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Phytochemical Profiling, Antimicrobial Activity, and Bioactive Compound Identification of *Gongronema Latifolium* (Utazi) Leaf Extracts

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Abstract

Gongronema latifolium (Utazi) is a medicinal plant widely used in traditional African medicine for the management of various infectious and metabolic diseases. Despite its extensive ethnomedicinal use, comprehensive information on its physicochemical characteristics, phytochemical composition and pharmaceutical potential remains limited. This study evaluated the physicochemical properties, phytochemical constituents, antimicrobial activity, and chemical profile of *Gongronema latifolium* leaf extracts using standard analytical techniques. Fresh leaves of *Gongronema latifolium* were subjected to proximate and mineral analysis following Association of Official Analytical Chemists (AOAC) methods. Phytochemical screening was performed using qualitative and quantitative procedures, while bioactive constituents were fractionated by column chromatography. The antimicrobial activities of the flavonoid, saponin, and tannin fractions were evaluated against selected bacterial and fungal isolates using the agar well diffusion method. Gas chromatography-mass spectrometry (GC-MS) and Fourier transform infrared (FTIR) spectroscopy were employed to identify bioactive compounds and functional groups present in the extracts. The Proximate analysis revealed moisture, ash, lipid, crude fibre, protein, and carbohydrate contents of 51.15± 1.87, 8.97±0.46, 11.45±0.97, 4.28± 0.15, 6.24±0.07 and 17.9± 1.00, respectively. Iron was the predominant mineral (6.99± 0.75), whereas cadmium occurred at the lowest concentration (0.06± 0.04). Phytochemical analysis demonstrated abundant levels of alkaloids and flavonoids, moderate amounts of Saponins and oxalates, and trace levels of tannins, phenols, terpenoids, phytates, cyanides, reducing sugars, and phlobatannins. The flavonoid-rich ethyl acetate fraction exhibited the strongest antimicrobial activity, with inhibition zones of 54.98mm against *Pseudomonas aeruginosa*, 50.06 mm against *Candida albicans*, and 50.03 mm against *Bacillus spp.*, 48.00mm against identified quercetin, catechin, oleic acid, phytol, camphor, resorcinol, fumaric acid, phenylcyanamide, anisole, and triacontane as major bioactive constituents, while FTIR analysis confirmed the presence of hydroxyl aromatic and ester functional groups. These findings demonstrate that *Gongronema latifolium* is a rich source of nutritionally valuable and pharmacologically active phytochemicals. The pronounced antimicrobial activity of the flavonoid fraction supports the traditional medicinal use of the plant and highlights its potential as a promising candidate for the development of novel pharmaceutical products.

Keywords: *Gongronema latifolium*; Physicochemical characterisation; antimicrobial activity; Biochemical Methods

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Introduction

Medicinal plants continue to play a significant role in primary health care and drug discovery because they contain diverse bioactive compounds with therapeutic properties. According to the World Health Organisation (WHO), a substantial proportion of the global population relies on traditional herbal medicines for the prevention and treatment of various diseases (Adebayo *et al*., 2020). Consequently, scientific validation of medicinal plants through physicochemical characterization, phytochemical profiling, and pharmacological evaluation has become increasingly important for the development of safe and effective phytopharmaceutical products (Eze *et al*., 2021). *Gongronema latifolium* Benth (family Apocynaceae), commonly known as Utazi in southeastern Nigeria, is an edible climbing plant widely distributed across tropical Africa, including Nigeria, Cameroon, Sierra Leone, and Guinea-Bissau (Ojo *et al*., 2021; Okokon *et al*., 2022). The leaves are commonly consumed as vegetables and spices and have long been used in traditional medicine for the management of malaria, diabetes mellitus, hypertension, gastrointestinal disorders, cough, dysentery, helminthic infections, inflammation, and microbial diseases. In many parts of southern Nigeria, the leaves are also used in postpartum diets because of their perceived nutritional and medicinal benefits (Nwosu *et al.,* 2022; Adeyemi *et al.,* 2023). Previous phytochemical investigations have shown that *Gongronema latifolium* contains numerous biologically active secondary metabolites, including flavonoids, alkaloids, Saponins, tannins, terpenoids, phenolic compounds, glycosides, oxalates, phytates, and other antioxidant constituents (Chukwuma *et al*., 2023; Nweze *et al.,* 2024). These compounds have been associated with antioxidant, anti-inflammatory, antimicrobial, antidiabetic, antihyperlipidaemic, hepatoprotective, and cardioprotective activities, thereby supporting the plant's extensive use in traditional medicine. Despite the documented medicinal importance of *Gongronema latifolium*, comprehensive studies integrating physicochemical properties, phytochemical composition, chromatographic characterisation, spectroscopic analysis, and antimicrobial evaluation remain limited. Furthermore, identifying the specific bioactive constituents responsible for its biological activities is essential for standardisation, quality control, and the development of plant-derived pharmaceutical products (Kumar *et al*., 2025). Physicochemical characterization provides valuable information on the nutritional composition and mineral profile of medicinal plants, while phytochemical screening identifies the classes of secondary metabolites responsible for biological activity. Advanced analytical techniques such as gas chromatography-mass spectrometry (GC-MS) enable the identification of volatile and semi-volatile bioactive compounds, whereas Fourier transform infrared (FTIR) spectroscopy facilitates the characterization of functional groups present within plant extracts. The integration of these analytical approaches provides a comprehensive understanding of the chemical composition and therapeutic potential of medicinal plants (Morah & Inaku 2021). In addition, increasing antimicrobial resistance among pathogenic microorganisms has intensified the search for novel antimicrobial agents from natural sources. Plant-derived phytochemicals, particularly flavonoids, have attracted considerable interest because of their broad-spectrum antimicrobial activity, low toxicity, and potential to serve as lead compounds for drug development. Therefore, the present study aimed at to investigate the physicochemical characteristics, mineral composition, phytochemical constituents, antimicrobial activity, and chemical composition of *Gongronema latifolium* leaf extracts using standard analytical methods,

including column chromatography, GC-MS, and FTIR spectroscopy. The study also sought to evaluate the pharmaceutical potential of the identified bioactive compounds and provide scientific evidence supporting the traditional medicinal use of the plant. It was reported that the extract or cold infusion of the pounded leafy branches together with lime juice expels intestinal worms, dispels stomach upset and serves as a blood tonic. The leaf juice mixed with pineapple and lime juice is used in the treatment of typhoid fever (Etetim "*et al"* 2008). In Imo State, Nigeria, *Gongronemia latifolium* leaves are used as vegetables for the preparation of pepper soup, usually given to a woman after childbirth and to treat stomach ache (Uzodinma, 2013). An infusion of the aerial parts is taken to treat cough, intestinal worms, dysentery, dyspepsia and malaria (Mosango, 2011). It is also taken to restore loss of appetite. In Sierra Leone, an infusion or decoction of the stem in the juice is taken as a purgative to treat colic and stomach ache (Mosango, 2011). The latex is applied to teeth affected by caries. Asthmatic patients use fresh leaves of *Gongronema latifolium* to relieve

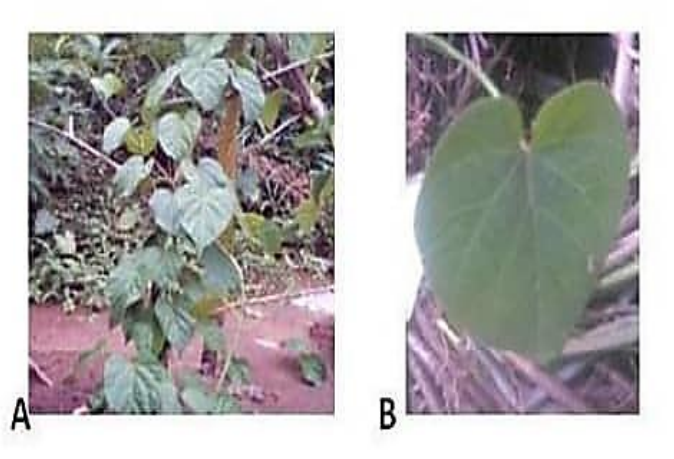

Figure 1: Structure of *Gongronema latifolium* plant (*utazzi*)
Source: (Osuagwu *et al,* 2013).

leaves have been reported to have hypoglycemic effects (Ugochukwu & Babady, 2003; Ogundipe *et al*., 2003) by decreasing the activity of the glucokinase enzyme and levels of hepatic glycogen, hepatic glucose, and blood glucose. It is rich in fats, proteins, vitamins, minerals and essential amino acids (Eleyinmi, 2007). Phytochemical studies of *Gongronema latifolium* show that the root contains polyphenols in abundance, alkaloids, glycosides and reducing sugars (Antai *et al*., 2009; Nwinyi *et al.*, 2008; Schneider *et al*., 1993; Nwanjo *et al.,* 2006; Ugochukwu *et al*., 2003). According to the World Health Organization (WHO, 2023), traditional medicine continues to play an important role in health care worldwide; see Figure 1.

2. Materials and Methods

2.1 Study Design

This study was designed to evaluate the physicochemical characteristics, phytochemical composition, antimicrobial activity, and chemical constituents of Gongronema latifolium leaves using standard analytical and spectroscopic techniques.

2.2 Sample collection and Authentication

Fresh leaves of *Gongronema latifolium* were collected from a local farm in Calabar Municipal, Cross River State, Nigeria. The plant material was authenticated by a taxonomist in the Department of Botany, University of Calabar.

2.3 Sample preparation

The collected fresh leaves were thoroughly washed with clean water to remove adhering soil and other contaminants. The samples were oven-dried at 30-40ºC using a Mermert thermostate ovun model (F-N C508.0272) until a constant weight was achieved, after which they were ground into a fine powder using a laboratory blender model (F No. 4 Quaker City Mill Philadelphia, P. A, U.S.A). The powdered samples were stored in airtight containers before analysis.

2.4 Chemicals and Reagents

All chemicals and reagents used in this study were of analytical grade. Methanol, ethyl acetate, acetone, ethanol, n-hexane, petroleum ether, sulphuric acid, sodium hydroxide, ferric chloride, Wagner's reagent, Benedict's reagent, lead acetate, ammonia solution, silica gel, aluminium oxide, and other analytical reagents were obtained from standard laboratory suppliers.

2.5 Proximate analysis

Moisture content, ash content, crude protein, crude fibre, crude lipid, and carbohydrate contents were determined according to standard procedures recommended by the Association of Official Analytical Chemists (AOAC). All analyses were performed in triplicate, and the results were expressed as mean and standard deviation values.

2.6 Mineral Analysis

The concentrations of Iron (Fe), magnesium (Mg), zinc (Zn), copper (Cu), cadmium (Cd), and cobalt (Co) were determined using AOAC standard analytical methods. Results were expressed as mg/kg of dry sample.

2.7 Phytochemical screening

Qualitative and quantitative phytochemical analysis were conducted to determine the presence and concentrations of alkaloids, flavonoids, Saponins, tannins, terpenoids, phenols, oxalates, phytates, cyanides, reducing sugars, and phlobatannins using established procedures described by Herborne (1984) and Sofowora (1988), (Indumathi *et al*., 2014).

2.8 Fractionation by Column Chromatography

Crude extracts were fractionated using glass column chromatography packed with activated silica gel and aluminium oxide. Appropriate solvent systems were employed to selectively elute alkaloids, flavonoids, Saponins, and tannins. The collected fractions were concentrated under reduced pressure and stored for antimicrobial and chromatographic analysis.

2.9 Antimicrobial Assay

Clinical isolates of *Pseudomonas aeruginosa, Escherichia coli, Candida albicans, Aspergillus niger Escherichia coli Staphylococcus aureus* and *Bacillus spp.,* were obtained from the Microbiology Culture Collection Centre, University of Calabar.

The antimicrobial activities of the phytochemical fractions were evaluated using the Kirby-Bauer agar well diffusion method. Standardised microbial inoculated onto Mueller-Hinton agar plates for bacteria and Sabouraud Dextrose Agar for fungi. Wells were filled with the respective extract fractions, and plates were incubated under appropriate conditions. Zones of inhibition were measured in millimetres (mm) after incubation (Choesbrough, 2002; Adeshina *et al,* 2010; Awafisayo *et al*, 2010; Bukar *et al.,* 2010).

2.10 GC-MS analysis

Gas chromatography-mass spectrometry (GC-MS) analysis was carried out using a BUCK M910 Gas chromatograph equipped with an Hp-5MS capillary column. Helium was used as the carrier gas at a flow rate of 1.0Ml/min. One microliter of each prepared extract was injected in splitless mode, and compounds were identified from their retention times, mass spectra, and comparison with spectral library data. Relative abundance was calculated from chromatographic peak areas.

2.11 Fourier Transform Infrared (FTIR) Analysis

FTIR spectra were recorded using a Bruker Scientific M530 FTIR spectrometer. Samples were prepared with Nujol and scanned within the spectral range of 4000-600^{-1} cm. Functional groups were identified by comparing the absorption bands with standard reference spectra. (Van der Weerd *et al,* 2004).

2.12 Statistical Analysis

All experiments were performed in triplicate, and results were expressed as mean $\pm$ standard deviation. Data were organised using Microsoft Excel for descriptive statistical analysis.

3. RESULTS

3.1 Proximate Composition of *Gongronema latifolium* Leaves

The proximate composition of *Gongronema latifolium* leaves is presented in Table 1**.** The results showed that the leaves possessed a high moisture content 51.15±1.87%, indicating a substantial water content in the fresh plant material. The ash content was 8.97±0.46%, suggesting the presence of appreciable quantities of mineral elements. The crude lipid, crude fibre, crude protein, and carbohydrate contents were 11.45±0.97%, 4.28±0.15%, 6.24±0.07% and 17.9+1.00 %, respectively. These findings demonstrate that *Gongronema latifolium* contains nutritionally important components that may contribute to its dietary and medicinal value.

Table 1: Nutritional values of *Gongronema latifolium*

	MC	ASH	FAT	CF	P	C
Standard deviation	51.15± 1.87	8.97 ± 0.46	11.45 ± 0.97	4.28± 0.15	6.24 ±.07	17.9± 1.00

MC- moisture content (51.15±1.87%)
ASH - ash content (8.97±0.46%)
FAT - percentage lipid (11.45±0.97%)
CF - crude fibre content (4.28±0.153%)
P - protein content (6.24±0.07%)
C- carbohydrate content (17.9±1.00%)

Mineral Composition

The concentrations of selected minerals in the leaf sample are presented in Table 2. Iron (Fe) was the most abundant mineral (6.99±0.75%), followed by magnesium (Mg) at 1.05±0.04% and copper (Cu) at 0.49±0.05%, respectively, while cobalt (Co) and cadmium (Cd) occurred at relatively low concentrations.

Table 2: Mineral compositions of some minerals in *Gongronema latifolium* (utazi) dry sample'

Minerals mg/kg)	Mean x	SD
Cu	0.49	0.49±0.05
Zn	0.42	0.42±0.11
Mg	1.05	1.05±0.04
Fe	6.99	6.99±0.75
Cd	0.06	0.06±0.04
Co	0.38	0.38±0.17

3.3 Qualitative phytochemical screening revealed the presence of several secondary metabolites in *Gongronema latifolium* leaf extracts. Alkaloids and flavonoids were abundant (+++), whereas Saponins and oxalates were moderately present (++). Tannins, terpenoids, phenols, phytates, phlobatanins, cyanides, and reducing sugars were detected in lower amounts (+). Quantitative analysis confirmed that flavonoids constituted the predominant phytochemical group, followed by alkaloids and Saponins. Lower concentrations were observed for tannins, phenols, terpenoids, cyanides, phytates, reducing sugars, and phlobatannins, as presented in Tables 3, 4 and 5.

3.4 Fractionation of phytochemical Constituents

Column chromatographic separation successfully yielded fractions enriched in alkaloids, flavonoids, Saponins, and tannins. Specific solvent systems were used for the selective elution of each phytochemical class, enabling subsequent antimicrobial and instrumental analysis as presented in Table 6.

Table 3: Phytochemical screening of *Gongronema latifolium* (utazi) extracts

Test	Alkaloids (Wagner's Reagent)	Flavonoids (Lead acetate test)	Saponins. Honeycomb test (frothing)	Tannins. Ferric chloride test	Reducing sugar	Terpenoids (Acid test)
Observation	Reddish-brown precipitate	Yellow colouration in lead acetate layer	Honeycomb-like persistent frothing formed	Dark bluish-black colour indicated the presence of tannins	Brick red-orange colour, a positive result indicating the presence of glucose	Formation of reddish-brown precipitate indicated the presence of terpenoids
inferences	+++	+++	++	+	+	+
Test	Oxalate	Phlobatannins	Phenol. (Ferric chloride test)	Phytate (Acid HCl + base NaOH+FeCl3 test)	Cyanide content (ferric chloride test + ammonium sulphide	
Observation	Formation of faint yellow precipitate	Formation of red colouration indicating the presence of phlobatannins	A dark green colouration was formed indicating the presence of phenol	Ferric phytate precipitate was formed	A red colouration indicated the presence of cyanide	
inferences	++	+	+	+	+	

Parameters	Indication
Alkaloids	+++
Flavonoids	+++
Oxalate	++
Phenol	+
Saponins	++
Tannins	+
Phlobatannins	+
Terpenoids	+
Cyanide	+
Phytate	+
Reducing Sugar	+

Table 4: Qualitative phytochemical screening of *Gongronema*

Table 5: Quantitative phytochemical analysis of *Gongronema latifolium* (utazi) extracts

Composition mg/kg / Mean ± SD	Composition mg/kg / Mean ± SD	Composition mg/kg / Mean ± SD
Oxalate - 2.75±1.63	Alkaloids - 6.68±0.31	Flavonoids - 10.73±0.77
Phenol - 1.35+0.48	Saponins - 3.29+0.09	Tannins - 0.68+0.04
Phlobatanins - 0.46±0.07	Terpenoids - 1.60±0.23	Cyanide - 0.19±0.03
Phytate - 0.87+-0.05	Reducing sugar - 0.08+ 0.01	

Table 6: Fractionation of alkaloids, flavonoids, tannins and saponins from methanol, acetone, methanol / acetone and ethyl acetate extracts, respectively.

Fractions of phytochemicals eluted:	Solvents used for elution of
Alkaloids	1:1:1 ratio of acetic acid, ethanol and ammonia was used to elute alkaloids from each of the extracts.
Flavonoids	80% methanol was used to elute flavonoids from each of the extracts
Saponins	20% ethanol was used to elute from each of the extracts
Tannins	50 mL acetone was used to elute tannins from each of the extracts.

Table 7: Antimicrobial susceptibility pattern (saponin extract fraction)

Pathogenic micro-organism	Clearance Zone mean/inhibition (mm)
Pseudomas aeruginosa	- - - -
Escherichia coli	- - - -
Staphylococcus aureus	19.93±0.12
Candida alblican	20.00± 0.00
Bacillus spp	- - - -
Aspergillus niger	24.87±0.12

- (Zone of resistance), Mm(millimetre)

Table 8: Antimicrobial susceptibility test results for flavonoid, ethyl acetate extract

Pathogenic micro-organism	Zones of clearance (mm)	Mean
Pseudomonas aeroginosa	54.93±0.12	54.98
Escherichia coli	48.00± 0.00	48.0
Staphylococcus aureus	40.06± 0.12	40.06
Bacillus spp	50.07±0.06	50.03
Candida alblican	50.07±0.12	50.06
Aspergillus niger	42.00±0.00	42.0

Table 9**:** Antimicrobial susceptibility pattern (Tannins, ethyl acetate extract fraction)

Microorganism	Clearance Zone (mm)	Mean
Pseudomonas aeruginosa	- - - -	
Escherichia coli	- - - -	
Staphylococcus aureus	- - - -	
Bacillus spp	24.97 ±0.06	
Candida albicans	- - - -	
Aspergillus niger	- - - -	

3.5 Antimicrobial Activity

The antimicrobial activities of the phytochemical fractions against selected bacterial and fungal isolates are summarised in Tables 7- 9. The saponin fraction exhibited inhibitory activity against *Staphylococcus aureus* (19.93±0.12mm), *Candida albicans* (20.00+0.00 mm), and *Aspergillus niger* (24.87±0.12 mm) but showed no detectable activity against *Pseudomonas aeruginosa* (00.00±0.00mm), *Eschericia coli* (00.00±0.00mm) and *Bacillus spp* (00.00 ± 0.00mm). The flavonoid – ethyl acetate fraction demonstrated the greatest antimicrobial activity against all tested microorganisms. The highest inhibition zone was recorded against *Pseudomonas aeruginosa* (54.93± 0.12 mm), *Bacillus spp*. (50.07±0.06 mm), *Escherichia coli* (48.00± 0.00mm), *Aspergillus niger* (42.00±0.00 mm), Candida albicans (50.07±0.12mm) and *Staphylococcus aureus* (40.06 ± 0.12mm). In contrast, the tannin fraction displayed selective antimicrobial activity, producing inhibition only against *Bacillus spp*. (24.97 ±0.06mm), while the remaining test organisms showed resistance under the experimental conditions.

The crude extracts compared with the control, showed significant differences, possibly because the active compounds were not isolated. Consequently, the crude extracts may have contained other constituents that influenced the observed activity. The crude extracts also showed some degree of inhibition against the clinical isolates of the microorganisms. All statistical tests were conducted at P= 0.05 (95% confidence level).

3.6 GC-MS Analysis

Gas chromatography-mass spectrometry analysis identified several bioactive constituents in the flavonoid–rich fraction. The major compounds detected included quercetin, catechin, oleic acid, camphor, phytol, resorcinol, phenylcyanamide, anisole, fumaric acid, and triacontane. Quercetin exhibited the highest relative abundance among the identified constituents, indicating that flavonoids constitute a major chemical component of the extract, as presented in Table 10.

Table 10: Result for GC MS analysis of flavonoid extract of *Gongronema latifolium(utazi).*

Retention Time	Compound	Mol.formula	Mol.weight g/mol	Peak Area	Concentration (mg/l).
17.621	Quercetin	$C_{15}H_{10}O_7$	302.236	12.10	12.10
23.602	Catechin	C15H1406	209.271	2.14	2.14
19.915	Oleic acid	C18H34O2	282.460	264	2.26
15.144	Camphor	C18H16O	152.23	108	1.66
20.970	Phytol	C20H40O	296.53	71	-
6.0-12.0	Resorcinole	C6H6O2	110.11	110	-
4.0-9.0	Phenylcyanamide	C7H6N2	118	76	-
3.0-6.0	Anisole	C7H80	108	77	-
2.0-5.0	Fumaric acid	C4HO4	116	-	-
15.565	Triacontane	C30H62	422.80	55	-

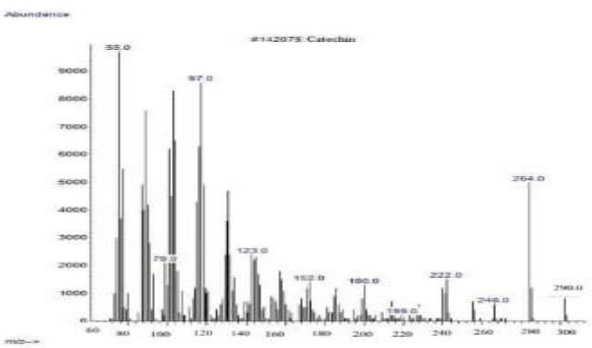

Fig. 1: Quercetin mass spectrum. The most intense peak in the mass spectrum of the quercetin flavonoid at m/z is 73^{+}. The mass number for this compound is 302.236 g/mol

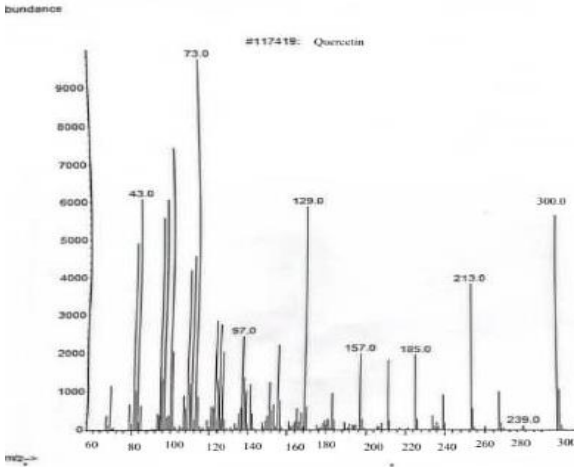

Fig. 2: Catechin mass spectrum. The most intense peak in the mass spectrum of Catechin flavonoid at m/z is 55^{+}. The mass number for this compound is 290.271g/mol.

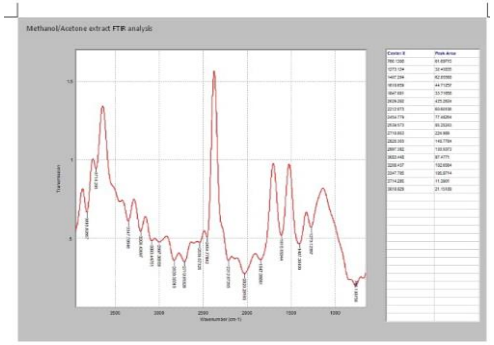

Fig. 3: FTIR Chromatogram

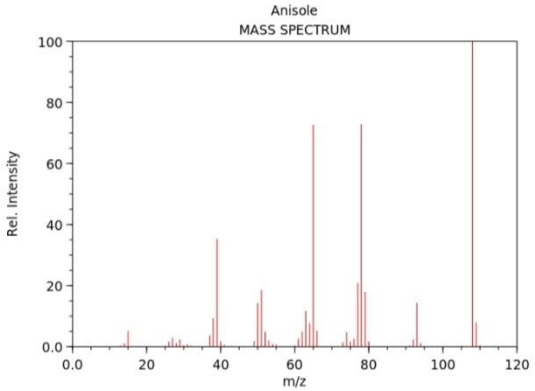

Fig. 4: Anisole mass spectrum**;** Anisole shows a m/z of 108^{+}

3.7 FTIR Analysis

The FTIR spectrum of the flavonoid fraction revealed characteristic absorption bands corresponding to hydroxyl (O-H), aromatic carbon-carbon (C=C), and ester (C-O) functional groups. Prominent absorption peaks were observed near 3400cm$^{-1,}$ 1600 cm$^{-1,}$ 1475 cm^{-1} and 1000-1300cm^{-1}, confirming the presence of phenolic, aromatic, and ester-containing phytochemicals in the extract as presented in FIG. 3. FTIR result for flavonoid extract of *Gongronema Latifolium* (utazi).

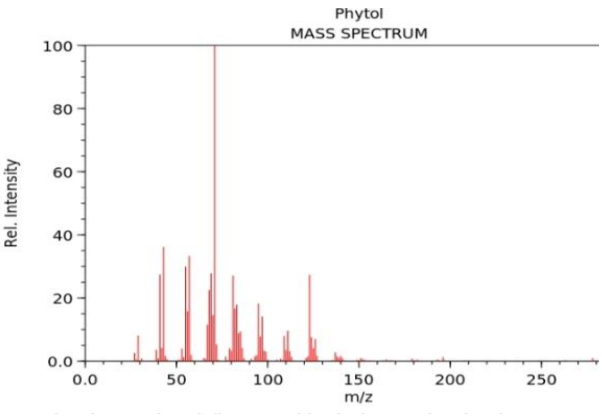

Fig. 5: Phytol mass spectrum; Phytol shows a m/z of 296^{+}

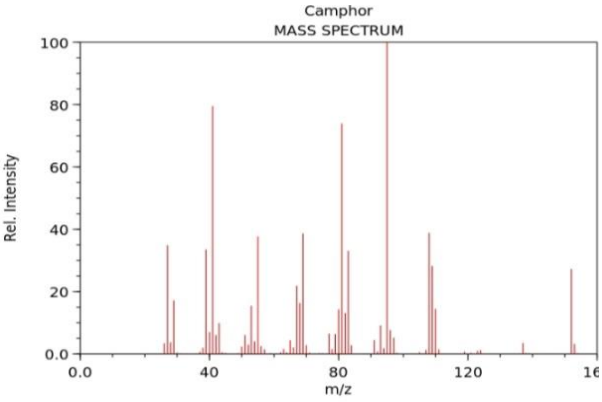

Fig. 6: Camphor mass spectrum; Camphor shows a m/z of 95^{+} and 100^{+}

4. **Discussion**

This study provides a comprehensive physicochemical, phytochemical, antimicrobial, and spectroscopic evaluation of Gongronema latifolium leaves, demonstrating their potential as a source of bioactive compounds for pharmaceutical applications. The findings support the plant's extensive traditional use and provide scientific evidence of its nutritional and therapeutic importance. The proximate analysis showed that *Gongronema latifolium* contains appreciable amounts of moisture, carbohydrates, lipids, proteins, fibre, and ash. The relatively high moisture content suggests that the fresh leaves are highly perishable and therefore require appropriate preservation methods after harvest. Conversely, the considerable carbohydrate content indicates that the plant contributes to dietary energy, while its protein and fibre contents enhance its nutritional value. The ash content reflects the presence of essential mineral elements required for normal physiological functions. These findings are consistent with previous reports describing *Gongronema latifolium* as a nutritionally valuable leafy vegetable commonly consumed in West Africa. Mineral analysis +- revealed that iron was the predominant element detected in the leaf samples, followed by magnesium, copper, zinc, cobalt, and cadmium. The high iron concentration suggests that regular consumption of *Gongronema latifolium* may contribute to haemoglobin synthesis and help reduce the risk of iron-deficiency anaemia. Magnesium and zinc are essential cofactors in numerous enzymatic reactions and play important roles in immune function, cellular metabolism, and bone health. The relatively low concentration of cadmium, a potentially toxic heavy metal, indicates that the plant is unlikely to pose significant toxicological concerns under the conditions investigated. Qualitative and quantitative phytochemical analysis confirmed that flavonoids and alkaloids were the dominant secondary metabolites present in the extracts, whereas Saponins and oxalates occurred in moderate amounts. Smaller quantities of tannins, terpenoids, phenols, phytates, cyanides, reducing sugars, and phlobatannins were also detected. These findings agree with earlier investigations reporting that *Gongronem latifolium* is rich in phytochemicals possessing

antioxidant, anti-inflammatory, antimicrobial, antidiabetic, and cardioprotective activities (Morebise *et al*., 2002). The diversity of phytochemical constituents identified in the present study supports the widespread ethnomedicinal applications of the plant. Among the phytochemical fractions evaluated, the flavonoid-rich ethylacetate fraction exhibited the highest antimicrobial activity against all tested bacterial and fungal isolates Morebise & Fafunsho, 1998). The large inhibition zones observed against *Pseudomonas aeruginosa, Escherichia coli*, *Staphylococcus aureus, Bacillus spp., Candida albicans*, and *Aspergillus niger* indicate broad-spectrum antimicrobial activity Ogunwande *et al*., 2005; Eleyinmi, 2007). In contrast, the saponin and tannin fractions displayed more selective inhibitory effects (Nwinyi *et., al 2008).* These observations suggest that flavonoids are likely the principal compounds responsible for the antimicrobial activity of *Gongronema latifolium* (Eze *et al*., 2021). Flavonoids are known to disrupt microbial cell membranes, inhibit nucleic acid synthesis, interfere with energy metabolism, and suppress essential microbial enzymes, thereby contributing to their broad-spectrum antimicrobial effects.

Gongronema latifolium (Utazi) exhibits a higher overall inhibitory effect and larger maximum zones of antimicrobial inhibition compared to *Jatropha curcas* leaf extracts, particularly when using methanol extraction. Comparative experimental data on clinical bacterial isolates (*Escherichia coli*, *Staphylococcus aureus*, and *Salmonella typhi*) demonstrate distinct differences between the two plants. (Alaebo *et al*.,2023). GC-MS analysis further confirmed the presence of several biologically active compounds, including quercetin, catechin, oleic acid, phytol, camphor, resorcinol, anisole, fumaric acid, phenylcyanamide, and triacontane. Quercetin, the predominant compound identified, is a well- established flavonoid with potent antioxidant, anti-inflammatory, antiviral, and antimicrobial properties. Catechin is similarly recognised for its antioxidant and cardioprotective activities, whereas phytol and oleic acid have been associated with antimicrobial and anti-inflammatory effects (Morebise *et al*., 2002). The combined presence of these bioactive constituents may explain the significant biological activity observed in the pharmaceutical potential of the plant extract. The crude extracts, compared with the control, showed significant differences, possibly because the active compounds were not isolated. Consequently, the crude extracts may have contained other constituents that influenced the observed activity. The crude extracts also showed some degree of inhibition against the clinical isolates of the microorganisms. All statistical tests were conducted at P= 0.05 (95% confidence level).

The FTIR spectra revealed characteristic absorption bands corresponding to hydroxyl, aromatic carbon-carbon, and ester functional groups. These functional groups are characteristic of phenolic compounds, flavonoids, and other oxygenated phytochemicals that contribute to antioxidant and antimicrobial activities Morebise & Fafunsho, 1998). The spectroscopic findings therefore corroborate the GC-MS results and further confirm the chemical complexity of the flavonoid–rich fraction.

Conclusion

This study successfully evaluated the physicochemical characteristics, mineral composition, phytochemical constituents, antimicrobial activity, and chemical profile of *Gongronema latifolium* (Utazi) leaves using standard analytical and spectroscopic techniques. The results demonstrated that the leaves are rich in nutritionally important components, including carbohydrates, lipids, proteins, fibre, and essential minerals, particularly iron, highlighting their value as both a food source and a medicinal plant. Phytochemical screening revealed the presence of several biologically active secondary metabolites, with flavonoids and alkaloids occurring in the highest concentrations. The

flavonoid-rich ethyl acetate fraction exhibited remarkable broad-spectrum antimicrobial activity against both bacterial and fungal pathogens, suggesting that flavonoids are the principal contributors to the antimicrobial properties of the plant. GC-MS analysis identified several pharmacologically important compounds, including quercetin, catechin, oleic acid, phytol, camphor, resorcinol, phenylcyanamide, anisole, fumaric acid, and triacontane, while FTIR analysis confirmed the presence of characteristic hydroxyl, aromatic, and ester functional groups associated with these bioactive constituents. Collectively, these findings provide scientific evidence supporting the traditional medicinal use of *Gongronema latifolium* and demonstrate its considerable potential as a source of bioactive compounds for pharmaceutical and nutraceutical applications. The study contributes to the growing body of evidence that medicinal plants represent valuable reservoirs of natural therapeutic agents. *Gongronema latifolium* should therefore be considered a promising candidate for further drug discovery, phytopharmaceutical development, and functional food applications.

Recommendations.

Based on the findings of this study, the following recommendations are proposed:

The major bioactive compounds identified by GC-MS, particularly quercetin and catechin, should be isolated and purified to evaluate their individual pharmacological activities. Molecular docking and molecular dynamics studies should be conducted to investigate the interactions of the identified compounds with relevant therapeutic targets involved in infectious and inflammatory diseases. *In vivo* pharmacological studies and toxicological evaluations should be undertaken to establish the efficacy, safety, and therapeutic dosage of the active constituents before clinical application.

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