PHYTOCHEMICAL ANALYSIS, ANTIOXIDANT AND ANTIMICROBIAL ACTIVITIES OF METANOLIC *Gmelina arborea* LEAVES EXTRACT

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Abstract
In this study, the phytochemical composition, antioxidant potential, and antimicrobial activity of methanolic *Gmelina arborea* leaf extract (MGALE) were evaluated. Fresh, mature *G. arborea* leaves (500 g) were collected from the College premises and processed for analysis. Both qualitative and quantitative phytochemical screenings were conducted, alongside antioxidant assays and antimicrobial testing against *Escherichia coli* using the disk diffusion method. Phytochemical analysis revealed that MGALE contained moderate levels of tannins, phenols, flavonoids, alkaloids, and saponins, while terpenoids, cardiac glycosides, anthraquinones, and steroids were also detected in the extract. Results shows that tannins, phenols, flavonoids, alkaloids, saponins and terpenoids contained 0.96 ± 0.003 mg/100mL, 1.01 ± 0.001mg/100mL, 13.78 ± 0.13mg/100mL, 4.25 ± 0.002%, 6.40 ± 0.004 % and 0.65 ± 0.001, respectively. The antioxidant activity of the extract was confirmed through multiple assays: Diphenylpicrylhydrazyl (DPPH) scavenging activity (54.91 ± 0.08 mg/100 mL), ferric reducing antioxidant potential (FRAP) (3.91 ± 0.03 mM Fe^{2+}/g), and Azino-bis (ethylbenzothiazoline sulfonic acid) (ABTS) assay (75.93 ± 0.25%). Furthermore, the extract demonstrated significant ($P<0.05$) antibacterial activity, with a zone of inhibition of 19.50 ± 2.12 mm against *E. coli*. These results suggested that MGALE possesses notable antioxidant and antimicrobial properties. In conclusion, MGALE may serve as a valuable natural source of antimicrobial agents, with potential application in the treatment of *E. coli* infections in livestock production, especially in the face of rising resistance to conventional drugs.

Keywords: Bioactive Extracts, Herbal-based medicines, Metabolites, Secondary, Phytochemicals

Description of Problem

Plants have long been recognized as valuable sources of medicine in traditional healthcare, and growing antimicrobial resistance has renewed global interest in herbal-based therapies as alternatives to conventional drugs. *Gmelina arborea* is one of such plant, with its fruits, leaves, and seeds reported to contain diverse nutrients, minerals, and phytochemicals including alkaloids, tannins, flavonoids, saponins, phenolic compounds, and proteins (1; 2). Phytochemicals are bioactive secondary metabolites that not only contribute to the sensory properties of plants but also play key roles in disease prevention, often acting synergistically with nutrients and dietary fiber (3; 4). They are broadly classified into phenolic acids, flavonoids, and stilbenes/lignans, with flavonoids further divided into subgroups such as anthocyanins, flavones, flavanones, isoflavones, and flavonols (5). Identifying these compounds through phytochemical analysis is essential for exploring their therapeutic potential and for developing novel drugs via appropriate biological and chemical processes (6; 7). In this context, the present study investigates the phytochemical profile, antioxidant activity, and antimicrobial properties of methanolic *Gmelina arborea* leaf extract to evaluate its potential as a natural antibacterial agent.

Materials and Methods

Plant collection and preparation of aqueous *Gmelina arborea* leaf extract: 500 g of fresh, mature *Gmelina arborea* leaves were harvested from the Botanical Garden of the Federal College of Animal Health and Production Technology, Moor Plantation, Ibadan, Oyo State, Nigeria. Only healthy leaves, free from visible signs of infection or damage, were selected to ensure the quality of the extract. The harvested leaves were

carefully washed under running water to eliminate dust, soil particles, and other surface contaminants. After cleaning, the leaves were chopped into small pieces to increase their surface area, thereby enhancing solvent penetration during extraction. For the extraction process, 150 mL of methanol was added to the chopped leaves to facilitate the release of bioactive constituents. The plant material was then thoroughly macerated and manually squeezed to obtain the crude juice. The resulting extract was carefully filtered through a fine mesh to remove residual particles and leaf fragments, yielding a clear filtrate. The filtrate was subsequently collected into a clean container, transferred into an airtight vessel, and stored in a cool environment to preserve its stability and prevent microbial spoilage prior to analysis.

Determination of phytochemicals screening, antioxidants and antimicrobial activities: This study was carried out at the Precision Food and Feed Analysis Laboratory, Ajia Road, Iyana Agbala, Ejikeye, Ibadan, Oyo State. Phytochemical screening, comprising both qualitative and quantitative analyses, was conducted to detect secondary metabolites following the standard procedures described by (8). These tests were designed to identify major phytochemical groups, including alkaloids, flavonoids, phenols, tannins, and saponins in the plant extract. The antioxidant potential of the extract was evaluated using established chemical assays, namely the 2,2-diphenyl-1-picrylhydrazyl (DPPH) radical scavenging assay and the ferric reducing antioxidant power (FRAP) assay, as described by (9). The antimicrobial activity of the methanolic *Gmelina arborea* leaf extract (MGALE) was determined using the disk diffusion technique. In this method, sterile paper disks impregnated with the extract were placed on agar plates previously inoculated with the test microorganism. The plates were then incubated, and the diameter of the inhibition zones surrounding each disk was measured to assess the susceptibility of the microorganism to the extract.

Statistical Analysis: All data collected were analyzed using (10). Results were replicated three times and were expressed as mean ± standard deviation.

Results and Discussion

Quantitative and qualitative phytochemical analysis of methanolic *Gmelina arborea* leaf meal extract

Table 1 presents the results of the qualitative and quantitative phytochemical analysis of MGALE. The extract was found to contain moderate levels of tannins, phenols, flavonoids, alkaloids, and saponins, while terpenoids, cardiac glycosides, anthraquinones, and steroids were also detected in the extract. Results shows that tannins, phenols, flavonoids, alkaloids, saponins and terpenoids contained 0.96 ± 0.003 mg/100mL, 1.01 ± 0.001mg/100mL, 13.78 ± 0.13mg/100mL, 4.25 ± 0.002%, 6.40 ± 0.004 % and 0.65 ± 0.001 respectively.

Phytochemical analysis of the methanolic *Gmelina arborea* leaf extract (MGALE) revealed abundant flavonoids, saponins, and alkaloids, compounds known for their strong antioxidant potential and overall bioactivity. These findings agree with earlier studies (11; 12) that highlighted the presence of bioactive constituents in different parts of *G. arborea*. Flavonoids were especially prominent, contributing not only to the fruit's aroma but also to human health through cholesterol regulation (13). They are regarded as "nature's tender pharmaceuticals" due to their wide-ranging biological effects, including antifungal, antiviral, antioxidant, anticancer, hepatoprotective, and antithrombotic activities. Tannins, attributed to polyphenolic compounds, provide antidiarrheal and haemostatic benefits (14), while phenolics such as hydroxycoumarins function as metal chelators and free radical scavengers, thereby strengthening antioxidant defenses (15). Collectively, these metabolites particularly flavonoids, saponins, and alkaloids underscore the therapeutic potential of MGALE as a rich natural source of antioxidants with broad pharmacological applications. The methanolic *Gmelina arborea* leaf extract (MGALE) contained key secondary metabolites, including phenols, saponins, and alkaloids, each with notable pharmacological significance. Phenols are widely applied in medicine and industry, while saponins are associated with antibacterial and antimicrobial activities (16). Alkaloids enhance immune function, support cardiovascular health, and aid in the clearance of harmful microorganisms. These findings align

with earlier reports (17) that identified tannins, saponins, flavonoids, alkaloids, and phenolic compounds in *G. arborea* extracts and highlighted their roles in regulating blood glucose, improving lipid metabolism, and correcting metabolic disorders. The abundance of these metabolites supports the plant's traditional medicinal uses and emphasizes the therapeutic value of flavonoids, phenols, and tannins (18).

Table 1: Phytochemical screening of Methanolic *Gmelina arborea* leaf extract

Parameters	*Gmelina arborea* Qualitative Extract	*Gmelina arborea* Quantitative Extract
Tannin (mg/100mL)	++	0.96 ± 0.003
Phenols (mg/100mL)	++	1.01 ± 0.001
Flavonoids (mg/100mL)	++	13.78 ± 0.13
Alkaloids (%)	++	4.25 ± 0.002
Saponin (%)	++	6.40 ± 0.004
Terpenoids	+	0.65 ± 0.001
Cardiac Glycosides	+	
Anthraquinance	+	
Steroids	+	

Present: +, Moderately present: ++, Excessively present: +++

Antioxidant and antimicrobial activities of methanolic *Gmelina arborea* leaves extract

Indicated in Table 2 is the antioxidant and antimicrobial activities of *Gmelina arborea* extract. The antioxidant activities of MGALE analyzed were Diphenylpicrylhydrazyl (DPPH), Ferric Reducing antioxidant Potential (FRAP), Azino bisethylbenzo thiazoline sulfonic Acid (ABTS)contained 54.91 ± 0.08%, 3.91 ± 0.03$MgFe^{2+}$/100mL and 75.93 ± 0.25% respectively. The value obtained (19.50 ± 2.12%) as zone of inhibition in this study suggested that AGALE exhibited antimicrobial activity against *Escherichia coli*.

MGALE demonstrated strong antioxidant potential, with FRAP, ABTS, and DPPH values of 54.91 ± 0.08 $mgFe^{2+}$/100 mL, 75.93 ± 0.25%, and 3.91 ± 0.03, respectively. The abundant presence of phytochemicals in plants has been reported to significantly increase the antioxidant properties of the leaves (19). While FRAP indicated modest reducing power, the high ABTS value suggests potent antioxidant capacity, contributing to the prevention of oxidative stress–related diseases such as cancer and cardiovascular disorders (20). Flavonoids, known for their free radical scavenging ability, likely played a major role, although non-flavonoid phenolics appear to be the primary contributors to antioxidant activity (21; 22). In addition, MGALE exhibited significant antibacterial activity against *Escherichia coli*, producing a 19.50 ± 2.12 mm zone of inhibition, which exceeded previously reported values (23). Differences may be attributed to extract concentration or solvent type. These results contrast with (14), who reported higher antibacterial activity in aqueous extracts, though higher concentrations were shown to enhance efficacy.

Table 2: Antioxidant and Antimicrobial activities of Methanolic *Gmelina arborea* leaves extract

Parameters	Methanolic *Gmelina arborea* leaf extract
% DPPH Scavenged	54.91 ± 0.08
FRAP ($mgFe^{2+}$/100mL)	3.91 ± 0.03
ABTS %	75.93 ± 0.25
E. coli (% Inhibition (mm)	19.50 ± 2.12

DPPH: Diphenylpicrylhydrazyl, ABTS: Azino bisethylbenzo thiazoline sulfonic Acid, FRAP: Ferric Reducing antioxidant Potential

Conclusion and Application

It can be concluded that MGALE contains bioactive substances such as tannins, flavonols, alkaloids, saponins, phenols, terpenoids, cardiac glycosides, anthraquinones, and steroids, which exhibit promising antioxidant properties and potential for new drug discoveries in the treatment of *E. coli* infections.

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