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Phytogenic Feed Additives on the Growth Performance of Broilers

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Abstract

This This study evaluated the effects of phytogenic feed additives on the growth performance and economic efficiency of broiler chickens using papaya (Carica papaya), katuray (Sesbania grandiflora), and aratiles (Muntingia calabura) leaf meals as natural alternatives to commercial antibiotic growth promoters. The study employed an experimental research design using a Completely Randomized Design (CRD) involving 150 broiler chicks distributed into five treatments with three replications. The treatments consisted of home-mixed rations without leaf meal, home-mixed rations with commercial antibiotic, and home-mixed rations supplemented with 5% papaya, katuray, and aratiles leaf meals. Data gathered included body weight, weekly weight gain, feed intake, percentage growth rate, feed conversion ratio, feed conversion efficiency, mortality rate, carcass characteristics, and return above feed and chick cost. The results revealed that phytogenic feed additives did not significantly affect body weight, weight gain, feed intake, and growth rate of broiler chickens. However, broilers supplemented with papaya leaf meal consistently showed better numerical performance in terms of final body weight, feed conversion ratio, feed conversion efficiency, and profitability. The proximate analysis further showed that papaya, katuray, and aratiles leaf meals contained appreciable levels of crude protein, crude fiber, calcium, and phosphorus, indicating their potential as alternative feed ingredients in poultry diets. Lower mortality rates were also observed among broilers fed phytogenic additives, suggesting favorable growth and survivability responses during the feeding period. The study concluded that papaya leaf meal has the greatest potential as a natural alternative to commercial antibiotic growth promoters by improving nutrient utilization, feed efficiency, and economic return without negatively affecting broiler performance. The findings support Sustainable Development Goal (SDG) 2 on Zero Hunger through improved poultry productivity and SDG 12 on Responsible Consumption and Production through the utilization of locally available plant-based feed additives. The study also contributes to sustainable and antibiotic-free poultry production by promoting environmentally friendly, cost-effective, and sustainable feeding practices in broiler farming.

Keywords: Aratiles Leaf Meal, Broiler Chickens, Feed Conversion Efficiency, Growth Performance, Katuray Leaf Meal, Papaya Leaf Meal, Phytogenic Feed Additives

1. Introduction

Broiler production plays a major role in global food security by providing affordable animal protein. The industry has expanded significantly due to improvements in breeding, feed efficiency, and growth performance. However, increasing feed costs and concerns regarding the use of synthetic antibiotic growth promoters have created challenges in sustainable poultry production. In response, phytogenic feed additives derived from plants such as papaya (Carica papaya), katuray (Sesbania grandiflora), and aratiles (Muntingia calabura) are being explored as natural alternatives that may enhance growth performance and feed efficiency in broilers while supporting sustainable agricultural practices.

1.1 Background of the Study

Broilers are chickens raised specifically for meat production, ranging from small fryers to large roasters. Advances in research and breeding programs have improved feed efficiency, growth rates, and productivity in modern broiler production systems. Commercial broiler hybrids require high-energy diets to achieve their genetic potential (Sadeghi, 2005). To improve productivity, poultry producers commonly use synthetic growth promoters and antibiotics to suppress harmful microorganisms and enhance nutrient utilization. The poultry industry remains essential to food security and socio-economic development worldwide (Alders, 2005, Dieye et al., 2010). However, rising feed costs and the dependence on conventional feed ingredients continue to threaten the profitability of poultry farming (Abbas, 2013). Feed expenses account for approximately 60–80% of total livestock production costs in developing countries (Igboeli, 2000; Esonu, 2006). Consequently, poultry producers increasingly seek alternative and low-cost feed resources, including ethnomedical plants and phytogenic additives (Okoli et al., 2001). Phytogenic feed additives derived from herbs, spices, and medicinal plants have gained attention as natural alternatives to antibiotic growth promoters. Studies have shown that plant extracts can improve poultry growth and feed utilization (Essien et al., 2007; Nworgu et al., 2007; Galib & Noor, 2010). Natural phytogenic compounds are now widely recognized for their potential to improve poultry productivity and nutrient efficiency (Hashemi and Davoodi, 2010; Khan et al., 2012). Among the promising phytogenic plants are papaya (Carica papaya), katuray (Sesbania grandiflora), and aratiles (Muntingia calabura), which are widely available in tropical regions. These plants contain bioactive compounds with antimicrobial, antioxidant, and digestive-enhancing properties that may improve growth performance and feed efficiency in broiler chickens.

1.2 Themes and Insights from Related Literature

Research on phytogenic feed additives has emphasized their importance as alternatives to synthetic antibiotics in poultry production. Feed additives such as phytogenics, probiotics, prebiotics, enzymes, and organic acids improve intestinal integrity, nutrient absorption, feed conversion, and growth performance while reducing disease incidence (Mehdi et al., 2018; Ayalew et al., 2022). The use of antibiotic growth promoters remains common in broiler production (Amerah et al., 2013), but increasing concerns regarding antibiotic resistance have encouraged the search for safer alternatives. Papaya (Carica papaya) contains proteolytic enzymes such as papain and chymopapain, together with flavonoids, alkaloids, phenolics, and saponins that support digestion and nutrient utilization (Akter et al., 2021). Studies reported that papaya leaf meal improves feed conversion ratio, growth performance, and nutrient digestibility in broilers (Oloruntola et al., 2016). Hasanah et al. (2023) found that 2.5% papaya leaf meal improved feeding performance, while Anigbogu et al. (2020) reported enhanced growth rate and feed efficiency. Additional studies indicated improvements in body weight gain, production efficiency, and gut health in broilers supplemented with papaya leaf products (Rahman et al., 2022; Omidiwura et al., 2020; Banjoko et al., 2023). These findings suggest that papaya leaf meal may serve as a natural growth promoter in poultry production. Sesbania grandiflora is recognized for its high protein content, vitamins, minerals, and phytochemical compounds such as flavonoids, tannins, and saponins (Devendra, 1992; Mohapatra et al., 2015). These compounds enhance nutrient digestibility and feed efficiency while supporting gut health. Ramasamy et al. (2009) reported significant improvements in body weight gain and feed ratio in broilers fed diets containing Sesbania grandiflora leaf meal. Similarly, Akinmutimi (2004) demonstrated that the plant could partially replace conventional protein sources without negatively affecting broiler performance. The antimicrobial properties of Sesbania grandiflora extracts further support its application as a phytogenic additive (Sarasu Packiyalakshmi et al., 2016; John Paul Matthew Domingo Guzman et al., 2018). Muntingia calabura contains flavonoids, polyphenols, triterpenoids, and saponins with antioxidant and antimicrobial properties (Hernandez et al., 2018; Ahmed et al., 2022). Studies showed that these phytochemicals improve gut health, nutrient absorption, and feed utilization (Sari et al., 2020). Dietary supplementation of Muntingia calabura leaf extract significantly improved body weight gain, feed intake, and feed efficiency in broilers (Alagbe, 2024). The plant's bioactive compounds contribute to improved intestinal morphology and nutrient partitioning, making it a promising natural growth promoter in poultry production systems.

1.3 Local, National, and Global Context

Globally, poultry production continues to expand because of increasing demand for affordable and accessible animal protein. However, the industry faces challenges related to feed costs, environmental sustainability, and public health concerns associated with synthetic antibiotic use. The prohibition or restriction of antibiotic growth promoters in many countries has accelerated interest in phytogenic feed additives as sustainable alternatives. In developing countries, poultry producers experience economic difficulties due to the high cost of feed ingredients and limited access to affordable growth-promoting supplements (Abbas, 2013). This situation has encouraged the use of locally available plant resources as alternative feed additives. Tropical plants such as papaya, katuray, and aratiles are widely accessible in the Philippines and other tropical regions, making them practical and economical feed resources for small-scale and commercial poultry producers. Locally, the utilization of indigenous phytogenic plants aligns with efforts to improve poultry productivity while reducing production costs and dependence on synthetic additives. The availability of these plants supports sustainable livestock production practices that can contribute to improved food security and agricultural resilience.

1.4 Theoretical or Conceptual Basis

The study is anchored on the concept that phytogenic feed additives improve broiler growth performance through their bioactive compounds, which enhance digestion, nutrient absorption, gut health, and feed efficiency. Phytogenic compounds such as flavonoids, phenolics, tannins, alkaloids, and saponins exert antimicrobial and antioxidant effects that reduce pathogenic microorganisms and oxidative stress within the gastrointestinal tract. Papaya leaf meal improves protein digestion through proteolytic enzymes such as papain, resulting in enhanced nutrient utilization and feed efficiency. Sesbania grandiflora contributes high-quality protein and fiber that support digestive activity and nutrient absorption, while Muntingia calabura improves intestinal integrity and feed utilization through its antioxidant and antimicrobial properties. The study assumes that incorporating phytogenic feed additives into broiler diets can enhance body weight gain, feed conversion ratio, feed efficiency, and overall growth performance without relying on synthetic antibiotic growth promoters.

1.5 Research Gaps and Rationale

Although numerous studies have investigated phytogenic feed additives in poultry production, limited research has compared the effects of papaya (Carica papaya), katuray (Sesbania grandiflora), and aratiles (Muntingia calabura) under similar broiler production conditions. Existing studies primarily focused on the individual effects of these plants, while comparative evaluations of their influence on growth performance and feed efficiency remain limited. Furthermore, there is insufficient localized research examining the practical use of these phytogenic additives in broiler production systems in the Philippines. The growing demand for affordable and sustainable poultry production highlights the need to evaluate natural alternatives that can improve growth performance while reducing production costs and dependence on synthetic antibiotics. This study therefore aims to evaluate the effects of selected phytogenic feed additives on the growth performance and economic efficiency of broiler production.

1.6 Alignment with Relevant Sustainable Development Goals (SDGs)

This study aligns with several Sustainable Development Goals (SDGs) by promoting sustainable and efficient poultry production through the use of phytogenic feed additives. It supports SDG 2: Zero Hunger by improving broiler growth performance and productivity, which may contribute to increased food security and the availability of affordable animal protein. The study also supports SDG 3: Good Health and Well-being by encouraging the reduction of synthetic antibiotic growth promoters in poultry production, thereby helping address concerns related to antimicrobial resistance. In addition, the utilization of locally available plant-based feed additives such as papaya (Carica papaya), katuray (Sesbania grandiflora), and aratiles (Muntingia calabura) promotes SDG 12: Responsible Consumption and Production through environmentally sound and sustainable agricultural practices. Furthermore, the study contributes to SDG 15: Life on Land by encouraging the sustainable use of plant resources and supporting biodiversity-friendly livestock production systems.

1.7 Importance of the Study to Multidisciplinary Sustainability

The study contributes to socio-economic sustainability by identifying affordable phytogenic feed additives that may reduce poultry production costs and improve profitability for poultry farmers. It supports agricultural and environmental sustainability through the utilization of natural plant resources as alternatives to synthetic growth promoters, reducing chemical dependence in livestock production systems. The research also contributes to public health sustainability by encouraging antibiotic-free poultry production practices that may help minimize antimicrobial resistance risks. Additionally, the study contributes to community and food production sustainability by promoting locally available phytogenic plants that can enhance broiler productivity, improve feed efficiency, and support sustainable poultry farming practices.

2. Material and methods

2.1 Research Design

The study employed an experimental research design using a Completely Randomized Design (CRD). A total of five treatments were used with three replications each, resulting in fifteen experimental units. Each replication consisted of ten broiler chickens, for a total of 150 birds. The treatments included home-mixed feeds without leaf meal, home-mixed feeds with commercial antibiotic, and home-mixed feeds supplemented with 5% papaya leaf meal, 5% katuray leaf meal, and 5% aratiles leaf meal.

2.2 Locale of the Study

The experimental study was conducted in a poultry facility composed of fifteen cages measuring 3 × 5 feet. The poultry house was constructed using locally available materials, including lumber and chicken netting, and each cage was supplied with a 25-watt incandescent bulb for brooding purposes. Prior to the arrival of the chicks, the poultry house and surrounding premises were cleaned and disinfected thoroughly to minimize the occurrence of diseases caused by harmful microorganisms. Proper sanitation and hygiene practices, including the regular removal of chicken dung and the use of carbonized rice hull beneath the cages, were maintained throughout the experimental period.

2.3 Respondents of the Study

The study involved 150 broiler chickens used as experimental birds. Upon arrival, the birds were weighed, acclimated for three days, and distributed equally across the treatment groups. The birds were managed under uniform environmental and feeding conditions throughout the duration of the study to ensure consistency in the experimental observations.

2.4 Sample and Sampling Procedure

A total of 150 broiler chickens were randomly distributed among the five treatment groups with three replications per treatment. Each replication contained ten birds. One broiler chicken from each replication was randomly selected on the 42nd day for carcass evaluation. The birds were slaughtered through rupture of the jugular vein, followed by bleeding, deplumation, and evisceration prior to carcass weighing.

2.5 Research Instrument

Fresh leaves of papaya, katuray, and aratiles were collected, cleaned, air-dried, and ground into leaf meal before incorporation into the experimental rations. Papaya leaves were air-dried for six days until crispy while retaining their green coloration. Katuray leaves were dried for three to five days, while aratiles leaves were air-dried for seven days before grinding. Proximate analysis of the leaf meals was conducted following the AOAC (2025) procedure to determine crude protein, crude fiber, calcium, and phosphorus content. The Kjeldahl method was used to determine crude protein, while crude fiber was analyzed through acid and alkali hydrolysis using the ANKOM Filter Bag Technique. Calcium content was measured using Atomic Absorption Spectrophotometry, and phosphorus concentration was determined through spectrophotometric analysis. The experimental rations were prepared using corn meal, rice bran, soybean meal, fish meal, molasses, vegetable oil, salt, vitamins, lysine, methionine, toxin binder, and phytogenic leaf meals. The starter diets contained metabolizable energy values ranging from 2818.36 to 2839.50 kcal/kg and crude protein levels ranging from 20.04% to 20.16%. Crude fiber content ranged from 3.79% to 4.08%, while calcium and phosphorus contents were maintained within recommended levels for broiler starter diets. The finisher diets contained metabolizable energy values ranging from 2702.47 to 2794.32 kcal/kg and crude protein levels ranging from 18.59% to 18.75%. The nutrient composition of the diets was adjusted according to the growth stage requirements of the broilers while maintaining the inclusion levels of the phytogenic feed additives. Clean drinking water was provided ad libitum and replaced regularly to maintain cleanliness and freshness. Feeding was also practiced ad libitum throughout the study. Feed was replenished three times daily at 6:00 AM, 12:00 noon, and 5:00 PM. A gradual feed transition method was implemented during the shift from starter to finisher diets to allow proper adaptation of the birds to the new feed formulations.

2.6 Data Gathering Procedure

Initial body weight of the broiler chickens was recorded upon arrival before distribution into the experimental cages. Weekly weighing was conducted throughout the experimental period, and weighing was performed before morning feeding to ensure consistency in measurements. Gain in weight was determined by subtracting the initial body weight from the final body weight of the birds. Feed consumption was measured by subtracting feed refusals from the total amount of feed offered to the birds. Feed Conversion Ratio (FCR) was computed by dividing feed consumed by weight gain, while Feed Conversion Efficiency (FCE) was calculated by dividing weight gain by feed consumed and multiplying the result by 100 using the formula of Biddle and Juerguenson. Percentage rate of growth was computed using the Asmundson and Leiners formula based on changes in body weight during the experimental period. Economic efficiency was evaluated through the computation of Return Above Feed and Chick Cost (RAFCC). Production costs were based on prevailing chick prices and feed ingredient costs, while gross income was determined using the market price of live broiler weight per kilogram. RAFCC was obtained by deducting feed and chick costs from the total return per broiler.

2.7 Data Analysis Techniques

All data gathered during the study were collated, tabulated, and analyzed using Analysis of Variance (ANOVA) under the Completely Randomized Design. Statistical analysis was performed using the Statistical Tool for Agricultural Research (STAR) to determine significant differences among treatment means.

3. Results and Discussion

3.1 Growth Performance of Broilers Fed with Phytogenic Feed Additives

3.1.1 Physical Condition and Mortality of Broilers

The experimental birds in all treatment groups remained generally healthy and active throughout the study. Feather development was normal and similar across treatments, indicating that the phytogenic feed additives did not negatively affect feather growth. Mortality was low among all treatments, with the highest mortality rate observed in the control group without phytogenic feed additives and the lowest mortality rate observed in the aratiles treatment. No mortality was recorded in the papaya and katuray treatments. The low and inconsistent mortality rates among treatments suggest that the inclusion of papaya, katuray, and aratiles leaf meals did not adversely affect the health and survival of broiler chickens. The normal physiological condition of the birds may indicate that phytogenic feed additives contributed to acceptable adaptation, gut health, and overall physiological stability during the feeding period.

3.1.2 Nutritional Composition of Phytogenic Feed Additives

The proximate analysis showed that papaya, katuray, and aratiles leaf meals contained appreciable amounts of crude protein, crude fiber, calcium, and phosphorus. Katuray leaf meal recorded the highest crude protein content, while aratiles leaf meal contained the highest crude fiber and calcium levels. Papaya leaf meal also showed considerable nutrient content and phytogenic compounds beneficial to broiler nutrition. These findings indicate that the phytogenic leaf meals can serve as alternative feed ingredients and natural growth-promoting supplements in broiler diets. The presence of bioactive compounds such as papain, flavonoids, tannins, saponins, and phenolic compounds may improve nutrient digestion, feed efficiency, gut health, and growth performance. Similar findings were reported by Onyimonyi et al. (2018), Rahman et al. (2022), and Hernandez et al. (2018), who noted the beneficial effects of phytogenic compounds on poultry productivity and nutrient utilization.

3.1.3 Initial and Weekly Body Weight

Initial body weights of the broilers were relatively uniform across all treatments, indicating equal distribution of the birds before the experiment. During the feeding trial, broilers supplemented with papaya leaf meal consistently showed higher numerical body weights compared with the other treatments. At the end of the sixth week, papaya leaf meal recorded the highest final body weight, followed by the control and aratiles treatments, while the katuray treatment obtained the lowest body weight. However, statistical analysis showed no significant differences among treatments throughout the experimental period. Although the differences were statistically insignificant, the higher numerical body weight observed in broilers fed papaya leaf meal suggests improved growth performance and nutrient utilization. This may be attributed to the antimicrobial and antioxidant properties of phytogenic compounds that enhance gut integrity and nutrient absorption efficiency in broilers (Hashemi & Davoodi, 2010; Khan et al., 2012; Hernandez et al., 2018). Similar observations were reported by Mehdi et al. (2018) and Ayalew et al. (2022), who found that phytogenic additives improve gut health and growth performance in poultry.

3.1.4 Weekly Gain in Weight

Weekly weight gain of the broilers showed no significant differences among treatments throughout the feeding period. However, numerical differences were observed across treatments. Papaya leaf meal generally recorded higher weight gains during several weeks of the study, particularly during the final week, while aratiles leaf meal showed relatively higher weight gain during the fifth week. Katuray leaf meal consistently showed lower weight gain compared with the other treatments. The numerical improvements in weight gain suggest enhanced metabolic efficiency and nutrient utilization associated with phytogenic feed additives. Plant-derived bioactive compounds such as flavonoids, phenols, and saponins may stimulate digestive enzyme activity and improve nutrient metabolism in poultry (Mehdi et al., 2018; Panda et al., 2023). Korede et al. (2018) similarly reported improved feed utilization and growth performance in broilers supplemented with plant extracts. The absence of significant differences may be due to variability among birds during the experimental period.

3.1.5 Weekly Feed Consumption

Feed consumption increased progressively from the first to the sixth week across all treatments. Statistical analysis revealed no significant differences in feed intake among broilers fed phytogenic feed additives and those fed commercial antibiotic or control diets. Cumulative feed consumption values were also relatively similar among treatments, with the lowest cumulative feed intake observed in the katuray treatment and the highest in the commercial antibiotic treatment. The similar feed intake among treatments indicates that the inclusion of papaya, katuray, and aratiles leaf meals did not negatively affect feed palatability and acceptability. Phytogenic feed additives may improve digestive efficiency and nutrient utilization without reducing feed consumption. Hashemi and Davoodi (2010) and Khan et al. reported that phytogenic additives can be incorporated into poultry diets without adversely affecting feed intake. The phytochemicals present in these leaf meals may have supported digestive processes and gut health, thereby improving nutrient utilization efficiency (Mehdi et al., 2018).

3.1.6 Percentage Rate of Growth

The percentage growth rate of broilers was statistically similar across all treatments throughout the experimental period. Higher growth rates were generally observed during the early weeks of feeding, followed by a gradual decline toward the final week as the birds approached market age. Papaya and aratiles leaf meals showed relatively higher growth rates during certain periods, particularly during the first, second, and final weeks. The observed growth trend is typical in broiler production, where rapid growth occurs during the early stages followed by slower growth near market age. The relatively higher growth rates observed in some phytogenic treatments may indicate improved metabolism, nutrient digestibility, and immune response associated with phytogenic compounds such as saponins and flavonoids. Panda et al. (2023) and Ayalew et al. (2022) reported that phytogenic feed additives improve nutrient digestibility and intestinal microbial balance, thereby enhancing broiler growth performance.

3.1.7 Feed Conversion Ratio and Feed Conversion Efficiency

Feed conversion ratio showed numerical differences among treatments, with papaya leaf meal obtaining the lowest feed conversion ratio and the highest feed conversion efficiency. Katuray leaf meal recorded the highest feed conversion ratio and the lowest efficiency. Although feed conversion efficiency did not differ significantly among treatments, broilers fed papaya leaf meal showed better numerical efficiency compared with the other groups. The improved feed conversion observed in broilers fed papaya leaf meal suggests enhanced digestion and nutrient absorption. Papaya leaves contain papain and other phytogenic compounds that may improve protein digestion and feed utilization efficiency (Akter et al., 2021; Onyimonyi et al., 2018). Rahman et al. (2022) also reported improved nutrient utilization associated with papaya leaf supplementation. These findings indicate that papaya leaf meal may enhance the ability of broilers to efficiently convert feed into body weight.

3.2 Economic Efficiency of Broiler Production

3.2.1 Return Above Feed and Chick Cost

Broilers fed papaya leaf meal recorded the highest return above feed and chick cost, followed by the control and aratiles treatments. Katuray leaf meal recorded the lowest economic return among all treatments. The improved profitability in the papaya treatment was associated with higher final body weight and better feed conversion efficiency. The higher profitability observed in broilers supplemented with papaya leaf meal supports previous findings that papaya contains bioactive compounds capable of improving growth performance, nutrient digestibility, and feed efficiency (Akter et al., 2021; Onyimonyi et al., 2018; Rahman et al., 2022). Oloruntala et al. (2016) also reported that papaya leaf meal improves production efficiency without increasing feed intake. The moderate profitability observed in the aratiles treatment may be related to improved nutrient utilization and gut health associated with phytogenic compounds (Hernandez et al., 2018; Alagbe, 2024), while the lower profitability in the katuray treatment may be influenced by anti-nutritional factors affecting growth performance (Akinmutimi & Okwu, 2006).

4. Conclusion and Recommendations

The study evaluated the effects of phytogenic feed additives such as papaya, katuray, and aratiles leaf meals on the growth performance and economic efficiency of broiler chickens. A total of 150 broiler chicks were distributed into five treatments under a Completely Randomized Design and reared for six weeks under proper management and sanitation practices. The findings revealed that the phytogenic feed additives did not significantly affect body weight, weight gain, feed intake, and growth rate of broilers. However, papaya leaf meal consistently produced better numerical results in terms of final body weight, feed conversion ratio, feed conversion efficiency, and profitability. The proximate analysis also showed that the leaf meals were good sources of crude protein, crude fiber, calcium, and phosphorus, indicating their potential as alternative feed ingredients. Lower mortality rates observed in broilers supplemented with phytogenic additives further suggest favorable growth and survivability responses. Overall, papaya leaf meal demonstrated the greatest potential as a natural alternative to commercial antibiotic growth promoters in broiler production by improving nutrient utilization, feed efficiency, and economic returns without negatively affecting bird performance.

The use of papaya leaf meal as a phytogenic feed additive is recommended in broiler diets due to its favorable effects on growth performance, feed efficiency, and economic return. Aratiles leaf meal may also be considered as an alternative phytogenic feed ingredient because of its acceptable performance in broiler production. Further studies should be conducted to determine the optimum inclusion levels of katuray and aratiles leaf meals and to evaluate the combined use of different phytogenic feed additives for possible synergistic effects on broiler growth performance. Additional research on long-term performance and broader production applications is also encouraged to further support the use of locally available phytogenic feed additives as sustainable and cost-effective alternatives to synthetic antibiotics.

The study was limited to the evaluation of growth performance, feed utilization, carcass characteristics, and economic return of broiler chickens fed with papaya, katuray, and aratiles leaf meals under a six-week feeding period. The experiment involved only 150 broiler chickens distributed under a Completely Randomized Design with specific management and environmental conditions, which may limit the applicability of the findings to other broiler strains, production systems, and feeding environments. Additionally, the study focused only on selected phytogenic feed additives and inclusion levels, which may not fully represent the effects of other plant-based feed additives or varying supplementation rates in broiler production.

Compliance with ethical standards

The authors declare no conflict of interest, and this study received no external funding. The researchers acknowledge the support of TESDA–Lasam Institute of Technology and the individuals involved in the conduct of the study. Participation in the study was voluntary, and informed consent was obtained prior to data collection. Data were gathered using non-invasive procedures, and all information collected was treated with strict confidentiality, with no identifying details disclosed.

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