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ANIMAL

Determination of garlic extract efficacy on growth, nutrient digestibility, and fecal score of growing pigs via diet supplementation

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Abstract

Garlic powder (GP) was supplemented in the diet to assess the growth efficiency, nutritional retention, and fecal score of growing pigs. In total, 80 growing pigs ([Yorkshire × Landrace] × Duroc) were arbitrarily allotted (22.04 ± 0.56 kg primary average body weight) to two different trial groups with eight repetitions (three males and two females) in each pen for the 42-day trial. The dietary treatment consisted of control (CON, basal diet), which included 0.2% GP (TRT1). Growing pigs fed the GP diet exhibited an increase ($p < 0.05$) in body weight on day 42 and a lower ($p < 0.05$) overall feed conversion ratio compared to the CON pigs; however, the average daily gain and feed intake showed no difference ($p > 0.05$). Additionally, nutrient utilization of dry matter was greater ($p < 0.05$) in the GP-supplemented diet group than in the CON group. The feeding methods did not adversely affect the nitrogen and energy utilization and the fecal score significantly ($p > 0.05$). In summary, growing pigs fed the GP diet showed increased growth and nutritional utilization, and no adverse impact on the fecal score; thus, it could be utilized as a stimulant for improved growth performance.

Key words: digestibility, fecal score, garlic extract, growing pigs, performance

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Introduction

The largest advancement in livestock biotechnology throughout the twentieth century was the introduction of antibiotic growth promoters (AGPs) in feeds. The AGPs serve a variety of purposes in the field of animal husbandry, which include enhancing the performance of animals and preventing and treating disease. However, through the food chain, overuse of AGP results in antimicrobial resistance in animals and serious health problems in humans. While concerns regarding antimicrobial resistance and residual drugs have been raised due to the prolonged usage of antibiotics, legislation prohibiting their use in pig production is increasingly being implemented (Bi et al., 2017; Chen et al., 2021; Sampath et al., 2021).

Several plant-based natural remedies have been used as growth promoters, herbal antioxidants, immune system boosters, and disease preventatives in pig diets (Liu et al., 2013, Bontempo et al., 2014). One of these, garlic has biologically active elements that act as antibacterial and have been demonstrated to prevent bacterial growth (Wang et al., 2011). According to several studies, GP (garlic powder), a common plant extract feed additive, contains allicin, alliin, ajoene, diallyl sulfide, dithiine, S-allylcysteine, and other organic sulfur-containing compounds, so the garlic can be used to promote the productivity of livestock (Lawson, 1996; Aji et al., 2011). Garlic has been utilized as a feed antioxidant or growth promoter for a very long time and is also regarded as a natural remedy for both the prevention and treatment of chronic antibacterial, genitourinary, and cardiovascular diseases, clots in the blood, Alzheimer's disease, leukemia, and kidney disorders (Kim et al., 2009). It was demonstrated that giving garlic and allicin to pregnant and lactating sows had a beneficial impact on body weight increase and the maturation of the piglets' digestive tracts, which can be appraised as a replacement for antibiotics (Tatara et al., 2005). Grela and Klebaniuk (2007) stated that garlic improved piglets' body weight gain (BWG), lowered the incidence of piglet losses, and decreased blood triglyceride and total cholesterol levels. According to Janz et al. (2007), finishing pigs fed a diet including garlic had significantly increased feed consumption and average daily gain (ADG). Huang et al. (2011) demonstrated that adding allicin to a diet may enhance growth, lower the frequency of diarrhea, and diminish the fly attraction of the feces of weanling pigs, possibly indicating diminished pathogen transmission.

According to our acquaintance, there is not enough research on the use of GP supplements to improve the productivity and welfare of growing pigs. We hypothesized that providing growing pigs with a diet enhanced with GP will improve their fecal score, nutrient retention, and production efficiency. Therefore, the experiment's goal was to assess the effects of GP inclusion on growth, nutritional absorption, and fecal score in growing pigs.

Materials and Methods

The Animal Care and Use Committee at Dankook University gave authorization to the research protocol (approval code: DK-1-2208).

Source and preparation of garlic powder

The supplement used in the current experiment was purchased from the market as dried and ground. At first, peel the garlic cloves. After that, slice them thinly and place them in a dry pan. Turn the slices of garlic frequently as the pan is heated to 150 degrees in the oven to dry it. The dry slices should be blended, and the pieces and finer powder should be separated by sifting the mixture through a sieve. For long-term storage, freeze the pieces or powdered garlic in sealed jars kept in a cool place.

Dietary regimens and animal care

Every instrument and pen used was sanitized before analysis. Eighty pigs ([Yorkshire × Landrace] × Duroc) were arbitrarily allotted to two nutritional regimens for six weeks (8 repetitions per treatment, 2 females and 3 males per pen) based on preliminary body weight (BW) (average 22.04 ± 0.56) and gender. The two nutritional regimens were basal diets based on corn-soybean-rice bran meals as control (CON), and basal diet incorporated with 0.2% GP as TRT1. The National Research Council's (NRC, 2012) recommendations for the nutritional requirements of pigs were followed in the preparation of pig feed (Table 1). The room was routinely cleaned and sterilized each week over the whole period of study. All of the pigs were housed in a space that was kept clean and had a slatted plastic floor (0.6 m × 2.0 m × 0.5 m), mechanical aeration, and environmental controls. The preferred room temperature and relative humidity were chosen as 25℃ and 60%, respectively. Stainless steel self-feeders and nipple drinkers were installed in each enclosure to provide the pigs with limitless access to feed and water.

Table 1. Composition of the experimental diets (as feed basis).

Ingredients (%)	Content
Corn	37.57
Soybean meal (crude protein 45 %)	3.00
Rice bran	2.00
Palm kernel meal	2.00
Wheat bran	2.00
Dehulled soybean meal	15.11
Wheat	19.00
Rape seed meal	4.00
Sesame meal	2.00
Brown rice	5.00
Animal fat	3.79
Molasses	2.00
Limestone	1.05
MCP	0.16
Salt	0.30
Lysine (25%)	0.50
Methionine (98%)	0.01
Threonine (98%)	0.02
Choline chloride (50%)	0.09
Vitamin /Mineral premix[y,z]	0.40
Total	100.00
Calculated composition (%)	
Digestible energy (kcal/kg)	3,560
Metabolic energy (kcal/kg)	3,280
Crude protein (%)	17.50
Crude fat (%)	6.70
Crude fiber (%)	3.80
Crude ash (%)	4.40
Total lysine (%)	0.99
Calcium (%)	0.75
Phosphorus (%)	0.42

MCP, monocalcium phosphate.

[y] Provided per kilograms of diet: Vitamin A, 13,000 IU; vitamin D_3, 1,700 IU; vitamin E, 60 IU; vitamin K_3, 5 mg; vitamin B_1, 4.2 mg; vitamin B_2, 19 mg; vitamin B_6, 6.7 mg; vitamin B_{12}, 0.05 mg; biotin, 0.34 mg; folic acid, 2.1 mg; niacin, 55 mg; D-calcium pantothenate, 45 mg.

[z] Provided per kilogram of diet: Fe, 115 mg as ferrous sulfate; Cu, 70 mg as copper sulfate; Mn, 20 mg as manganese oxide; Zn, 60 mg as zinc oxide; I, 0.5 mg as potassium iodide; Se, 0.3 mg as sodium selenite.

Measuring and sampling

The amount of feed consumed was estimated on a per-pen basis. The recorded data on feed intake and the pigs' BW were utilized to estimate ADG, average daily feed intake (ADFI), and feed conversion ratio (FCR).

One week before fecal assembly, the feed was combined with chromium oxide (Cr_2O_3, 0.2%), a nondigestible indicator, to measure the amount of dry matter (DM), nitrogen (N), and energy (E) utilization. The fecal samples were collected on day 42 using the rectal messages of two pigs (one male and one female) in every pen. Following a per-pen pooling of the specimens, the chosen specimens were stored at -20℃ in a freezer until analysis. The specimens of feces were crushed to a size that has the ability to move through a 1 mm screen and then dried at 60℃ for 72 hours prior to analysis. In order to determine DM, E, and N, the feed and feces specimens were evaluated using the Association of Official Analytical Chemists (AOAC, 2000) method. To determine E, the combustion heat of the specimen was measured with a Parr 6100 bomb calorimeter. Under the use of atomic absorption spectroscopy (UV-1201, Shimadzu, Japan), the samples' chromium content was assessed. We used the method used by Biswas and Kim (2022) below to calculate the apparent total tract digestibility (ATTD).

$$\mathrm{Digestibility}(\%) = \left\{1 - \left[\frac{(\mathrm{Nf} \times \mathrm{Cd})}{(\mathrm{Nd} \times \mathrm{Cf})}\right]\right\} \times 100 \quad (1)$$

Where Nf was the nutrient concentration in feces (% DM), Nd was the nutrient concentration in the diet (% DM), Cd was the chromium concentration in the diet (% DM), and Cf was the chromium concentration in the feces (% DM).

The fecal score was calculated at the initial and week 6 at 8:00 and 20:00 h. The fecal score was calculated using a 5-grade scoring method based on the average value of five pigs from each pen. The fecal grading technique must adhere to the following standards: There are five categories in which feces can be categorized: 1: hard, dry pellets in a small, hard mass; 2: firm, formed, remaining solid and soft; 3: soft, formed, and moist, maintaining its shape; 4: loose, unformed, taking the shape of the container; 5: watery, liquid, pourable feces (Biswas et al., 2023).

Statistical analysis

All data were statistically evaluated utilizing the student's t-test in SAS software (version 9.4, 2014, SAS Institute Inc., USA); each record was checked using the pen as the testing unit. The standard error of the means is a way of expressing data variability. The p values of 0.10 were considered trends, whereas p values of 0.05 denoted significant differences.

Results and Discussion

Growing pigs fed a diet containing GP supplements had a greater ($p < 0.05$) BW on day 42, reduced ($p < 0.05$) FCR at the overall period than the CON group. Conversely, the dietary intervention had no discernible effect ($p > 0.05$) on ADG and ADFI (Table 2). According to previous research in our laboratory, adding a yeast-garlic mixture to the diet could increase the growth performance of finishing pigs (BWG and ADG) and broilers (BWG and feed intake) (Sun and Kim, 2020; Biswas and Kim, 2023). Finishing pigs that utilized a diet that contained garlic had considerably higher feed consumption and ADG, as demonstrated by Janz et al. (2007). After six weeks of feeding, finishing pigs' ADG and ADFI were enhanced, according to Yan et al. (2011) research. Based on an investigation conducted by Yun et al. (2018), adding fermented garlic by *Leuconostoc mesenteroides* KCCM35046 to diets (0.1% and 0.2%) prevented breast feeding sows from losing body weight and increased the ADG of suckling piglets throughout the lactation period. The results of many animal investigations, however, were not constantly consistent. For instance, Horton et al. (1991) stated that adding either 0.1% or 1% of garlic to pig diets did not influence on the animals' growth efficiency. Additionally, Cullen et al. (2005) discovered that dietary garlic supplementation (0.1% or 1%) decreased feed consumption while enhancing FCR with no substantial effect on the ADG of grower-finisher pigs. These inconsistencies might be caused by variations in the type, quality of the supplement, animal species, and age (Chen et al., 2008).

Based on Table 3, feeding growing pigs GP had a higher ($p < 0.05$) DM digestibility than feeding them CON diet. But there was no noticeable treatment effect on N and E retention ($p > 0.05$). Pigs that were given the yeast-garlic supplementing diet (0.1%) had higher DM absorption than the CON group, but there was no change in N retention (Sun and Kim, 2020). Conversely, the yeast-garlic combined supplement (0.3%) had no substantial impact on the nutrient utilization of DM, N, and E (Biswas and Kim, 2023). Additionally, when added to the diet of growing-finishing pigs, fermented garlic powder (0.2% or 0.4%) enhanced the apparent digestibility of DM and N in comparison to the negative control diet (Yan et al., 2011). Likewise, Yan and Kim (2013) showed that weaned piglets' DM and N absorption were enhanced with the inclusion of 0.05% fermented GP. Earlier research (Kewan et al., 2021) found that the administration of yeast-garlic mixed feed into lamb finishing diets improved the nutrient retention of DM, N, and E. Several studies have suggested that GP may promote gut health, which may enhance nutritional digestion and absorption in monogastric animals. Aged GP and allicin substantially enhanced the morphological characteristics of pigs' gut villi; these improvements had a positive impact on the pigs' health state, efficiency, and systemic growth (Tatara et al., 2008). Increased nutrient consumption and digestibility in monogastric animals may result from garlic powder's improvement of intestinal health conditions (Biswas and Kim, 2023).

Table 2. The effect of dietary garlic powder on growth performance in growing pigs.

Item	CON	TRT1	SEM	p-value
Body weight (kg)				
Initial	22.04	22.04	0.75	0.998
Week 6	28.41	32.73	0.94	0.010
Overall				
ADG (g)	626	629	11.06	0.874
ADFI (g)	1,160	1,163	19.95	0.921
FCR	1.90	1.85	0.02	0.047

Control (CON), basal diet; TRT1, basal diet + 0.2% garlic powder; ADG, average daily gain; ADFI, average daily feed intake; FCR, feed conversion ratio; SEM, standard error of the mean.

Table 3. The effect of dietary garlic powder on nutrient digestibility in growing pigs.

Item (%)	CON	TRT1	SEM	p-value
Dry matter	75.82	79.02	0.65	0.021
Nitrogen	75.30	76.21	0.41	0.445
Energy	72.62	73.50	0.22	0.682

Control (CON), basal diet; TRT1, basal diet + 0.2% garlic powder; SEM, standard error of the mean.

Table 4 displays the results of GP inclusion in the diet on the fecal score of growing pigs. Feeding methods had no impact ($p > 0.05$) on fecal scores between treatments. Numerous studies have demonstrated that allicin or garlic may be useful in suppressing pathogenic microorganisms and defending host cells from parasites in vitro (Cellini et al., 1996; Ross et al., 2001). As the amount of allicin supplement increased the frequency of female piglets' diarrhea decreased linearly and tended to decrease quadratically (Huang et al., 2011). Tatara et al. (2005) determined that garlic or allicin treatment induced favorable outcomes in animals at the beginning of their growth and maturity. As mentioned by Nghia (2016), developing pigs fed a diet containing GP could decrease the amount of *E. coli* in their guts, reducing the number of pathogenic bacteria released into the environment. Numerous studies have presented ways to increase the performance of pigs by lowering the amount of *E. coli* in feces and reducing the amount of *E. coli* germs released into the environment (Yun et al., 2018; Ayrle et al., 2019). It can be related to the fact that garlic has antibacterial properties, boosts immune system performance, and controls diarrhea incidence. Research on the effects of GP supplements on fecal scores in pigs is limited, so more research is needed for assessment.

Table 4. The effect of dietary garlic powder on fecal score in growing pigs.

Item	CON	TRT1	SEM	p-value
Fecal score				
Initial	3.25	3.25	0.03	0.967
Week 6	3.23	3.24	0.02	0.910

Control (CON), basal diet; TRT1, basal diet + 0.2% garlic powder; SEM, standard error of the mean.

Conclusion

Garlic powder incorporation in the diet for growing pig's results in improved BW and FCR and increased DM digestibility compared with control pigs without affecting fecal score. Given the positive impact on growing pig growth performance and nutritional digestibility, dietary inclusion with GP in growing pigs might be an effective strategy for increasing productivity.

Conflict of Interests

Regarding this manuscript, the researchers proclaim no conflict.

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