Research Article

The Use of Garlic (*Allium sativum*) Skin Meal as a Substitute for Antibiotic Growth Promoter in Broiler Feed

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Abstract | This study aimed to evaluate the effect of different levels of garlic skin meal (GSM) as a substitute for antibiotic growth promoters (AGPs) on the performance and carcass quality of broiler chickens. A total of 120 Arbor Acres CP-707 broiler chicks were reared for five weeks. The experiment employed a completely randomized design with six treatments and four replicates, each consisting of five chicks. The treatments were as follows: T1 (no AGP), T2 (with AGP), T3 (0.25% GSM), T4 (0.50% GSM), T5 (0.75% GSM), and T6 (1% GSM). Performance and carcass quality parameters were observed. Analysis of variance revealed that the treatments had a significant effect (P<0.05) on both production performance and carcass quality. The inclusion of growth promoters whether synthetic (zinc bacitracin) or natural (garlic skin meal) resulted in improved performance and carcass quality.

Keywords | Allicin, Broiler, Feed additive, Garlic skin meal, Zinc bacitracin

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INTRODUCTION

Antibiotics in livestock production are crucial in enhancing animal health, nutrition, and productivity (Callaway *et al*., 2021). Antibiotics inhibit or kill the growth of bacteria, thus preventing and treating bacterial infections in livestock. However, widespread antibiotic use has raised concerns due to potential negative consequences, such as antibiotic residues in animal products and the development of antibiotic-resistant bacteria (Xu *et al*., 2022; Manyi-Loh *et al*., 2018).

Zinc bacitracin, a synthetic antibiotic, is commonly used in livestock manufacturing to promote animal growth and enhance performance. However, the use of Zinc bacitracin can result in residues in products derived from animals, which may pose risks to human health (Yordanova *et al*., 2024). In response to these concerns, there is an increasing need to explore natural alternatives to synthetic antibiotics. One promising natural candidate is garlic skin meal (GSM), which possesses strong antimicrobial properties against pathogenic bacteria (Abdulrahman *et al*., 2017). Research has shown that adding GSM to animal feed can improve animal health and reduce dependence on synthetic antibiotics (Chen *et al*., 2021). A garlic skin contains various nutrients, including carbohydrates (8.5%), crude fiber (62.10%), crude protein (2.61%), and fat (0.22%). In addition, garlic skin is also rich in minerals, such as calcium (20,610 mg/kg), potassium (9,081 mg/kg), phosphorus (721 mg/kg), zinc (12.9 mg/kg), and copper (2.09 mg/kg), among others (Azmat *et al*., 2023).

Several studies have documented the benefits of *Allium spp*. (especially garlic and onion) on poultry growth per-

formance by increasing body weight gain, feed intake, and feed efficiency (Rusli *et al*., 2021; Montesqrit *et al*., 2023). The garlic extract (1%) in drinking water improved growth performance and biochemical characteristics of blood. They attributed this effect to garlic FOS, which can help maintain beneficial gut microorganisms and enhance nutrient absorption (Faharani *et al*., 2015). The garlic's have improved growth performance, immunity, gut health, anti-oxidant status, blood parameters, and intestinal microbiota of poultry (Abd El-Ghany, 2024).

This study investigated the use of garlic skin meal (GSM) as a substitute for zinc bacitracin in broiler chicken diets, with a focus on performance and carcass quality. By evaluating various levels of GSM supplementation in feed, the research aimed to determine its potential as a natural alternative to antibiotic growth promoters. A completely randomized block design was employed to assess key performance indicators, including feed consumption, weight gain, feed conversion ratio, live weight, carcass percentage, and abdominal fat percentage. The findings from this study are expected to provide valuable insights into the efficacy and safety of GSM as a replacement for antibiotic growth promoters in broiler production. This research supports the development of sustainable and environmentally friendly farming practices by reducing dependence on synthetic antibiotics.

MATERIALS AND METHODS

Preparation of Garlic Skin Meal

GSM was obtained from the local market. The garlic skins obtained were first weighed before undergoing an oven-drying process at 40°C for two hours. After the oven-drying process, the garlic skin waste was re-weighed to determine the amount of lost moisture. Subsequently, the garlic skin waste was ground into powder.

Animal, Experimental Design and Feed

All research procedures involving animals were carried out in accordance with ethical guidelines and regulations applicable to animal research. This study used one hundred and twenty (n=120) commercial Arbor Acres broiler chicks aged one day. The research used a completely randomized design, consisting of 6 treatments and four replications (five chicks for each replication). The treatments administered are as follows: no addition of antibiotic growth promoter (as control feed/T1), feed with the addition of AGP zinc bacitracin (T2), and other feeds with the addition of GSM at levels of 0.25%, 0.5%, 0.75%, and 1.0% (T3 to T6). The chicks were distributed at random into 20 cages measuring 80cm x 75cm x 30cm.

The feed was prepared based on Leeson and Summer (2005) with a 23% crude protein and 3200 kcal/kg metabolizable energi (starter phase), and 20% crude protein of 20% and 3200 kcal/kg (finisher phase). The ingredients and composition of the research feed can be seen in Table 1. The feed and drinking water were provided ad libitum for 35 days.

Table 1: Ingredients, chemical composition, and energy of basal feed.

Feed Ingredients	Phase	
	Starter	Finisher
Corn (%)	53.00	61.00
Rice bran (%)	0.50	2.00
Soy bean meal (%)	25.00	18.00
Meat and bone meal (%)	12.00	12.00
Corn Gluten Meal (%)	6.00	4.00
Bone meal (%)	0,00	0.50
Coconut oil (%)	3.00	2.50
Top mix (%)	0.50	0.50
Total	100.00	100.00
Crude protein (%)	23.00	20.00
Metabolizable Energy (kcal/kg)	3200	3200
Crude fiber (%)	2.78	2.97
Crude fat (%)	5.75	5.44
Calcium (%)	2.24	1.36
Phosphorus (%)	0.52	0.49
Methionine (%)	0.48	0.41
Lysine (%)	1.40	1.18

Data Collection

Performance and broiler carcass quality data were observed throughout the research period. The measured parameters include feed consumption, body weight gain, feed conversion ratio, live weight, carcass percentage, and abdominal fat percentage. These data were collected and recorded accurately.

Data Analysis

The collected data were analyzed using analysis of variance (ANOVA) at a significance level of 0.05. When significant differences among treatments were detected, further analysis was conducted using Duncan's Multiple Range Test to identify specific differences between treatment means.

RESULTS AND DISCUSSION

The research findings reveal variations in both production performance and the quality of broiler chicken carcasses among different treatment groups (T1 to T6) that utilized zinc bacitracin and various levels of GSM as a substitute for antibiotic growth promoters. The impact of these treatments on performance and carcass quality during treatment ration feeding can be seen in Tables 2 and 3 respectively.

Feed Intake

In Table 2, the average weekly feed consumption ranged from 465.91 to 560.12 g/bird/week. Analysis of variance showed a significant effect (P<0.05) of GSM feeding in various treatments on feed consumption. The control feed (T1) and feed with the addition of the synthetic growth promoter, zinc bacitracin (T2), resulted in high feed consumption. In contrast, diets supplemented with GSM (T3 to T6) showed no significant difference in feed consumption compared to the zinc bacitracin treatment, indicating that adding GSM up to 1% was well-received and tolerated by broiler chickens without causing adverse effects. This finding aligns with the research conducted by Jannah *et al.* (2024), which demonstrated that the addition of garlic peel and onion peel at a 1% level could be used as feed additive on broiler.

Table 2: The effect of treatment on production performance of broiler.

Treatment*	Feed intake (g/bird/week)	Average body weight (g/bird/week)	Feed conversion ratio
T1 (control feed)	560.12[a]	221.98[b]	2.52[a]
T2 (+AGP)	498.51[a]	246.94[a]	2.02[b]
T3 (+ 0.25% GSM)	465.91[b]	227.85[b]	2.04[b]
T4 (+ 0.50% GSM)	503.74[b]	242.95[a]	2.07[b]
T5 (+ 0.75% GSM)	499.98[b]	246.79[a]	2.02[b]
T6 (+ 1.00% GSM)	482.63[b]	245.52[a]	1.96[b]

***AGP:** Antibiotic growth promoter (synthetic zinc bacitracin); **GSM:** garlic skin meal; Different superscripts within the same column indicate statistical significance (P<0.05).

Efficient feed consumption was observed due to the overall health of the broiler chicken's digestive system. This is attributed to phytochemical compounds in onion bulbs and skins that act as antibacterial and antioxidant agents, thereby enhancing the health of chickens, especially in the digestive tract. Karangiya *et al.* (2016) indicated that garlic supplementation increased the surface area of intestinal absorption (villus height, width, and crypt depth), correlating with improved body weight gain in broiler chickens. Feeds containing propyl propane thiosulfonate (PTS-O) derived from garlic have also been shown to enhance absorption surface at the ileum level in broiler chickens (Peinado, 2012).

Body Weight Gain

In Table 2, it can be observed that the average body weight gain of broiler chickens ranged from 221.98 to 246.94 g/bird/week. The analysis of variance showed that the administration of GSM treatments had a significant effect (P<0.05) on body weight gain. It is essential to emphasize that the significant differences in body weight gain among treatments may be attributed to varying feed consumption levels, as feed intake significantly affects body weight gain. This aligns with Leeson and Summer (2005), who stated that the amount of feed consumed determines the extent of weight gain achieved. Higher feed consumption leads to the absorption of more nutrients in the digestive tract, subsequently influencing body weight gain.

In Table 2, it is also seen that the control feed without adding a growth promoter (T1) inhibited growth, resulting in low body weight gain. In contrast, supplementation of synthetic growth promoter zinc bacitracin (T2) or GSM (T4 to T6) significantly increased body weight gain compared to the control treatment. In addition, the addition of GSM at levels ranging from 0.50% to 1% also showed no significant difference, indicating that adding GSM up to 1% was well accepted and tolerated by broilers without any side effects. Several other studies, such as those conducted by Chitra (2020) and Hayat *et al.* (2022), also reported increased growth with garlic added to broiler feed.

Tanti *et al.* (2022) reported that supplementation with 3% garlic powder (T2) significantly improved broiler weight gain compared to other treatments, indicating it was the most effective among the tested garlic processing methods. While the T1 group exhibited high feed intake, T2 achieved the highest final body weight. The improved weight gain observed in birds fed garlic may be attributed to allicin, a bioactive compound in garlic known for its antibacterial properties. Inclusion of garlic in broiler diets has been shown to enhance digestibility and promote weight gain, potentially by stimulating saliva secretion and increasing the activity of digestive enzymes.

Feed Conversion Ratio

Feed conversion ratio (FCR) is one of the measures used to assess the efficiency of feed utilization by livestock or the efficiency of converting feed into final products, such as meat. Table 2 shows that the average FCR of broiler chickens ranges from 1.96 to 2.52. Analysis of variance shows that the provision of GSM between treatments significantly affected (P<0.05) FCR. The critical difference in the impact of therapy on FCR is caused by the direct proportional relationship between feed consumption and body weight gain, resulting in the same FCR value. High feed consumption and low body weight gain on the control feed without adding growth promoters cause the FCR to be higher.

In this study, the FCR value was still within the normal range. Leeson and Summer (2005) also showed that broiler production is efficient if the FCR is below 2. Furthermore, according to the National Research Council (1994), broiler chickens aged 22-42 days should have an FCR of around 2.06.

Live Weight

Table 3 shows that broilers' average final live weight during the 5-week study period ranged from 975.25 g/head to 1046.75 g/head. Analysis of variance showed that the provision of GSM among treatments had significant effect ($P < 0.05$) on the live weight of broilers. The lower live weight in T1 (control feed without adding growth promoters) was due to lower body weight gain than other treatments. In this study, the live weight was lower than that reported by Kartasudjana and Suprijatna (2006), which stated that the live weight of broilers in the 4-5th week ranged from 1200 g/bird to 1900 g/bird. This difference is likely due to using self-mixed basal feed, which may cause limited amino acid variation. Body weight is directly influenced by the availability of amino acids for tissue formation, so protein intake is directly related to the growth process.

Table 3: The effect of treatment on carcass quality of broiler.

Treatment*	Live weight (g/bird/week)	Carcass (%)	Abdominal fat (%)
T1 (control feed)	975.25[b]	60.05[b]	2.08[b]
T2 (+AGP)	1034.50[a]	64.24[a]	0.59[a]
T3 (+ 0.25% GSM)	1016.00[a]	63.62[a]	1.89[b]
T4 (+ 0.50% GSM)	1038.75[a]	64.58[a]	2.02[b]
T5 (+ 0.75% GSM)	1046.75[a]	66.49[a]	1.30[ab]
T6 (+ 1.00% GSM)	1032.00[a]	65.21[a]	1.23[a]

*AGP: Antibiotic growth promoter (synthetic zinc bacitracin); **GSM:** garlic skin meal. Different superscripts within the same column indicate statistical significance ($P<0.05$).

The absence of significant differences in live weight between treatments suggests that supplementation with 0.50% garlic skin meal (GSM) may effectively replace synthetic zinc bacitracin as a growth promoter. One of the key organosulfur compounds found in garlic is allicin, which possesses strong antibacterial properties and can inhibit the growth of various pathogenic bacteria. The active compounds in garlic skin may help suppress harmful microorganisms in the digestive tract, thereby enhancing nutrient utilization in broiler chickens. Although the differences in feed intake, body weight gain, feed conversion ratio, and live weight among treatment groups were not statistically significant, numerical variations were observed. These trends may indicate biological relevance and highlight the need for further investigation to confirm the efficacy of GSM as a natural alternative to synthetic antibiotics.

Carcass Percentage

Table 3 shows that the average carcass percentage of broilers in this study ranged from 60.05% to 66.49%. These values fall within the normal range reported by Amrullah (2004), who stated that broiler carcass percentages typically range from 65% to 75% of live weight. Carcasses represent the primary product in the broiler industry, making carcass yield a critical performance indicator. Analysis of variance revealed that GSM supplementation had a significant effect ($P < 0.05$) on carcass percentage. The significant variation observed among treatments was primarily due to the lower live weight in the T1 group (control without additives), which resulted in a reduced carcass yield. However, no significant difference in carcass percentage was observed between the zinc bacitracin treatment and GSM treatments up to 1%, indicating that GSM can serve as a viable natural alternative to synthetic antibiotics. Additionally, the use of GSM offers the advantage of being free from antibiotic residues, making it a safer and more consumer-friendly option for broiler production.

Percentage of Abdominal Fat

Table 3 shows that broiler chickens' average percentage of abdominal fat ranges from 0.59% to 2.08%. Based on the analysis of variance, the use of GSM in feed has a significant effect ($P<0.05$) on the abdominal fat percentage in broiler chickens. In this study, it was seen that adding 1% zinc bacitracin and GSM in feed effectively reduced abdominal fat in broiler chickens. Adding 0.75% and 1% GSM in feed reduced abdominal fat in broiler chickens and had the same effect as adding zinc bacitracin. Meanwhile, adding 0.50% GSM had the same effect as adding 0.25% or without using a growth promoter.

The decrease in abdominal fat percentage in this study was thought to be caused by the presence of organosulfur compounds in GSM, especially allicin. This is in line with the opinion of Syamsiah and Tajudin (2003), who stated that allicin in garlic skin contains sulphur, which can help break down fat. Allicin compounds facilitate lipolysis, thereby increasing the metabolic effects of fat use as an energy source. This finding aligns with previous studies that have reported the potential of natural additives, such as garlic compounds, to improve carcass properties and reduce fat deposits in poultry (Ferreira *et al*., 2020).

CONCLUSIONS AND RECOMMENDATIONS

The findings of this study indicate that garlic skin meal (GSM) can be effectively included at a level of 0.50% in broiler feed as a natural feed additive to replace the synthetic antibiotic growth promoter (AGP) zinc bacitracin. At this level, GSM supports comparable performance and carcass quality, making it a promising alternative for promoting growth and maintaining meat yield in broiler production.

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NOVELTY STATEMENT

We investigated the use of a garlic skin meal as a natural feed additive to replace the role of synthetic antibiotic growth promoter in broiler production.

AUTHOR'S CONTRIBUTIONS

M. Montesqrit: Conceptualization, methodology, formal analysis, validation, writing-original draft.
H. Harnentis: Validation, reviewing and editing.
Y. S. Nur: Reviewing and editing.
R. K. Rusli: Reviewing and editing.

Conflict of Interest

All authors declare that they have no conflicts of interest that could inappropriately influence this manuscript.

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