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Influence of enzyme mixture supplementation on growth performance, nutrient digestibility, and fecal score in growing pigs

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Abstract

This study evaluated the influence of enzyme mixture supplementation on the growth performance, nutrient digestibility, and fecal score of growing pigs. A total of 72 pigs with an initial body weight of 20.23 ± 1.46 kg were randomly assigned to two treatments consisting of a basal diet and the basal diet supplemented with 0.5% enzyme mixture. During a 19-day trial, no significant difference was observed in the body weight (BW) and average daily feed intake (ADFI) of the pigs. However, a gradual increase in the average daily gain (ADG) was observed during the period from day 14 to day 19 and the overall period in pigs fed a diet supplemented with the 0.5% enzyme mixture ($p < 0.10$) as compared to the pigs that were fed the control diet. From days 4 to 14 and in the overall experiment, a gradual increase in the feed conversion ratio (FCR) ($p < 0.10$) was observed with the inclusion of 0.5% enzyme mixture supplementation. The nutrient digestibility of dry matter (DM), nitrogen (N), and energy were not affected by enzyme mixture supplementation. In addition, dietary supplementation with the enzyme mixture had no significant effects on the fecal score of growing pigs. In summary, supplementation with the enzyme mixture had beneficial effects on the ADG performance but failed to have a significant effect on growth performance (BW), nutrient digestibility, and fecal score.

Keywords: enzyme mixture, fecal score, growing pigs, growth performance

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Introduction

The amount of feed accounts up to 70% of entire production costs, and the agricultural and industrial byproducts are evaluated as feed ingredients to reduce the costs (Ewan, 2001). Corn-Soybean meal (SBM) based diets are commonly used as energy and protein sources in swine diets at South Korea. The consumption of agriculture residues and its byproduct in the past as substitutes to soybean meal in feeds was not effective due to high fiber content in those feeds which lead to poor digestibility in animals (Sayehban et al., 2016). The oligosaccharides in soybean meal have two α-galactosides (i.e., stachy-ose and raffinose) which was not metabolized in monogastric animals because of the absence of α-1,6-galactosidase enzyme activity in the intestinal mucosa (Gitzlemann

and Auricchio, 1965). A soybean has oligosaccharides which increases the intestinal feed passage rate and lowers the fiber digestion. So, consideration is paid on enzyme application in livestock nutrition. Exogenous enzyme supplementation in Corn-SBM diet targets non-starch polysaccharides (NSP) and protein that consequently improves the digestion, weight gain in monogastric animals (Kim et al., 2006; Fang et al., 2007). It also absorbs energy and protein, reducing the feed costs (Jo et al., 2012). Further, improvement in growth performance and feed efficiency are due to increasing dietary energy from the added enzyme. Whitney et al. (2006) and Ying et al. (2011) stated that growth performance was improved by the enzyme-based liquid supplementation in pigs. Balasubramanian et al. (2020) showed that enzyme blend supplementation could increase body weight (BW) and average daily gain (ADG) in grower-finisher pigs. Therefore, our present study was to investigate the influence of enzyme mixture supplementation on growth performance and fecal score of growing pigs.

Materials and method

Source of feed additive and animal ethics

In this study, a commercial product (Alcopro®, Simco Nutrition Group™, Irvine, California, CA, USA) containing about 10,000 kcal·kg^{-1} metabolizable energy (ME), high energy source ingredients (corn distillers condensed soluble and ethyl alcohol) and a natural digestive enzyme mixture (glucoamylase from *Aspergillus niger*, alpha-amylase from *Bacillus stearothermophilos*, lipase, maltase, cellulose, protease) were used. The energy supplementation quantity used as diet was based on the guidance level given by the manufacturer. The product supplemented to the animal was not oxidized or rancid and was a stable liquid in storage. The experiment protocol was reviewed and approved by the Animal Care and Use Committee of Dankook University (DK-1-2006), Cheonan, Republic of Korea, for animal experimentation.

Animals and facilities

A total of 72 crossbred growing pigs (Landrace × Yorkshire × Duroc) with an initial average weight of 20.23 ± 1.46 kg (Mean ± SE) were used in 19-days experimental trial. Growing pigs were divided into pens according to their initial body weight, 4 pigs per pen. Eighteen pens were randomly assigned to 2 treatments, where each pen was counted as one replication and each treatment had 9 replications. Pigs were fed a basal diet (control) and the basal diet supplemented with 0.5% enzyme mixture. The corn-soybean meal diet was formulated as per recommendation of NRC (2012) (Table 1). Pigs were caged in a thermostatically controlled ambient environmental temperature (25℃) with the slatted plastic floor and equipped with one side self-feeder and nipple drinker. Each pig was individually identified by using tags and the feed and water were provided by *ad libitum* throughout the experimental period.

Sampling measurements

BW was measured at initial, 4th day, 14th day, and 19th day. To calculate the ADG, average daily feed intake (ADFI) and feed conversion ratio (FCR), the feed consumption was recorded on a pen basis. To calculate apparent total tract digestibility (ATTD) of dry matter (DM), nitrogen (N), and energy, 0.20% chromium oxide was added to the diet as an indigestible marker for 7 days prior to fecal collection at day 19. Fecal samples were collected randomly from at least 2 pigs (1 barrow

and 1 gilt) per pen then pooled with representative sample and stored in a freezer at -20℃. All feed and fecal samples were freeze-dried and finely ground to pass through a 1 mm screen. DM and N amounts were determined using methods established by the Association of Official Analytical Chemists (AOAC, 2000). UV absorption spectrophotometry (UV-1201, Shimadzu, Kyoto, Japan) was used to determine chromium in the diets. The energy was determined by using a Parr 6100 oxygen bomb calorimeter (Parr Instrument Co., Moline, Illinois, USA). The apparent total tract digestibility was calculated using the following formula: digestibility (%) = [1− {(Nf × Cd)/ (Nd × Cf)}] × 100, where Nf = nutrient concentration in faeces (% DM), Nd = nutrient concentration in diet (% DM), Cd = chromium concentration in diet (% DM), and Cf = chromium concentration in faeces (% DM). The fecal score was measured and recorded at 4th day, 14th day and 19th day and it was determined by the following 1 = hard, dry pellets in a small, hard mass; 2 = hard, formed stool that remains firm and soft; 3 = soft, formed, and moist stool that retains its shape; 4 = soft, unformed stool that assumes the shape of the container; 5 = watery, liquid stool that can be poured. Fecal Scores and signs of stool consistency were recorded on a pen basis of an individual pig.

Table 1. Composition of growing pig diets (as fed-basis).

Items	CON	Enzyme mixture
Ingredients (%)		
Corn	74.99	75.31
Soybean meal	19.99	19.93
Animal fat	1.88	1.12
AlcoPro (enzyme mixture)	-	0.50
Digestible crude protein	1.28	1.28
Limestone	0.73	0.73
Salt	0.20	0.20
Methionine, 99%	0.08	0.08
Lysine, 78%	0.47	0.47
Threonine, 98%	0.13	0.13
Tryptophan, 98%	0.02	0.02
Mineral mix[y]	0.10	0.10
Vitamin mix[z]	0.10	0.10
Choline, 25%	0.03	0.03
Total	100.00	100.00
Calculated value (%)		
CP	16.00	16.00
Ca	0.66	0.66
P	0.56	0.56
LYS	1.12	1.12
MET	0.32	0.32
THR	0.72	0.72
TRP	0.19	0.19
ME (kcal·kg^{-1})	3,300	3,300
FAT	4.75	4.02
Fiber	2.48	2.48
Ash	4.57	4.57

CP, crude protein; LYS, lysine; MET, methionine; THR, threonine; ME, metabolizable energy; FAT, crude fat; CON, control.
[y] Provided per kg of diet: Fe, 138 mg as ferrous sulfate; Cu, 84 mg as copper sulfate; Mn, 24 mg as manganese oxide; Zn, 72 mg as zinc oxide; I, 0.6 mg as potassium iodide; and Se, 0.36 mg as sodium selenite.
[z] Provided per kg of diet: Vitamin A, 15,600 IU; vitamin D_3, 2,040 IU; vitamin E, 72 IU; vitamin K_3, 6 mg; vitamin B_1, 5.04 mg; vitamin B_2, 22.8 mg; vitamin B_6, 8.04 mg; vitamin B_{12}, 0.06 mg; biotin, 0.408 mg; folic acid, 2.52 mg; niacin, 66 mg; D-calcium pantothenate, 54 mg.

Statistical analysis

All data were statistically analyzed by t test using SAS program (SAS Inst. Inc., Cary, NC, USA). Results were considered significant at $p < 0.05$ level and $p < 0.10$ was considered as a trend.

Results and Discussions

The present research was aimed to evaluate the effect of an enzyme mixture supplementation on growing pig's growth performance, nutrient digestibility and fecal score. According to the studies of Balasubramanian et al. (2020) enzyme blend supplementation had positive influence on BW, ADG and gain : feed (G : F) in grower-finisher pigs. The xylanase, amylase and protease enzyme had improved the digestion and ADG in monogastric animals (Fang et al., 2007; Moehn et al., 2007; Nortey et al., 2007; Li et al., 2010). Enzyme mixture supplementation on growing pig's growth performance was shown in Table 2. The enzyme mixture supplementation had tendency to increase ADG during day 14, day 19 and overall period with 0.5% enzyme mixture supplementation to the basal diet ($p < 0.10$) and no significant effects on ADFI. This result is suited for low energy composition of the diet and Kerr et al. (2003) reports it was concluded that the diet has a change in energy content which is lower than 124 kcal which is not suitable for the feed intake. There was no influence on BW during overall experiment with the addition of enzyme mixture supplementation. However, earlier studies indicated contrary results, that dietary enzyme mixture liquid feed additive had no effect on growth performance in nursery pigs (Ying et al., 2012). These inconsistent results in the study were due to amount of dosage given to the experimental animal, their health status, breed and differences in dietary compositions. Xylanases have been a preferred choice for enhancing nutrient digestibility due to their advantages such as enabling access to trapped nutrients to digestive enzymes and their action of cell wall degradation (Woyengo et al., 2008). Previously, Balasubramanian et al. (2020) and Li et al. (2010) reported that enzyme blend supplementation had positive effect on nutrient digestibility of DM and energy. But the present study revealed that dietary inclusion of enzyme mixture supplementation in growing pigs had no significant effect ($p > 0.05$) on nutrient digestibility of DM, N, energy (Table 3). The reason for the absence in nutrient digestibility is due to the better development of digestive system as pigs become older (Hoque and Kim, 2021).

Lan et al. (2017) reported that fecal score was decreased in weaning pigs when xylanase supplementation was added in diet. In contrary, the present study (during 4th day, 14th day, and 19th day) showed no significant difference ($p > 0.05$) on fecal score associated with the inclusion of enzyme mixture supplementation (Table 4). In addition, the present study did not test the fecal microbiota. An excess of coliform bacteria which is present in the gastrointestinal system causes diarrhea, that leads to a decline in the growth performance in domesticated animals. If the microbiota balance in the gut can be optimized it may enhance the utilization of nutrients and reduced fecal score. Hence, more studies are needed with different levels of enzyme mixture supplementation to know the exact cause for the absence of a substantial change in fecal score and growth performance.

Table 2. The influence of enzyme mixture supplementation on growth performance of growing pigs.

Items	CON	TRT1	SEM	p-value
Body weight (kg)				
Initial	20.15	20.14	0.01	0.9878
Day 4	22.54	22.51	0.05	0.9608
Day 14	29.56	29.21	0.16	0.6271
Day 19	33.22	32.71	0.23	0.4840
Day 4				
ADG (g)	598	592	12	0.7087
ADFI (g)	1,039	1,056	23	0.6455
FCR	1.737	1.783	0.017	0.0792
Day 14				
ADG (g)	692	661	13	0.0814
ADFI (g)	1,416	1,394	29	0.6190
FCR	2.044	2.107	0.031	0.0557
Day 19				
ADG (g)	733	701	14	0.0816
ADFI (g)	1,817	1,787	41	0.6555
FCR	2.476	2.552	0.042	0.2885
Overall				
ADG (g)	683	657	12	0.0981
ADFI (g)	1,442	1,426	25	0.6970
FCR	2.110	2.170	0.022	0.0829

Means in the same row with different superscript differ significantly ($p < 0.05$).

CON, basal diet; TRT1, CON + 0.5% enzyme mixture; SEM, standard error of means; ADG, average daily gain; ADFI, average daily feed intake; FCR, feed conversion ratio.

Table 3. The influence of enzyme mixture supplementation on nutrient digestibility of growing pigs.

Items	CON	TRT1	SEM	p-value
Dry matter	79.51	78.96	0.85	0.6246
Nitrogen	75.67	75.95	0.69	0.7534
Digestibility energy	78.21	77.25	0.80	0.6484

Means in the same row with different superscript differ significantly ($p < 0.05$).

CON, basal diet; TRT1, CON + 0.5% enzyme mixture; SEM, standard error of means.

Table 4. The influence of enzyme mixture supplementation on fecal score of growing pigs.

Items	CON	TRT1	SEM	p-value
Fecal score[z]				
Day 4	3.22	3.25	0.04	0.3910
Day 14	3.20	3.23	0.05	0.4779
Day 19	3.18	3.20	0.06	0.7502

Means in the same row with different superscript differ significantly ($p < 0.05$).

CON, basal diet; TRT1, CON + 0.5% enzyme mixture; SEM, standard error of means.

[z] Fecal score = 1 hard, dry pellet; 2 firm, formed stool; 3 soft, moist stool that retains shape; 4 soft, unformed stool that assumes shape of container; 5 watery liquid that can be poured.

Conclusion

The present study will be the base of our future research. The supplementation of enzyme mixture had beneficial effects on ADG of growth performance but failed to show the significant effect of growth performance (BW), nutrient digestibility and fecal score. On other hand further research with different standards of enzyme mixture is required to understand the influences of enzyme mixture in growing pigs.

Conflict of Interests

No potential conflict of interest relevant to this article was reported.

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