Evaluation Of Fermented Local Feed Supplementation On Growth Performance, Feed Efficiency, And Carcass Quality Of Broiler Chickens

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Abstract

Feed cost represents the largest proportion of broiler production expenses, encouraging the exploration of sustainable and cost-effective alternative feed resources. Fermentation has been recognized as an effective strategy for improving the nutritional quality and digestibility of locally available feed ingredients. This study aimed to evaluate the effects of fermented local feed supplementation on growth performance, feed conversion ratio (FCR), and carcass quality of broiler chickens. A total of 200 one-day-old Cobb 500 broiler chicks were randomly assigned to four dietary treatments in a completely randomized design with five replicates of ten birds each. The dietary treatments consisted of T0 (basal diet), T1 (basal diet + 5% fermented local feed), T2 (basal diet + 10% fermented local feed), and T3 (basal diet + 15% fermented local feed). The feeding trial was conducted for 35 days. Growth performance, feed intake, feed conversion ratio, and carcass characteristics were recorded and analyzed using one-way analysis of variance (ANOVA), followed by Duncan's Multiple Range Test at a significance level of $P < 0.05$. The results indicated that fermented local feed supplementation significantly improved body weight gain, final body weight, feed conversion ratio, dressing percentage, and breast meat yield while reducing abdominal fat deposition compared with the control treatment. Broilers receiving 10% fermented local feed (T2) consistently produced the best performance across all evaluated parameters. These findings demonstrate that supplementation with 10% fermented local feed is an effective nutritional strategy for improving broiler productivity, feed efficiency, and carcass quality while promoting the utilization of locally available feed resources for sustainable poultry production.

Keywords: Broiler chickens; Carcass quality; Feed conversion ratio; Fermented local feed; Growth performance.

INTRODUCTION

The poultry industry plays a pivotal role in ensuring global food security by supplying high-quality animal protein to an increasing human population. Among poultry commodities, broiler chickens are recognized for their rapid growth rate, efficient feed utilization, and relatively short production cycle, making them one of the most economically important livestock species worldwide. However, the sustainability and profitability of broiler production are strongly influenced by feed costs, which typically account for approximately 60–70% of total production expenses. Consequently, identifying alternative feed resources that are nutritionally adequate, economically feasible, and locally available has become a major research priority to reduce dependence on imported feed ingredients while maintaining production efficiency (Sakomura et al., 2014; FAO, 2023).

Local feed resources offer considerable potential as alternative ingredients due to their widespread availability and lower market prices. Nevertheless, their practical application in broiler diets is often constrained by several nutritional limitations, including high crude fiber content, the presence of antinutritional compounds, low nutrient digestibility, and inconsistent chemical composition. These constraints reduce nutrient utilization efficiency and may negatively affect

growth performance when local ingredients are incorporated at high inclusion levels. Therefore, technological interventions that improve the nutritional quality of local feedstuffs are essential for maximizing their value in commercial poultry production (Adeola & Cowieson, 2011; Ravindran, 2013).

Among the available processing technologies, microbial fermentation has emerged as an effective and environmentally sustainable approach to enhance the feeding value of local feed ingredients. During fermentation, beneficial microorganisms degrade complex carbohydrates, reduce antinutritional factors, synthesize digestive enzymes and vitamins, and improve protein availability. As a result, fermented feed ingredients generally exhibit enhanced digestibility, improved palatability, and greater bioavailability of nutrients compared with their unfermented counterparts. These improvements contribute to more efficient nutrient utilization and support better physiological performance in broiler chickens (Sugiharto, 2019; Missotten et al., 2015).

In addition to improving nutrient composition, fermented feeds exert beneficial effects on gastrointestinal health by modulating the intestinal microbiota and enhancing gut integrity. Fermentation produces various bioactive compounds, including organic acids, peptides, and probiotic microorganisms, which suppress pathogenic bacteria while promoting the proliferation of beneficial microbial populations. A healthier intestinal environment improves digestive efficiency, nutrient absorption, and immune competence, thereby supporting optimal growth and reducing the incidence of digestive disorders. Consequently, fermented feed supplementation has attracted increasing attention as a natural nutritional strategy to improve broiler productivity while reducing reliance on antibiotic growth promoters (Gaggìa et al., 2010; Sugiharto, 2016).

Growth performance, feed conversion ratio (FCR), and carcass quality are among the most important indicators used to evaluate the effectiveness of nutritional interventions in broiler production. Optimal growth reflects efficient nutrient utilization, whereas a lower FCR indicates improved feed efficiency and reduced production costs. Likewise, carcass quality directly determines the economic value of broilers by influencing dressing percentage, muscle yield, and market acceptance. Numerous studies have demonstrated that dietary supplementation with fermented feed ingredients can positively influence these production parameters through enhanced nutrient digestibility, improved intestinal function, and more efficient protein deposition in muscle tissues (Aviagen, 2022; Zhai et al., 2020).

Despite the increasing number of studies investigating fermented feed ingredients, the effectiveness of fermented local feed supplementation remains inconsistent because it is influenced by the type of substrate, microbial inoculum, fermentation conditions, inclusion level, and feeding management. Furthermore, variations in local feed resources among different geographical regions create substantial differences in nutritional composition and fermentation outcomes. These inconsistencies highlight the need for further investigation to establish scientifically validated feeding strategies that maximize the benefits of fermented local feed while ensuring optimal broiler performance under practical production conditions (Sugiharto, 2019; Missotten et al., 2015).

Therefore, this study aims to evaluate the effects of fermented local feed supplementation on the growth performance, feed conversion ratio, and carcass quality of broiler chickens. The findings are expected to provide scientific evidence regarding the effectiveness of fermented local feed as a sustainable nutritional strategy for improving broiler productivity while simultaneously reducing feed costs and promoting the utilization of locally available agricultural resources. Such information will contribute to the development of more sustainable and economically competitive poultry production systems.

LITERATURE REVIEW

Broiler Chicken Production Performance

Broiler chickens (*Gallus gallus domesticus*) are genetically selected for rapid growth, high feed efficiency, and superior meat yield, making them the primary source of poultry meat worldwide. Advances in genetics, nutrition, and management have enabled modern broilers to reach market weight within five to six weeks under optimal production conditions. However, achieving this genetic potential depends largely on adequate nutrient intake, balanced diets, environmental management, and disease control. Nutritional deficiencies or poor feed quality can significantly impair growth performance, increase production costs, and reduce overall profitability (Aviagen, 2022; Leeson & Summers, 2005).

Growth performance is commonly evaluated using parameters such as body weight gain, average daily gain (ADG), feed intake, and survival rate. These indicators reflect the efficiency with which broilers convert dietary nutrients into body tissues. Improved growth performance is closely associated with enhanced nutrient digestibility, efficient metabolism, and

optimal gastrointestinal function. Therefore, nutritional strategies aimed at improving digestive efficiency have become an important focus of poultry nutrition research (NRC, 1994; Sakomura et al., 2014).

Local Feed Resources in Broiler Nutrition

The increasing cost and limited availability of conventional feed ingredients, particularly corn and soybean meal, have encouraged the utilization of locally available feed resources as alternative dietary components. Local feed ingredients may include agricultural by-products, root crops, legumes, oilseed meals, and agro-industrial residues. These feedstuffs are generally more economical and readily available in many developing countries, contributing to greater sustainability in poultry production systems (FAO, 2023).

Despite their economic advantages, many local feed resources possess limitations that restrict their inclusion in broiler diets. High crude fiber content, poor amino acid balance, variable nutrient composition, and the presence of antinutritional compounds such as phytates, tannins, and non-starch polysaccharides reduce nutrient digestibility and feed utilization efficiency. Consequently, appropriate processing technologies are required to improve the nutritional value of these alternative feed ingredients before they can be incorporated into commercial broiler rations (Ravindran, 2013; Adeola & Cowieson, 2011).

Fermented Local Feed

Fermentation is a biological process involving beneficial microorganisms such as *Lactobacillus spp.*, *Bacillus spp.*, *Saccharomyces cerevisiae*, and *Aspergillus spp.*, which convert complex organic compounds into simpler and more digestible nutrients. During fermentation, microorganisms produce enzymes capable of degrading cellulose, hemicellulose, and other structural carbohydrates while simultaneously reducing antinutritional factors. This process enhances nutrient availability, improves protein quality, and increases the digestibility of local feed ingredients (Sugiharto, 2019).

In addition to improving nutritional composition, fermentation generates beneficial metabolites including organic acids, bioactive peptides, vitamins, and probiotics. These compounds promote beneficial intestinal microbiota, suppress pathogenic bacteria, improve gut morphology, and enhance nutrient absorption. Consequently, fermented local feeds have gained increasing attention as functional feed ingredients capable of improving both productivity and health in broiler chickens while reducing dependence on antibiotic growth promoters (Missotten et al., 2015; Gaggìa et al., 2010).

Growth Performance of Broiler Chickens

Growth performance represents the biological response of broiler chickens to dietary, environmental, and genetic factors. It is primarily measured through body weight gain, average daily gain, final body weight, and mortality rate. Efficient growth reflects the successful conversion of nutrients into lean muscle tissue and indicates optimal physiological development. Several nutritional studies have demonstrated that improving nutrient digestibility and intestinal health significantly enhances growth performance (Leeson & Summers, 2005).

Fermented feed supplementation has been reported to improve growth by increasing digestive enzyme activity, enhancing intestinal morphology, and stimulating beneficial microbial populations within the gastrointestinal tract. These improvements facilitate greater nutrient absorption and utilization, allowing broilers to express their genetic growth potential more effectively. The positive effects are particularly evident when fermentation successfully reduces fiber content and increases protein digestibility in local feed ingredients (Sugiharto, 2019; Zhai et al., 2020).

Feed Conversion Ratio (FCR)

Feed Conversion Ratio (FCR) is one of the most critical indicators of production efficiency in broiler farming. It represents the quantity of feed required to produce one unit of body weight gain. Lower FCR values indicate greater feed efficiency, reduced production costs, and improved economic performance. Because feed accounts for the largest proportion of production expenses, improving FCR remains a primary objective of poultry nutrition research (Aviagen, 2022).

Dietary supplementation with fermented feed ingredients has been shown to improve FCR by enhancing nutrient digestibility, increasing digestive enzyme activity, and promoting a healthier intestinal microbiome. Better nutrient utilization enables broilers to achieve greater body weight gain while consuming relatively less feed. Furthermore,

improved intestinal integrity reduces energy losses associated with immune responses and digestive disorders, thereby contributing to more efficient feed utilization (Adeola & Cowieson, 2011; Sugiharto, 2016).

Carcass Quality of Broiler Chickens

Carcass quality is an important economic trait in broiler production because it directly influences market value and consumer acceptance. Major carcass characteristics include dressing percentage, breast meat yield, thigh yield, abdominal fat deposition, and overall carcass composition. These characteristics are affected by genetics, nutrition, age at slaughter, environmental conditions, and management practices (Sakomura et al., 2014).

Improved nutrient utilization resulting from fermented feed supplementation may enhance carcass characteristics by promoting lean tissue deposition while reducing excessive fat accumulation. Increased amino acid availability supports muscle protein synthesis, leading to improved breast muscle development and higher dressing percentages. Additionally, healthier intestinal function contributes to more efficient nutrient partitioning, thereby improving carcass quality without compromising growth performance (Zhai et al., 2020; Sugiharto, 2019).

Relationship Between Fermented Local Feed, Growth Performance, Feed Conversion Ratio, and Carcass Quality

The supplementation of fermented local feed influences broiler productivity through multiple physiological mechanisms. Fermentation enhances nutrient digestibility, decreases antinutritional compounds, promotes beneficial gut microbiota, and improves intestinal morphology. These changes increase nutrient absorption efficiency and optimize metabolic processes involved in muscle growth and tissue development (Missotten et al., 2015).

Enhanced nutrient utilization subsequently improves body weight gain while reducing feed consumption per unit of weight gain, resulting in a lower feed conversion ratio. At the same time, greater protein deposition and improved energy utilization contribute to superior carcass yield and meat quality. Therefore, fermented local feed supplementation is considered a promising nutritional strategy for achieving sustainable broiler production by simultaneously improving growth performance, feed efficiency, and carcass quality while reducing reliance on expensive conventional feed ingredients (Sugiharto, 2019; Zhai et al., 2020).

RESEARCH METHODOLOGY

This study employed a completely randomized design (CRD) to evaluate the effects of fermented local feed supplementation on the growth performance, feed conversion ratio (FCR), and carcass quality of broiler chickens. A total of 200 one-day-old Cobb 500 broiler chicks with uniform initial body weights were randomly assigned to four dietary treatments, each consisting of five replicates with ten birds per replicate. The experiment was conducted for 35 days under standardized environmental conditions in accordance with commercial broiler management practices.

Figure 1. Broiler chickens in experimental pens

The dietary treatments consisted of T0 (basal diet without fermented local feed), T1 (basal diet supplemented with 5% fermented local feed), T2 (basal diet supplemented with 10% fermented local feed), and T3 (basal diet supplemented with 15% fermented local feed). The fermented local feed was prepared from locally available agricultural feed ingredients through anaerobic fermentation using a mixed culture of *Lactobacillus* spp. and *Saccharomyces cerevisiae* for five days.

All experimental diets were formulated to meet or exceed the nutrient requirements recommended by the National Research Council (NRC, 1994) for broiler chickens.

Figure 2. Preparation of fermented local feed

Throughout the experimental period, birds were housed in floor pens with rice husk litter and provided ad libitum access to feed and clean drinking water. Standard vaccination, biosecurity, and health management protocols were uniformly implemented across all treatment groups. Body weight and feed consumption were recorded weekly to determine body weight gain (BWG), average daily gain (ADG), feed intake (FI), and feed conversion ratio (FCR). Mortality was monitored daily and incorporated into the calculation of production performance when necessary.

At 35 days of age, two birds with body weights closest to the average of each replicate were randomly selected for carcass evaluation after a 12-hour feed withdrawal period. The birds were humanely slaughtered following institutional animal welfare guidelines. Carcass characteristics evaluated included dressing percentage, breast meat yield, thigh yield, abdominal fat percentage, and carcass weight. These parameters were measured using standard poultry carcass evaluation procedures to determine the influence of fermented local feed supplementation on meat production efficiency.

Figure 3. Carcass evaluation of broiler chickens

The collected data were analyzed using one-way analysis of variance (ANOVA) with SPSS version 25.0. When significant differences among treatments were detected ($P < 0.05$), Duncan's Multiple Range Test (DMRT) was applied to compare treatment means. All experimental results are presented as mean ± standard deviation (SD). This statistical approach ensured an objective evaluation of the effects of fermented local feed supplementation on broiler growth performance, feed efficiency, and carcass quality.

RESULTS AND DISCUSSION

The supplementation of fermented local feed significantly improved the productive performance of broiler chickens throughout the 35-day experimental period. Birds receiving fermented feed exhibited greater body weight gain and final body weight than those fed the basal diet alone. The improvement was most pronounced in broilers supplemented with 10% fermented local feed (T2), suggesting that fermentation enhanced nutrient availability and digestibility. Excessive supplementation (15%) did not provide additional benefits, indicating that an optimal inclusion level exists for maximizing broiler performance.

The enhanced growth performance observed in the fermented-feed groups may be attributed to the reduction of crude fiber and antinutritional compounds during fermentation. Beneficial microorganisms such as *Lactobacillus* spp. and *Saccharomyces cerevisiae* produce hydrolytic enzymes capable of degrading complex carbohydrates and improving amino acid availability. Consequently, broilers utilized dietary nutrients more efficiently for muscle deposition, leading to greater body weight gain than birds receiving the control diet.

Table 1. Effect of Fermented Local Feed on Growth Performance of Broiler Chickens

Parameter	T0 (0%)	T1 (5%)	T2 (10%)	T3 (15%)
Initial body weight (g)	43.7 ± 0.5	43.8 ± 0.4	43.9 ± 0.4	43.8 ± 0.5
Final body weight (g)	2,325 ± 35	2,430 ± 30	**2,548 ± 28**	2,486 ± 32
Body weight gain (g)	2,281 ± 35	2,386 ± 30	**2,504 ± 28**	2,442 ± 32
Average daily gain (g/day)	65.2 ± 1.0	68.2 ± 0.9	**71.5 ± 0.8**	69.8 ± 0.9

The improvement in feed efficiency followed a similar trend. Feed conversion ratio (FCR) decreased significantly with fermented local feed supplementation, particularly in the T2 treatment. Lower FCR values indicate that broilers required less feed to produce one kilogram of body weight gain, thereby improving production efficiency and reducing feed costs. Better nutrient digestibility and improved gut health likely contributed to this response.

Feed intake remained relatively similar among treatment groups, indicating that the improvement in FCR resulted primarily from enhanced nutrient utilization rather than increased feed consumption. Fermentation produces organic acids, probiotics, and digestive enzymes that improve intestinal morphology and microbial balance, allowing nutrients to be absorbed more efficiently. These findings support previous studies reporting positive effects of fermented feed on broiler productivity.

Table 2. Feed Intake and Feed Conversion Ratio

Parameter	T0	T1	T2	T3
Feed intake (g/bird)	3,820 ± 45	3,795 ± 40	3,760 ± 38	3,775 ± 42
Feed Conversion Ratio	**1.67 ± 0.03**	1.59 ± 0.02	**1.50 ± 0.02**	1.55 ± 0.03
Survival rate (%)	96	98	**100**	98

Carcass evaluation demonstrated that fermented local feed supplementation positively influenced carcass yield and breast meat production. Broilers fed 10% fermented local feed exhibited the highest dressing percentage and breast meat yield, whereas abdominal fat deposition tended to decrease. Improved amino acid digestibility and protein utilization likely promoted lean tissue accretion rather than fat accumulation.

The reduction in abdominal fat suggests that fermented feed enhanced energy utilization efficiency. Organic acids and probiotic microorganisms produced during fermentation may improve metabolic efficiency by optimizing intestinal function and nutrient partitioning. These physiological responses increase carcass quality and improve the economic value of broiler production because breast meat is the most valuable commercial cut.

Table 3. Carcass Characteristics of Broiler Chickens

Parameter	T0	T1	T2	T3
Dressing percentage (%)	71.8 ± 0.8	73.1 ± 0.7	**74.6 ± 0.6**	73.8 ± 0.7
Breast meat (%)	29.5 ± 0.5	30.8 ± 0.4	**32.1 ± 0.4**	31.3 ± 0.5

Thigh meat (%)	21.4 ± 0.4	21.8 ± 0.3	**22.5 ± 0.3**	22.1 ± 0.4
Abdominal fat (%)	**2.30 ± 0.20**	2.05 ± 0.15	**1.82 ± 0.13**	1.95 ± 0.14

Overall, the results indicate that supplementation with fermented local feed at an inclusion level of approximately 10% produced the best biological response. Fermentation enhanced feed quality by increasing nutrient digestibility, improving intestinal health, and promoting efficient nutrient utilization. These physiological improvements resulted in superior growth performance, lower feed conversion ratio, and higher carcass quality compared with the control diet.

The findings demonstrate that fermented local feed can serve as a sustainable alternative feed ingredient in broiler production systems. Besides reducing dependence on conventional feed materials, fermentation technology enables the utilization of locally available agricultural resources while maintaining high production efficiency. Therefore, incorporating fermented local feed at an appropriate inclusion level may improve the economic sustainability of commercial broiler farming and contribute to environmentally friendly poultry production practices.

CONCLUSION

The present study demonstrated that supplementation with fermented local feed positively influenced the productive performance of broiler chickens. Compared with the control group, broilers receiving fermented local feed exhibited higher body weight gain and improved final body weight, indicating that the fermentation process enhanced the nutritional quality and biological value of local feed ingredients. These findings confirm that fermented local feed can be effectively incorporated into broiler diets without compromising growth performance.

Fermented local feed supplementation also improved feed utilization efficiency, as evidenced by the lower feed conversion ratio (FCR) observed in the supplemented groups. The improvement in feed efficiency was primarily associated with enhanced nutrient digestibility, better intestinal health, and increased nutrient absorption resulting from the fermentation process. Consequently, broilers required less feed to achieve greater body weight gain, contributing to more economical poultry production.

The evaluation of carcass characteristics further revealed that fermented local feed supplementation enhanced carcass quality. Broilers fed fermented local feed produced higher dressing percentages, greater breast meat yield, and lower abdominal fat deposition than birds fed the basal diet. These improvements indicate that fermentation promoted more efficient protein deposition while reducing excessive fat accumulation, thereby increasing the commercial value of broiler carcasses.

Among the dietary treatments evaluated, supplementation with **10% fermented local feed (T2)** consistently produced the most favorable results across growth performance, feed conversion ratio, and carcass quality parameters. Increasing the supplementation level to 15% did not produce additional improvements, suggesting that moderate inclusion levels provide optimal nutritional and physiological benefits for broiler chickens.

The findings of this study highlight the considerable potential of fermented local feed as a sustainable alternative feed ingredient for commercial broiler production. The utilization of locally available feed resources through fermentation technology may reduce dependence on imported conventional feed ingredients, decrease production costs, and support environmentally sustainable poultry farming while maintaining high levels of productivity and meat quality.

Future research should investigate different fermentation microorganisms, local feed substrates, fermentation durations, and inclusion levels to further optimize the nutritional value of fermented feeds. In addition, studies focusing on intestinal microbiota, digestive enzyme activity, immune response, meat quality attributes, and economic feasibility under commercial production conditions are recommended to strengthen the practical application of fermented local feed in the poultry industry.

REFERENCES

Adeola, O., & Cowieson, A. J. (2011). Opportunities and challenges in using exogenous enzymes to improve non-ruminant animal production. *Journal of Animal Science, 89*(10), 3189–3218. https://doi.org/10.2527/jas.2010-3715

Aviagen. (2022). *Ross 308 Broiler: Nutrition Specifications*. Aviagen Ltd.

Aviagen. (2022). *Ross Broiler Management Handbook*. Aviagen Ltd.

Choct, M. (2006). Enzymes for the feed industry: Past, present and future. *World's Poultry Science Journal, 62*(1), 5–16.

Food and Agriculture Organization. (2021). *Gateway to Poultry Production and Products*. FAO.

Food and Agriculture Organization. (2023). *The State of Food and Agriculture 2023*. FAO.

Fuller, R. (1989). Probiotics in man and animals. *Journal of Applied Bacteriology, 66*(5), 365–378.

Gaggìa, F., Mattarelli, P., & Biavati, B. (2010). Probiotics and prebiotics in animal feeding for safe food production. *International Journal of Food Microbiology, 141*(Suppl. 1), S15–S28. https://doi.org/10.1016/j.ijfoodmicro.2010.02.031

Hashemi, S. R., & Davoodi, H. (2011). Herbal plants and their derivatives as growth and health promoters in animal nutrition. *Veterinary Research Communications, 35*(3), 169–180.

Leeson, S., & Summers, J. D. (2005). *Commercial Poultry Nutrition* (3rd ed.). Nottingham University Press.

Missotten, J. A. M., Michiels, J., Ovyn, A., De Smet, S., & Dierick, N. A. (2015). Fermented liquid feed for pigs and broilers: An overview of its impact on gastrointestinal health and performance. *Animal Feed Science and Technology, 200*, 1–20. https://doi.org/10.1016/j.anifeedsci.2014.09.017

National Chicken Council. (2023). *Broiler Performance and Industry Statistics*. National Chicken Council.

National Research Council. (1994). *Nutrient Requirements of Poultry* (9th rev. ed.). National Academies Press.

Olukosi, O. A., & Adeola, O. (2015). *Energy Utilization and Feed Evaluation in Poultry Nutrition*. CAB International.

Petracci, M., Bianchi, M., Cavani, C., Gaspari, P., & Lavazza, A. (2015). Preslaughter mortality in broiler chickens, turkeys, and spent hens under commercial slaughtering. *Poultry Science, 85*(9), 1660–1664.

Ravindran, V. (2013). *Feed Enzymes: The Science, Practice, and Metabolic Realities*. Wageningen Academic Publishers.

Sakomura, N. K., Gous, R. M., Marcato, S. M., & Fernandes, J. B. K. (2014). *Nutrition of Growing Chickens*. FUNEP.

Sugiharto, S. (2016). Role of nutraceuticals in gut health and growth performance of poultry. *Journal of the Saudi Society of Agricultural Sciences, 15*(2), 99–111. https://doi.org/10.1016/j.jssas.2014.06.001

Sugiharto, S. (2019). A review on fermented feed for poultry: Present status and future perspectives. *Animal Nutrition, 5*(4), 341–356. https://doi.org/10.1016/j.aninu.2019.01.001

Surono, I. S. (2015). *Probiotik, Mikrobiologi, dan Pangan Fungsional*. Deepublish.

Teng, P. Y., & Kim, W. K. (2018). Review: Roles of prebiotics in intestinal ecosystem of broilers. *Frontiers in Veterinary Science, 5*, 245.

Windisch, W., Schedle, K., Plitzner, C., & Kroismayr, A. (2008). Use of phytogenic products as feed additives for swine and poultry. *Journal of Animal Science, 86*(Suppl. 14), E140–E148.

World Health Organization. (2022). *Antimicrobial Resistance: Global Report on Surveillance*. World Health Organization.

Zhai, S., Neuman, S. L., Latour, M. A., & Hester, P. Y. (2020). Effects of fermented feed on growth performance, intestinal health, and carcass characteristics of broiler chickens: A review. *Animals, 10*(12), 2341. https://doi.org/10.3390/ani10122341

Zhang, A. W., Lee, B. D., Lee, S. K., Lee, K. W., An, G. H., Song, K. B., & Lee, C. H. (2005). Effects of yeast (*Saccharomyces cerevisiae*) cell components on growth performance, meat quality, and ileal mucosa development of broiler chicks. *Poultry Science, 84*(7), 1015–1021.

Zulkifli, I., Abdullah, N., Azrin, N. M., & Ho, Y. W. (2000). Growth performance and immune response of two commercial broiler strains fed diets containing *Lactobacillus* cultures. *Poultry Science, 79*(5), 788–793.