.2 <sup>a</sup>	80.2 <sup>a</sup>	79.6 <sup>a</sup>	1.7
Lysine	63.9 <sup>a</sup>	67.4 <sup>a</sup>	65.3 <sup>a</sup>	66.4 <sup>a</sup>	1.9
Methionine	71.7 <sup>a</sup>	74.9 <sup>a</sup>	75.0 <sup>a</sup>	75.6 <sup>a</sup>	1.5
Phenylalanine	75.9 <sup>a</sup>	75.0 <sup>a</sup>	75.3 <sup>a</sup>	77.9 <sup>a</sup>	2.2
Threonine	61.7 <sup>a</sup>	64.6 <sup>a</sup>	63.6 <sup>a</sup>	64.9 <sup>a</sup>	1.8
Valine	67.8 <sup>a</sup>	71.4 <sup>a</sup>	71.4 <sup>a</sup>	72.5 <sup>a</sup>	1.4
Essential AA	70.1 <sup>a</sup>	72.2 <sup>a</sup>	71.9 <sup>a</sup>	73.3 <sup>a</sup>	1.1
Nonessential AA	64.4 <sup>a</sup>	66.4 <sup>a</sup>	67.2 <sup>a</sup>	68.6 <sup>a</sup>	1.2
Total AA	67.1 <sup>a</sup>	69.2 <sup>ab</sup>	69.4 <sup>ab</sup>	70.8 <sup>b</sup>	0.8

<sup>a,b</sup> Means within a column followed by the different superscript are significantly different (P<0.05)

## CONCLUSION

The diets with a high proportion of rye, supplemented by enzymes complex with xylanase, significantly improved the apparent digestibility of dry matter, NDF, arabinoxylans and NSP. Digestibility of all other nutrients was numerically increased. The use of enzyme complex efficiently degrades the NSP, resulting in better availability of other nutrients and amino acids in the intestine. Given the effectiveness of the enzyme complex and its price is recommended to use a concentration of 100 mg.kg<sup>-1</sup> of the feed.

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