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Effect of Aqueous Gmelina (*Gmelina arbore)* Leaf Extract on Performance Characteristics and Blood Profile of Broiler Chickens

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Abstract

A six-week study was conducted to evaluate the effects of aqueous Gmelina (Gmelina arborea) leaf extract (AGALE) on the performance characteristics and blood profile indices of broiler chickens. A total of 120 Arbor Acres broiler chicks were randomly assigned into four treatment groups of 30 birds each consisting of 10 birds per replicate in a completely randomized design. All birds were fed same diet while the treatment groups received daily oral administration of 0, 2.5, 5.0, or 7.5 mL AGALE through their drinking water. Data collected on growth performance and blood profile were subjected to one-way analysis of variance at 5% level of significance. Results indicated that AGALE significantly (P<0.05) influence virtually all growth parameters of broiler chickens evaluated. Birds administered 2.5mL AGALE recorded the highest average daily weight gain (38.89 g/b/day) while the lowest value (29.05 g/b/day) was obtained in those receiving 5mL AGALE. The average daily feed intake values observed in this study varied significantly across the treatment groups in which birds on 0mL (91.03g/b/day), 2.5mL (91.51g/b/day) and 7.5 mL (89.92g/b/day) AGALE had similar values but significantly higher than those administered 5mL AGALE. Birds administered 2.5mL AGALE (2.37) recorded the best feed conversion ratio. With respect to haematological indices, AGALE had no significant effect (P>0.05) on most parameters, except the white blood cell (WBC) count and heterophil concentration. Birds supplemented with 2.5 mL AGALE recorded the highest WBC count (27.85 × 10^3/μL), while the lowest value (12.50 × 10^3/μL) was observed in the 7.5 mL group. Similarly, heterophil concentration was significantly (P<0.05) higher in birds administered 2.5 mL AGALE (53.50%), compared with birds on 0 mL (18.00%), 5 mL (20.00%), and 7.5 mL (18.00%) AGALE groups, which had statistically similar values. Results revealed no significant (P>0.05) differences among all the serum biochemical indices measured. It can be concluded that broiler chickens administered 2.5 mL AGALE had positive effects on growth performance and optimized immune function in broilers due to the elevated WBC, heterophil concentration and stable serum biochemical balance.

Keywords: Medicine, *Gmelina arborea*, Extract, Herbs, Phytochemicals, browse plant, Additive

Introduction

Herbal and spice-derived medicinal products have long been utilized as feed additives in livestock production (Agu *et al.,* 2017). Plant-based feed additives are increasingly valued in poultry production as natural alternatives to synthetic compounds, owing to their ability to enhance growth, health, and overall productivity (McGaw, 2023). *Gmelina arborea*, a widely distributed tropical multipurpose tree, contains leaves rich in protein, flavonoids, tannins, and phenolic compounds, bioactive nutrients known to promote gut integrity and provide antioxidant benefits (Abdullahi and Umar, 2020). Its aqueous leaf extract (AGALE) has demonstrated potential in enhancing nutrient utilization and improving health status across different animal species (Aye, 2016). Previous studies have reported positive effects of *G. arborea* components, such as leaf meal or seed meal, on animal performance in both ruminants and poultry (Fatokun *et al.,* 2013). However, evidence regarding the specific impact of its aqueous leaf extract (AGALE) on broiler growth performance and haematological indices remains limited. Plant-derived additives such as *Gmelina arborea* are increasingly recognized not only for their nutritional properties but also for their immunomodulatory activities, which influence both innate and adaptive immune responses in poultry. Phytochemicals including flavonoids, saponins, tannins, and terpenoids act as secondary metabolites that stimulate macrophage activity, enhance cytokine production, and modulate immune cell proliferation (Swaggerty *et al.,* 2019). These compounds also play a role in balancing pro-inflammatory and anti-inflammatory responses, supporting gut-associated lymphoid tissue (GALT) function, and promoting mucosal immunity through elevated secretory immunoglobulin levels (Obianwuna *et al.,* 2024). In broiler chickens, this immunological balance is vital for maintaining health under intensive rearing conditions, where oxidative stress and pathogen exposure can compromise productivity and welfare (Phillips, 2023). The phytochemical composition of *Gmelina arborea* notably its high levels of flavonoids, alkaloids, and phenolic acids has been associated with strong antioxidant and anti-inflammatory effects (Raji *et al.,* 2021). These compounds help reduce reactive oxygen species and lipid peroxidation in tissues, thereby protecting immune cells from oxidative damage. Antioxidant protection is essential for efficient immune function, as oxidative stress can suppress lymphocyte activity and antibody production. By mitigating oxidative stress, AGALE may indirectly strengthen the immune system, enhancing the bird's resistance to diseases and improving feed conversion efficiency. Studies have also demonstrated that herbal extracts such as *Moringa oleifera, Azadirachta indica,* and *Gmelina arborea* can enhance the weights of immune organs such as the spleen, thymus, and bursa of Fabricius key indicators of immune competence (Dey and Patra, 2021; Ogbuewu *et al.,* 2020). Increased relative organ weight and improved lymphocyte proliferation reflect a stronger capacity to respond to immunological challenges. In this context, *Gmelina arborea* extracts could enhance the development of immune tissues, contributing to higher immunoglobulin concentrations in serum and mucosal secretions. Such responses are crucial for both systemic and local immunity, ensuring better disease resistance and overall performance. Furthermore, phytogenic feed additives are known to modulate the gut microbiota, which plays a pivotal role in immune regulation. Beneficial microbes such as Lactobacillus spp. and Bifidobacterium spp. contribute to pathogen exclusion, production of short-chain fatty acids, and stimulation of immune signaling pathways in the intestinal mucosa (Gopi *et al.,* 2020). The bioactive components of *Gmelina arborea*, particularly phenolics and flavonoids, may act as prebiotics that foster a favourable microbial balance, suppress harmful bacteria, and maintain intestinal barrier integrity. Improved gut health not only enhances nutrient absorption but also lowers systemic inflammation, leading to better growth rates and feed efficiency. The immune enhancing role of AGALE can also be attributed to its hepatoprotective and hematopoietic properties. A healthy liver is essential for immune homeostasis because it synthesizes acute phase proteins and complements components of immune defense. The presence of bioactive compounds like luteolin, apigenin, and quercetin in *Gmelina arborea* has been associated with hepatoprotective effects that could support hematological stability, including maintenance of red and white blood cell counts (Raji *et al.,* 2021). This aligns with earlier findings suggesting that *Gmelina arborea* supplementation leads to improved haematological indices and reduced oxidative stress biomarkers in livestock (Aye, 2016). In addition to immune modulation, the use of *Gmelina arborea* extract aligns with the global push towards reducing antibiotic growth promoters in animal feed due to concerns about antimicrobial resistance. Natural immune stimulants like AGALE offer a dual advantage enhancing performance while supporting the immune system without contributing to antibiotic resistance (Yang *et al.,* 2015). Its potential use as a natural growth promoter thus provides a sustainable and eco-friendly alternative to conventional feed additives. This study therefore investigates the effects of AGALE supplementation via drinking water on broiler chickens, with the aim of assessing its potential as a natural growth promoter and immune modulator.

Materials and Methods

Experimental site:

The experiment was conducted at the Teaching and Research Farm, of the Federal College of Animal Health and Production Technology, Moor Plantation, Ibadan. The area lies within the rain forest ecological zone of longitude and latitude $7^{o}15^{l}$ - 7^{o} 30^{1} N and 3^{o} 45^{l}- 4E, respectively at altitude 200-300m above the sea level with an annual rainfall of about 1350mm.The temperature and relative humidity ranges from 35 - 40°C and 76-84% respectively (Google Earth 2025).

Duration of the Experiment:

The experiment lasted for six (6) weeks, excluding a two (2) weeks brooding period. The birds were raised under standard management and hygienic conditions, with adequate lighting and ventilation provided throughout the experiment.

Experimental animals, diet and design:

A total of one hundred and twenty (120) day-old Arbor Acres broiler chicks were used for the study. The chicks were brooded for two weeks on commercial starter feed before they were randomly distributed into four treatment groups of 30 birds each. Each treatment was replicated three times, with 10 birds per replicate, in a completely randomized design (CRD). All treatment groups were fed the same diet formulated to meet the nutrient requirements of broiler chickens, throughout the experiment. Feed and water were provided ad libitum, and the experimental pens were cleaned daily to ensure optimal biosecurity.

Source of Test Ingredient and its Preparation:

Fresh *Gmelina arborea* leaves were collected from the premises of the Federal College of Animal Health and Production Technology Ibadan. The leaves were rinsed under running water to remove sand and debris and contaminants. The leaves were manually macerated to obtain the liquid extract. The mixture was filtered through a muslin cloth to obtain the aqueous extract, which was stored in a transparent bottle at room temperature and administered daily to broiler chickens through their drinking water. Dosages were accurately measured using a syringe, with treatment groups receiving 0, 2.5, 5.0, and 7.5 mL of the extract, respectively.

Data Collection:

Daily feed intake:

Daily feed intake was determined as the difference between the feed offered and the leftovers each day from the data obtained, total feed intake and average daily feed intake was calculated

Weight Gain

The initial body weights of the birds were recorded at the start of the trial and subsequently on a weekly basis, while final weights were measured at the end of the experiment. From these data, total weight gain, average daily weight gain and feed conversion ratio (calculated as feed intake divided by weight gain) were determined.

Blood collection and analysis

On the 42nd day of the study, approximately 5 mL of blood was collected from two randomly selected birds per replicate using sterilized 5 mL syringes and needles via the jugular vein. 2.5mL of the blood were transferred into sterilized bottles containing ethylene diamine tetraacetic acid (EDTA) as an anticoagulant and gently inverted to ensure proper mixing and prevent clotting, the remaining 2.5 mL blood sample was then transferred into a plain sample bottles. The collected blood samples were analyzed for haematological and serum biochemical indices. Haemoglobin (Hb) concentration was determined spectrophotometrically using an SP6-500 UV spectrophotometer, while red blood cell (RBC) and white blood cell (WBC) counts were estimated with a haemocytometer. The serum metabolites determined were Total protein, Albumin, Globulin, blood glucose, Uric acid, Creatinine and cholesterol. Serum parameters were analysed spectrophotometrically following methods of Reitman and Frankel (1957).

Chemical Analysis: The proximate analysis of the experimental diet was determined according to the procedures of AOAC (2009).

Statistical Analysis: All data obtained were subjected to analysis of variance using statistical package; SAS (2005) and the means among the variables were separated using Duncan multiple range test of the same statistical package.

Table 1: Gross Composition of the Experimental Diet

Ingredients	Starter	Finisher
Maize	50.00	53.00
Soybean meal	31.55	24.50
Fishmeal	4.00	2.00
Palm Kernel Cake	10.00	15.50
Palm oil	0.60	1.15
Bone meal	3.00	3.00
Salt	0.25	0.25
Premix	0.25	0.25
Methionine	0.25	0.25
Lysine	0.10	0.10
Calculated Analysis		
Energy (MJ/Kg)	11.92	10.68
Crude Protein (%)	21.96	20.22
Crude Fibre	4.20	5.98

Premix composition: Vitamin A, 8,500,000.00 iu, Vitamin D3 1,500,000.00 iu, Vitamin E 10,000mg,Vitamin K3 1500mg,Vitamin B1,1600mg,Vitamin B2,4000mg, Niacin,20,000mg, Panthothenic acid, 5000mg,Vitamin B6, 1500mg, Vitamin B12, 10mg,Folic acid,500mg,Biotin,750mg,Chlorine chloride 175,000mg, Cobalt, 200mg, Copper 3000mg, Iodine 1,000mg,Iron, 20,000mg, Manganese 40,000mg, Selenium 200mg, Zinc 30,000mg Antioxidant 1250mg

Results and Discussion

Presented in Table 2 is the effect of aqueous *Gmelina arborea* leaf extract (AGALE) on the growth performance of broiler chickens. AGALE significantly (P<0.05) influenced nearly all growth parameters assessed. Birds administered 2.5 mL AGALE recorded the highest average daily weight gain (38.89 g/bird/day), whereas the lowest values were observed in birds receiving 5 mL AGALE. Average daily feed intake varied significantly among the treatment groups, with birds on 0 mL (91.03 g/bird/day), 2.5 mL (91.51 g/bird/day), and 7.5 mL (89.92 g/bird/day) AGALE showing comparable values, all of which were significantly (P<0.05) higher than those on 5 mL AGALE administration. Additionally, the best feed conversion ratio (FCR) was recorded in birds administered 2.5 mL AGALE. Broilers supplemented with 2.5 mL AGALE showed improved feed intake, weight gain, and feed conversion efficiency, likely due to the hermetic effect of phytogenic additives, which at moderate levels stimulate appetite, support gut health, and enhance nutrient utilization

(Yang *et al*., 2015). The improved performance at 2.5mL supplementation suggests a dose dependent response to the extract, bioactive compounds such as flavonoids, tannins and saponins enhance feed palatability, stimulate digestive secretions and promote intestinal enzyme activity (Asolo *et al.,* 2020; Abdelli *et al.,* 2021). These compounds are known to reduce pathogenic microbial loads in the gut and improve nutrient absorption, leading to enhanced growth performance. Conversely, higher doses (5.0–7.5 mL) depressed performance, probably due to excess phytochemicals exerting anti-nutritional effects, such as reduced palatability, impaired nutrient absorption, and metabolic stress (Ram *et al.,* 2020). This dose-dependent response agrees with earlier reports that phytogenic additives benefit poultry at optimal levels but become detrimental when oversupplied (Abdelli *et al.,* 2021). The consistency between feed intake and weight gain observed in this study indicates that AGALE may have improved nutrient utilization efficiency at moderate levels. Feed intake values were similar for 0, 2.5 and 7.5mL treatments groups but significantly lower at 5.0mL. The slight reduction at 5.0mL dosage could be attributed to reduced palatability or astringency caused by excess tannins. Nonetheless, the best feed efficiency recorded at 2.5mL inclusion level supports the hypothesis that the extract exerts a positive metabolic modulation, balancing nutrient digestibility with improved gut health. Thus, 2.5 mL AGALE is the optimum supplementation level for enhancing broiler growth, while higher doses may compromise performance.

Table 2: Effect of Aqueous *Gmelina arborea* Leaf Extract on the Growth Performance of Broiler Chickens

	AGALE (mL)					P value
Parameters	**0**	**2.5**	**5**	**7.5**	**SEM**	
Initial Weight (g/b)	400.00	400.00	400.00	420.00	14.43	0.09
Final Weight (g/b)	1876.67^{ab}	2033.33^{a}	1620.00^{c}	1760.00^{bc}	50.27	0.01
Total weight gain (g/b)	1476.67^{ab}	1633.33^{a}	1220.00^{c}	1340.00^{bc}	50.98	0.02
ADWG (g/b/d)	35.16^{ab}	38.89^{a}	29.05^{c}	31.91^{bc}	1.21	0.02
Total feed intake (g/b)	3823.33^{a}	3843.33^{a}	3420.00^{b}	3776.67^{a}	54.70	0.01
ADFI (g/b/d)	91.03^{a}	91.51^{a}	81.43^{b}	89.92^{a}	1.30	0.02
FCR	2.59^{ab}	2.37^{b}	2.81^{a}	2.82^{a}	0.07	0.04

^{a,b,c} means along the same row with different superscripts are significantly different (p<0.05). ADWG: Average Daily Weight Gain, ADFI: Average Daily Feed Intake, FCR: Feed Conversion Ratio, AGALE: Aqueous *Gmelina arborea* Leaf Extract

Indicated in Table 3 is the effect of aqueous *Gmelina arborea* leaf extract (AGALE) on the haematological indices of broiler chickens. AGALE had no significant effect (P>0.05) on most of the haematological parameters, except the white blood cell (WBC) count and heterophil concentration. The WBC values varied significantly (P<0.05) across the treatment groups, with birds administered 2.5 mL AGALE recording the highest count (27.85×10^{3}/uL), while those given 7.5 mL AGALE had the lowest value (12.50 ×10^{3}/ uL). Similarly, heterophil concentration was highest in birds receiving 2.5 mL AGALE (53.50%), compared to birds on 0 mL (18.00%), 5 mL (20.00%), and 7.5 mL (18.00%) AGALE groups, which showed statistically similar values. The elevated WBC count and heterophil proportion observed in broilers administered 2.5 mL AGALE may be linked to an enhanced innate immune response, likely stimulated by the bioactive compounds in the extract. White blood cells play a vital role in the prevention of disease or infection, thus animals with low WBC level stand a risk of disease infections. Birds on 2.5mL AGALE with high WBC are capable of generating antibodies and have a high degree of resistance to diseases (Zekarias *et al.,* 2002). In contrast, higher doses (5.0–7.5mL) appeared to suppress leukocyte activity, the decline at higher inclusion levels could indicate immunosuppression caused by excessive bioactive compounds. This aligns with Abdelli *et al.* (2021), who observed that excessive levels of phytochemical can impose metabolic stress, leading to reduced leukocyte activity and compromised immunity. Flavonoids, alkaloids and phenolic compounds found in *Gmelina arborea* have been reported to possess immunostimulatory and antimicrobial effects, which can enhance leukopoiesis and bolster the bird's ability to resist infections (Abdullahi and Umar, 2020). The higher heterophil count observed also implies improved surveillance, as heterophils function as the avian equivalent of mammalian neutrophils, providing the first line of defense against pathogenic invasion (Abbas *et al.,* 2019). These findings aligns with Asolo *et al* .(2020), who observed elevated leukocycte levels in Japanese quails supplemented with *Gmelina arborea* leaf extract, suggesting improved immune function and health status. Phytogenic feed additives exert hormetic effects promoting health and immunity at moderate levels but becoming detrimental when administered in excess (Abdelli *et al.*, 2021). Other haematological parameters such as packed cell volume (PCV), haemoglobin (Hb), red blood cell (RBC), platelet count and lymphocyte percentage showed no significant differences across the treatments, indicating that AGALE administration did not adversely affect erythropoiesis or blood oxygen carrying capacity. The stability of Hb and PCV values across all groups suggests that the extract was non-haemolytic and non-toxic to blood cells, a desirable characteristic for any herbal additive intended for livestock use.

Table 3: Effect of Aqueous *Gmelina arborea* Leaf Extract on the Haematological indices of Broiler Chickens

Parameters	AGALE (mL)				SEM	P value
	0	2.5	5	7.5		
PCV (%)	25.00	25.00	23.50	24.50	0.38	0.55
Hb (mg/dL)	8.05	8.60	7.30	7.15	0.28	0.24
RBC ($\times 10^{12}$/L)	2.33	2.26	2.16	2.06	0.05	0.24
WBC ($\times 10^{3}$/ uL)	20.70^{ab}	27. 85^{a}	14.13^{bc}	12.50^{c}	2.42	0.02
Platelets ($\times 10^{4}$/L)	24.90	31.40	29.90	30.5	2.95	0.92
Heterophils (%)	18.00^{b}	53.50^{a}	20.00^{b}	18.00^{b}	6.02	0.02
Lymphocytes (%)	68.00	35.50	65.00	50.00	6.18	0.22
Eosinophil (%)	2.50	30.00	3.00	2.00	0.26	0.58
Monocytes (%)	11.50	7.50	2.50	7.00	2.07	0.61
Basophils (%)	0.00	0.50	0.50	0.50	0.18	0.80

^{a,b,c} Means along the same row with different superscripts are significantly different ($p<0.05$). PCV: Packed Cell Volume, Hb: Hemoglobin RBC: Red Blood Cell.WBC: White Blood Cell.

Presented in Table 4 is the effect of aqueous *Gmelina arborea* leaf extract (AGALE) on the serum biochemical indices of broiler chicken. Results revealed that AGALE had no significant effect (P>0.05) on all the serum biochemical indices parameters measured. This suggests that AGALE did not adversely affect the liver and kidney function of birds across all treatments and did not cause metabolic toxicity in the birds. The absence of significant differences in serum total protein, albumin and globulin concentrations indicates that protein metabolism and hepatic synthetic activity were not adversely affected by AGALE supplementation. Albumin and globulin serve as indicators of liver health and immune function, respectively. Therefore, the observed stability in their values across treatments implies that the extract did not compromise liver integrity or humoral immune response.

Similar results were reported by Afolabi *et al.* (2020), who found that broiler chicken fed herbal extracts maintained normal serum protein levels, reflecting healthy liver function and efficient protein utilization. Furthermore, the unchanged activities of serum enzymes (ALT, AST and ALP) across treatment groups suggested that AGALE did not induce hepatocellular damage or enzyme leakage. Elevated serum enzyme levels typically indicate tissue injury or hepatic stress, however, the enzyme values observed here fall within the normal physiological range for healthy broilers (Esonu *et al.,* 2018). This indicates that the extract was non-hepatotoxic and safe for use as a phytogenic supplement. Serum blood urea nitrogen (BUN) and creatinine remain stable across the treatment groups, this implies that kidney function and nitrogen metabolism were maintained. These parameters reflect the efficiency of renal clearance and the degree of protein catabolism in the body (Njidda *et al.,* 2014). Since no alteration was observed, these suggest that AGALE supplementation did not impair renal filtration or lead to accumulation of metabolic wastes in the bloodstream. The findings in this study align with those of Animut *et al.* (2008), who reported that moderate inclusion of phytogenic compounds in animal diets did not alter serum biochemical indices, as most plant secondary metabolites act within safe physiological thresholds. Ezeonu *et al.* (2021), also observed that aqueous extracts of medicinal plants containing phenolic compounds improved broiler growth without affecting serum enzyme activities, confirming their non-toxic nature when used at appropriate dosages.

Table 4: Effect of Aqueous *Gmelina arborea* Leaf Extract on Serum Biochemical Indices of Broiler Chickens

Parameters	AGALE (mL)				SEM	P value
	0	2.5	5	7.5		
Total protein (g/dL)	3.35	3.15	3.40	3.05	0.09	0.56
Albumin (g/dL)	0.55	0.50	0.55	0.60	0.04	0.90
Globulin (g/dL)	2.80	2.65	2.85	2.45	0.10	0.62
AST (uL)	175.00	176.50	178.00	173.5	0.94	0.44
ALT (uL)	21.00	20.00	20.00	21.00	0.33	0.62
ALP (uL)	206.00	199.00	209.50	198.00	2.47	0.33
BUN (g/dL)	4.40	4.25	4.15	4.35	0.12	0.93
Creatinine (g/dL)	0.45	0.50	0.50	0.50	0.01	0.48

AST= Aspartate aminotransferase, ALT= Alanine aminotransferase, ALP= Alkaline phosphatase, BUN= Blood Urea Nitrogen

Conclusion: From the results obtained in this study**,** it can therefore be concluded that AGALE administered to broiler chickens at 2.5mL, improved weight gain, feed efficiency and immune response of broiler chickens as it enhanced WBC and heterophil counts. It could also be seen that AGALE administered 7.5mLis safe and non-toxic to broiler chickens, as this did not compromise liver or kidney functions.

Recommendation: Future studies should investigate the bioactive compounds responsible for these effects, as well as the long-term safety and economic implications of AGALE supplementation in poultry nutrition.

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