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Short communication

Effects of exogenous phytase and β-mannanase on ileal and total tract digestibility of energy and nutrient in palm kernel expeller-containing diets fed to growing pigs

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ABSTRACT

The objective of the present study was to determine the effects of phytase and β-mannanase on apparent ileal and total tract digestibilities of energy and nutrients in diets containing 10% palm kernel expellers fed to pigs. A basal diet was mainly based on maize, soybean meal, and palm kernel expellers without inorganic P. Four experimental diets were prepared in a 2 × 2 factorial treatment arrangement with 2 concentrations of supplemental phytase at 0 or 1000 U/kg and 2 concentrations of supplemental β-mannanase at 0 or 1600 U/kg. Eight pigs with an initial body weight of 70.9 kg (SD = 11.9) were fitted with ileal T-cannulas and were fed experimental diets in a replicated 4 × 4 Latin square design with 4 dietary treatments and 4 periods. In each period, faeces were collected on d 7 and ileal digesta samples were collected on d 8 and 9. Supplemental phytase increased the coefficient of ileal apparent digestibilities (CIAD) and the coefficient of total tract apparent digestibilities (CTTAD) of P by 0.161 and 0.191, respectively ($P < 0.01$). Supplemental β-mannanase increased CIAD of dry matter, organic matter and energy by 0.035–0.038 ($P < 0.05$), and CTTAD of energy by 0.019 ($P < 0.05$). However, no interaction between phytase and β-mannanase was observed in the digestibility of nutrients. Phytase increased CIAD of aspartic acid, glutamic acid, and serine, by 0.021–0.029 ($P < 0.05$), and β-mannanase increased CIAD of leucine and phenylalanine by 0.018 and 0.019, respectively ($P < 0.05$). In conclusion, phytase and β-mannanase improved P and organic nutrient digestibilities, respectively, and to a lesser extent, the 2 enzymes improved amino acid digestibility.

1. Introduction

Supplemental phytase in swine diets improve the digestibility of P by hydrolyzing phytic acids in plant feedstuffs (Mroz et al., 1994; Sands and Kay, 2007; Agudelo Trujillo et al., 2010). Mannan in swine diets has been suggested to hinder the utilization of nutrients (Rainbird et al., 1984). Effects of supplementation of β-mannanase to maize–soybean meal (SBM)-based diets on nutrient digestibility and growth performance have been studied (Pettey et al., 2002). Interestingly, the contents of mannan in palm kernel expellers (PKE; 244 g/kg) is much greater than in maize (9 g/kg), barley (27 g/kg), wheat

Abbreviations: AA, amino acids; CIAD, coefficient of ileal apparent digestibility; CTTAD, coefficient total tract digestibility; DM, dry matter; OM, organic matter; PKE, palm kernel expellers; SBM, soybean meal.

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Table 1
Ingredient composition of experimental diets (g/kg, as-fed basis).[a]

Phytase (U/kg):	0	0	1000	1000
Ingredient β-mannanase (U/kg):	0	1600	0	1600
Maize	672	672	672	672
Soybean meal	200	200	200	200
Palm kernel expellers	100	100	100	100
Maize starch	3	1	2	–
Phytase product	–	–	1	1
β-Mannanase product	–	2	–	2
Limestone	11	11	11	11
Salt	4	4	4	4
Vitamin-mineral premix[b]	5	5	5	5
Chromic oxide	5	5	5	5

[a] Provided g per kg of diet on an as-fed basis unless otherwise indicated: organic matter, 823; gross energy, 13.9 MJ/kg; crude protein, 162; ether extract, 29; crude fibre, 34; calcium, 5.6; phosphorus, 3.8; neutral detergent fibre, 209; acid detergent fibre, 88; mannan, 34; arginine, 9.7; histidine 3.6; isoleucine, 5.3; leucine, 13.7; lysine, 7.7; methionine, 2.2; phenylalanine, 7.2; threonine, 5.9; tryptophan, 1.6; valine, 6.2; alanine, 8.4; aspartic acid, 14.7; cysteine, 3.1; glutamic acid, 27.5; glycine, 6.3; proline, 11.0; serine, 7.7; tyrosine, 4.2.

[b] Provided per kg of diet: vitamin A, 25000 IU; vitamin D_3, 4000 IU; vitamin E, 50 IU; vitamin K, 5.0 mg; thiamine, 4.9 mg; riboflavin, 10.0 mg; pyridoxine, 4.9 mg; vitamin B_{12}, 0.06 mg; D-pantothenic acid, 37.5 mg; niacin, 62 mg; folic acid, 1.10 mg; biotin, 0.06 mg; Cu, 25 mg as copper sulfate; Fe, 268 mg as iron sulfate; I, 5.0 mg as potassium iodate; Mn, 125 mg as manganese sulfate; Se, 0.38 mg as sodium selenite; Zn, 313 mg as zinc oxide; and butylated hydroxytoluene, 50 mg.

(20 g/kg), SBM (20 g/kg), canola meal (30 g/kg), and cottonseed meal (15 g/kg). Palm kernel expellers and palm kernel meal have been used in swine diets to reduce feed costs (Kim et al., 2001).

However, effects of β-mannanase on PKE-containing swine diets have not yet been reported. Moreover, information on the interactive effects of phytase and β-mannanase on nutrient digestion by pigs fed PKE-containing diets is limited. Thus, the objective of the present study was to test the effects of supplementing maize–SBM–PKE-based diets with phytase, β-mannanase, or both enzymes on apparent ileal and total tract digestibility of energy and nutrients by growing pigs.

2. Materials and methods

The protocol for the present experiment was reviewed and approved by the Institutional Animal Care and Use Committee at Konkuk University (KU11082).

2.1. Animals and experimental design

Eight crossbred boars with an initial body weight of 70.9 kg (SD = 11.9) were used to measure the effects of phytase and β-mannanase as feed additives. Animals were allotted to a replicated 4 × 4 Latin square design with 4 diets and 4 periods per square (Kim and Kim, 2010). Pigs were surgically fitted with a T-cannula in the distal ileum using procedures adapted from Stein et al. (1998). Pigs were individually housed in metabolism crates that were equipped with a feeder and a nipple drinker.

2.2. Diets and ingredients

Four experimental diets were prepared in a 2 × 2 factorial treatment arrangement with 2 concentrations of supplemental *Escherichia coli*-derived phytase at 0 or 1000 U/kg and 2 concentrations of supplemental β-mannanase at 0 or 1600 U/kg. Beta-mannanase was produced from *Bacillus subtilis* grown on Luria broth. A basal diet was based on 67% maize, 20% SBM and 10% PKE. Phytase, β-mannanase, or both enzyme products were added to the basal diet at the expense of maize starch (Table 1). All diets contained 0.5% Cr_2O_3 as an indigestible index. Vitamins and minerals were included in all diets to meet or exceed nutrient requirement estimates (NRC, 1998). Feed was provided in a mash form at daily amounts of 2.3 times the estimated maintenance requirement for metabolizable energy, and equal amount of meals were provided at 08:00 and 16:00 h. The maintenance energy of each diet was calculated based on maintenance energy values for each ingredient (NRC, 1998). The feed allowance for each pig was adjusted at the beginning of each period when the body weight of the pigs was recorded. Animals had free access to water with nipple drinkers.

2.3. Sample collection

Each period lasted 9-d. The initial 6 d of each period were an adaptation period to the experimental diet. Faeces were collected on d 7 and ileal digesta samples were collected for 7 h on d 8 and 9. Ilealdigesta collection was based on the procedures described by Kim et al. (2009) with minor modification. A wired plastic bag (Whirl-Pak®) was attached to the cannula barrel and digesta flowing into the bag was collected. Bags were removed whenever they were filled with digesta,