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Short Communication

Growth Promoting Potential of Caesalpinia Bonduc Leaf Oil in Broiler Diets: A Natural Alternative to Synthetic Antibiotics

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Received Date: June 05, 2026; Accepted Date: July 16, 2026; Published Date: August 25, 2026

Citation: Alagbe Olujimi John (2026), Ethical Ideas of Al-Ghazali Role of Knowledge in Moral Development, *Clinical Trials and Clinical Research,*5(5); **DOI:**10.31579/2834-5126/159

Abstract

The global push for antibiotics free poultry production has intensified the search for natural growth promoters. This study evaluated the effects of graded levels of Caesalpinia bonduc leaf oil on the growth performance and nutrient digestibility of broiler chickens. A total of 300 -1 day old broiler chicks were randomly assigned into five dietary treatments in a Completely Randomized Design for a 42 day trial. The birds were reared in a battery cage and fed basal diet formulated to NRC (1994) standards. The treatment consisted of: Treatment 1 (T1) basal diet only; T2 (basal diet with 0.5 mL Caesalpinia bonduc leaf oil/kg diet; T3 (basal diet with 1.0 mL Caesalpinia bonduc leaf oil/kg diet; T4 (basal diet with 1.5 mL Caesalpinia bonduc leaf oil/kg diet and T5 (basal diet with 2.0 mL Caesalpinia bonduc leaf oil/kg diet. Phytochemical analysis of T2 (basal diet with 0.5 mL Caesalpinia bonduc leaf showed that it contained phenols (13.76 %), flavonoids (10.22 %), terpenoids (8.77 %), tannins (4.31 %), and saponins (1.87 %). Result showed that the overall body weight gain was significantly higher ($p<0.05$) in birds receiving Caesalpinia bonduc leaf oil (T2-T5) compared to the control group (T1). Correspondingly, the feed to gain ratio significantly improved ($p<0.05$) in oil supplemented groups. Nutrient digestibility of dry matter, organic matter, crude protein, ether extract and ash was significantly enhanced ($p<0.05$) in birds fed Caesalpinia bonduc leaf oil diet. It was concluded that Caesalpinia bonduc leaf oil at an inclusion of 2.0 mL/kg is an effective phytogenic feed additive for optimizing growth and nutrient utilization in broiler chickens.

Keywords: caesalpinia bonduc; phytogenics, broiler; performance; phytochemicals; nutrient digestibility

Introduction

The global poultry industry is currently undergoing a significant transition toward sustainable, antibiotic-free production systems (Abdelli et al., 2021; El-Sayed et al., 2022). Traditionally, antibiotic growth promoters were used extensively to enhance performance and control subclinical infections; however, their use has been largely restricted or banned in many countries due to the rising threat of antimicrobial resistance and the presence of drug residues in animal products (Alagbe, 2024; Adewale et al., 2021). This shift has catalyzed research into phytogenic feed additives, basically derived from plants, such as herbs, spices, and essential oils—as effective natural alternatives (Haque et al., 2020; Ojediran et al., 2024). Among these natural alternatives, Caesalpinia bonduc (L.) Roxb., commonly known as the "grey nicker nut," stands out due to its rich profile of secondary metabolites, including tannins, flavonoids, alkaloids, and terpenoids (Paraskeuas et al., 2017; Ri et al., 2017). Essential oils extracted from it's leaves are particularly valued for their lipophilic nature and broad-spectrum antimicrobial activity (Singh et al., 2022; Mohiti et al., 2017). These oils have the potential to modulate the intestinal microbiota, stimulate the secretion of endogenous digestive enzymes, and improve the morphology of the gastrointestinal tract, thereby enhancing both growth performance and nutrient utilization in broiler chickens (Engberg et al., 2012; Giannen et al., 2018). Despite the well-documented potential of various phytogenics, the poultry industry faces persistent challenges in maintaining high productivity and bird health in the absence of conventional antibiotics (Bozkurt et al., 2012; Bravo et al., 2011). Standard diets often fail to provide the necessary gut health support needed to maximize feed efficiency and nutrient digestibility, leading to increased susceptibility to enteric pathogens and economic losses (Alp et al., 2012; Amerah et al., 2011; Hernandez and Alagbe, 2024b). Furthermore, while Caesalpinia bonduc is known for its pharmacological properties, there is a significant lack of standardized data regarding its application as a leaf essential oil in broiler nutrition. The efficacy of phytogenic feed additives can be highly inconsistent due to variations in inclusion levels, plant part used, and the specific chemical composition of the oil (Isabel et al., 2009; Xu et al., 2003). Without a comprehensive evaluation of its specific effects on growth parameters and nutrient digestibility, its potential as a reliable feed additive remains largely untapped and unoptimized for commercial use. This study is justified by the urgent need for safe, residue-free, and cost-effective growth promoters that align with modern consumer demands for safe products from birds (Hamedi et al., 2017; Park et al., 2018). Caesalpinia bonduc is an abundant, locally available medicinal plant that offers a sustainable alternative to synthetic chemicals (Jumroz et al., 2006; Chen et al., 2020).

Materials And Methods

Experimental site and duration

The experiment was conducted over a 42 days period at the Poultry Section, Gandhi College of Agricultural Technology, Rajasthan, India between the months of June – September 2025. All experimental procedures followed the guidelines for the care and use of experimental birds outlined at the Animal Production and Health Department of the Institution (ASD/008L/2025). Preparation of plant materials, Identification and extraction of oil Fresh Caesalpinia bonduc leaves were harvested in the early morning within the Biological Sciences Department garden, Gandhi College of Agriculture, Rajasthan India and taken to Botany Department of the same institution for proper authentication by Mr. Ham Singh and assigned a reference number GD/09/2411 for future botanical verification. The collected leaves were manually sorted, washed with distilled and spread on a plastic tray to dry under shade for 12 days until a constant weight was achieved. The dried leaves was pulverized into coarse powder with mortar and pestle to increase the surface area for extraction and stored in an airtight containers until further use. 100 g of pulverized Caesalpinia bonduc leaf was taken to the laboratory to determine the composition of phytochemicals in the sample. Analysis (Table 2) was carried out according to the methods outlined by Harbone (1998). Extraction of Caesalpinia bonduc leaf oil was carried out using Clavenger –type equipment. 200 g of pulverized Caesalpinia bonduc leaves was placed in a 2 liter round bottom flask mixed with distilled water at a ratio of 1:3 (w/v). The flask is mounted on a heating mantle and maintained at a temperature of 80 °C for 45 minutes, mixture of water and oil vapor passes through the condenser and it is collected in a graduated receiver. The oil layer which floats on the surface was carefully removed from the mixture residual moisture in the oil was removed by adding 0.5 g of anhydrous sodium sulfate. Final oil was transferred into glass vial and stored in the refrigerator at a temperature of 4°C.

Experimental birds and management practices

300 – 1 day old broiler chicks (Ross 307) was used for this experiment. Upon arrival, birds were unboxed, weighed with automated digital weighing scale to obtain their initial body weight gain and randomly distributed into one of the five dietary treatment groups, each treatment group consisted of 60 birds. The birds were housed in a clean disinfected battery cage measuring 0.8 m by 0.5 m by 0.35 m (L×B×H). Brooding was done in the first two weeks using gas heaters to maintain optimum temperature. Clean drinking water and basal diets were provided throughout the experimental period. Vaccinations (Table 2) were strictly followed according to the Veterinary Regulations in Rajasthan.

Experimental diets and design

A completely randomized design was adopted and basal diet was formulated to meet the specified nutrient requirements of broiler chickens according to NRC (1994) recommendations. The birds were distributed into 5 treatments with 6 replicates consisting of 10 birds each. The treatment group were as follows:

Treatment 1 (control): Basal diet only without Caesalpinia bonduc leaf oil

Treatment 2: Basal diet with 0.5 mL + Caesalpinia bonduc leaf oil /kg diet

Treatment 3: Basal diet with 1.0 mL + Caesalpinia bonduc leaf oil /kg diet

Treatment 4: Basal diet with 1.5 mL + Caesalpinia bonduc leaf oil /kg diet

Treatment 5: Basal diet with 2.0 mL + Caesalpinia bonduc leaf oil /kg diet

To ensure the full dose of Caesalpinia bonduc leaf oil was consumed, daily oil requirements of each group was mixed with 100 g of feed and offered as the first meal in the morning. The remainder of the daily feed allowance was provided after the treated portion was fully consumed.

Data collection

Birds were weighed weekly in the morning before feeding to evaluate the body weight gain. Feed consumed was recorded daily by subtracting the weight of the left over from the weight of feed given. Feed to gain ratio was calculated as the ratio of feed consumed to weight gain.

Nutrient digestibility trial

Nutrient digestibility trial was carried out on the last day of the trial. 5 birds were randomly selected per treatment and transferred into a metabolic cage. Birds were allowed to adjust to their new environment for 2 days. The digestibility trial wasted for 5 days, a known quantity of feed was given to birds, total excreta were collected, weighed and oven dried at a temperature of 70 °C for 4 hours. Samples of feed and excreta were analyzed for dry matter, crude protein, crude fibre, ether extract and ash using CSD® near infra-red feed analyzer (Model 3400C, China), calibrated and adjusted to the manufacturer's instruction to ensure precision in results

$$\% \text{ Nutrient digestibility} = \frac{\text{Nutrient intake} - \text{Nutrient voided}}{\text{Nutrient intake}} \times 100$$

Statistical analysis

All data collected on growth performance and nutrient digestibility were subjected to One- way Analysis of Variance for Completely Randomized Design. Significant difference between treatment means were separated using Duncan Multiple Range Test at a probability level of $p<0.05$.

Ingredients	Diet 1 (Starter diet; 0-21d	Diet 2 (Finisher diet; 22-42d)
Maize	50.00	53.55
Wheat bran	2.15	2.00
Soya meal	37.00	32.00
Fish meal	2.00	2.00
Limestone	2.50	3.00
Bone meal	5.00	6.00
Methionine	0.25	0.25
Lysine	0.25	0.25
*Mineral-Vitamin Premix	0.25	0.25
Sodium chloride	0.40	0.50
Toxin binder^{TMR}	0.20	0.20
Total	100.00	100.00

Determined analysis (%)		
Dry matter	87.12	89.36
Crude protein	23.16	21.09
Crude fibre	3.98	4.11
Ether extract	3.53	3.95
Calcium	1.73	1.85
Phosphorus	0.82	0.87
Energy (Kcal/kg)	3009.5	3201.7

Table 1: Ingredient and chemical composition of basal diet (% DM).

Starter Min-Vitamin Premix; 2.5 kg contains—vitamin A: 10,000,000 IU; vitamin D3: 4,000,000 IU; vitamin E: 27,000 IU; vitamin K: 3,000 mg; thiamine B1: 1,800 mg; riboflavin B2: 7000 mg; pyridoxine B6: 2,800 mg; niacin: 30,500 mg; vitamin B12: 20 mg; pantothenic acid: 9000 mg; folic acid: 8000 mg; biotin: 70 mg; choline chloride: 350 g; antioxidant: 115 mg; magnesium: 100 g; zinc: 70 g; iron: 13 g; copper: 8.00 g; iodine: 1.25 g; selenium: 100 mg; cobalt: 100 mg.

Finisher Min-Vitamin Premix; 2.5 kg contains —vitamin A: 10,000,000 IU; vitamin D3: 2,000,000 IU; vitamin E: 20,000 IU; vitamin K: 2,250 mg; thiamine B1: 1750 mg; riboflavin B2: 5000 mg; pyridoxine B6: 2750 mg; niacin: 27,500 mg; vitamin B12: 15 mg; pantothenic acid: 7500 mg; folic acid: 7500 mg; biotin: 50 mg; choline chloride: 400 g; antioxidant: 125 mg; magnesium: 80 g; zinc: 50 g; iron: 20 g; copper: 5 g; iodine: 1.2 g; selenium: 200 mg; cobalt: 200 mg.

Days	Vaccines	Route of administration
1	Marek's (at hatchery)	Subcutaneous
7	RDV F1	Ocular
11	RDV Lasota	Drinking water
16	IBD	Drinking water
21	Lasota (booster)	Drinking water
27	IBD (booster)	Drinking water

Table 2: Vaccination schedule for birds.

Components	% Composition
Tannins	4.31
Flavonoids	10.22
Alkaloids	3.55
Saponins	1.87
Phenols	13.76
Terpenoids	8.77

Table 3: Phytochemical composition Caesalpinia bonduc leaf.

Starter phase (0 - 21d)							
Parameters	Diet 1	Diet 2	Diet 3	Diet 4	Diet 5	SEM	p-value
Initial body weight (g/bird)	47.87	48.01	47.66	47.89	47.93	0.02	0.07
Final body weight (g/bird)	859.9^{b}	1061.2^{a}	1066.4^{a}	1068.4^{a}	1069.6^{a}	45.12	0.02
Body weight gain (g/bird)	812.03^{b}	1013.19^{a}	1018.74^{a}	1020.51^{a}	1021.67^{a}	40.80	0.01
Daily weight gain (g/bird)	38.66^{b}	48.25^{a}	48.51^{a}	48.59^{a}	48.65^{a}	0.96	0.001
Feed consumption (g/bird)	1748.2^{b}	1954.2^{a}	1960.9^{a}	1961.2^{a}	1963.2^{a}	61.98	0.03
Daily consumption (g/bird)	83.24^{b}	93.05^{a}	93.37^{a}	93.39^{a}	93.48^{a}	0.18	0.01
Feed to gain ratio	2.15^{a}	2.00^{b}	2.00^{b}	2.00^{b}	2.00^{b}	0.01	0.001
Finisher phas(22-42 d)							
Body weight gain (g/bird)	1441.6^{b}	1702.1^{a}	1730.2^{a}	1735.1^{a}	1741.4^{a}	44.86	0.02
Daily weight gain (g/bird)	68.64^{b}	81.05^{a}	82.39^{a}	82.62^{a}	82.92^{a}	2.65	0.001
Feed consumption (g/bird)	3100.0^{b}	3239.0^{a}	3249.1^{a}	3251.8^{a}	3258.1^{a}	136.8	0.04
Daily feed consumption (g/bird)	147.6^{b}	154.2^{a}	154.7^{a}	154.8^{a}	155.1^{a}	0.44	0.21
Feed to gain ratio	2.15^{a}	2.00^{b}	2.00^{b}	2.00^{b}	2.00^{b}	0.01	0.001
Overall production (1- 42d)							
Body weight gain (g/bird)	2253.63^{b}	2715.29^{a}	2748.94^{a}	2755.61^{a}	2763.07^{a}	103.6	0.03
Daily weight gain (g/bird)	53.65^{b}	64.64^{a}	65.45^{a}	65.60^{a}	65.78^{a}	2.56	0.001
Total feed consumption (g/bird)	4848.2^{b}	5193.2^{a}	5210.0^{a}	5213.0^{a}	5221.3^{a}	0.81	0.001
Daily feed consumption (g/bird)	115.4^{b}	123.6^{a}	124.0^{a}	124.1^{a}	124.3^{a}	0.17	0.006
Feed to gain ratio	2.17^{a}	2.00^{b}	2.00^{b}	2.00^{b}	1.95^{a}	0.11	0.01

Table 4: Growth performance of broiler chickens fed different levels of Caesalpinia bonduc leaf oil.

a,b,c Means within the same row with different superscript differ significantly ($p<0.05$).

Components (%)	Diet 1	Diet 2	Diet 3	Diet 4	Diet 5		

Dry matter	79.17^{b}	83.12^{a}	83.88^{a}	84.02^{a}	84.05^{a}	SEM	P-value
Organic matter	38.74^{b}	45.28^{a}	46.77^{a}	46.93^{a}	46.98^{a}	2.63	0.01
Crude protein	69.06^{b}	76.33^{a}	77.82^{a}	77.93^{a}	77.95^{a}	4.08	0.001
Crude fibre	57.08^{a}	48.11^{b}	48.83^{b}	48.86^{b}	48.91^{b}	1.90	0.004
Ether extract	61.94^{b}	72.01^{a}	73.22^{a}	73.25^{a}	73.28^{a}	0.56	0.0001
Ash	55.35^{b}	61.94^{a}	62.88^{a}	63.04^{a}	63.21^{a}	0.42	0.02

Table 5: Nutrient digestibility of broiler chickens fed different levels of Caesalpinia bonduc leaf oil.

a,b,c Means within the same row with different superscript differ significantly ($p<0.05$).

Results And Discussion

Table 4 reveals the growth performance of broiler chickens fed different levels of Caesalpinia bonduc leaf oil at starter and finisher phase. Variables obtained in this study follow similar trend as body weight gain, feed to gain ratio and feed consumption were significantly ($p<0.05$) influenced by the treatment. In the overall performance, body weight gain was higher in T2-T5 compared to T1. Total feed consumed was lower in T1 (4848.2 g/bird) than T2 (5193.2 g/b), T3 (5210.0 g/b), T4 (5213.0 g/b) and T5 (5221.3 g/b). Feed to gain ratio was higher in T1 compared to the other treatments. The observed increase in average daily body weight and significant reduction in feed conversion ratio in treatments T2 – T5 compared to the control (T1) from the starter, finisher and overall production indicates that Caesalpinia bonduc leaf oil acts as a natural growth promoter. This improvement is likely driven by the diverse phytochemical profile of the essential oil. The high concentration of phenolic compounds (13.76 %) and flavonoids (10.22 %) facilitates the protection of the intestinal mucosal of birds from oxidative stress and the improvement in their overall health (Alagbe et al., 2021; Husceyin et al., 2023). Terpenoids (8.77 %) and alkaloids (3.55 %) possess antimicrobial and antibacterial properties that can inhibit pathogenic gut microflora thereby making more energy available for the growth of birds (Ojediran et al., 2024; Abdel - Nareth et al., 2019). At low concentration, saponins can increase the permeability of intestinal mucosal cells, facilitating efficient nutrient absorption (Noirot et al., 2007). The final body weight gain obtained in this study was within 1923.3 – 3000.2 g reported by (Musa et al., 2020), when phytogenics was supplemented in the diet of broiler chickens at 3 mL/liter of water. Musa et al. (2020) also recorded a feed conversion ratio of 2.1 – 2.4 when herbs at 3 g/kg was added in the diet of broilers. Higher feed consumption all through the starter and finisher phase in birds fed graded levels of Caesalpinia bonduc leaf oil indicates that it has an appetizer effect. According to Alagbe et al. (2020), phytogenic compounds that are rich in terpenoids and phenolic compounds often act as sensory stimulators. These compounds provides a unique aroma and flavor to the diet that can stimulate bird's appetite (Adewale et al., 2021). Although birds have fewer taste buds compared to mammals. However, their olfactory system responds positively to certain plant phyto-constituents leading to increased feed intake (Ghazaghi et al., 2014 ; Jang et al., 2009) This outcome suggests that Caesalpinia bonduc leaf oil relatively promote balanced intestinal flora thus preventing intestinal inflammation and promoting a healthier gut. Total overall feed consumption range obtained in this study 4848.2 – 5221.3 g/b was similar to 4800.2 g – 5200.8 g reported by Shittu et al. (2021) when Polyalthia longifolia leaf meal was supplemented in the diet of broiler chickens. However, values were lower than 5307.1 – 5600.2 g/b recorded by Alagbe (2024); Alagbe et al. (2024); Hernandez and Alagbe (2024a), when graded levels of Eucalyptus oil was added in the diet of broilers. This variation could be due to concentration of phyto-compounds as well as dose administered. Nutrient digestibility of broiler chickens fed different levels of Caesalpinia bonduc leaf oil is revealed in Table 5. Dry matter digestibility value varied from 79.17 - 84.05 %, organic matter (38.74 - 46.98 %), crude protein (69.06 - 77.95 %), crude fibre (48.91 - 57.08 %), ether extract (61.94 - 73.28 %) and Ash (55.35 - 63.21 %). All values were significantly ($p<0.05$) affected by the treatment. The improved nutrient digestibility of dry matter, organic matter, crude protein and ether extracts in group supplemented with Caesalpinia bonduc leaf oil (T2 – T5) explains the physiological basis for lower feed conversion ratio. According to (Shittu et al., 2021), addition of essential oil in the diet of birds can stimulate the activities of endogenous enzymes such as lipase, amylase and trypsin which directly enhances the breakdown and absorption of nutrients (Xu et al., 2008; Lambert et al., 2021).

Conclusion

The inclusion of Caesalpinia bonduc leaf oil at up to 2.0 mL/kg diet successful improved the growth of birds over the 42 days period. The increase in nutritient digestibility suggests that the phyto-components (particularly terpenoids and phenols) enhanced enzymatic activities and intestinal health.

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