



## The Phytochemical Composition and Antimicrobial Activities of the Solvent Fractions of the Fruits and Stem Bark of *Sarcocephalus latifolius* (Sm.) E.A. Bruce

Imah-Harry JU<sup>1\*</sup>, Obinna PM<sup>2</sup> and Alor OO<sup>3</sup>

<sup>1</sup>Department of Natural Sciences, Faculty of Pure and Applied Sciences, Precious, Cornerstone University, Ibadan, Nigeria

<sup>2</sup>Laboratories for Biomembrane Research and Biotechnology Department of Biochemistry, College of Medicine, University of Ibadan, Nigeria

<sup>3</sup>Department of Pharmaceutical Chemistry, Faculty of Pharmacy, University of Ibadan, Nigeria

\*Corresponding Author: Imah-Harry JU, Department of Natural Sciences, Faculty of Pure and Applied Sciences, Precious, Cornerstone University, Ibadan, Nigeria.

DOI: 10.31080/ASPS.2026.10.1269

Received: January 23, 2026

Published: March 27, 2026

© All rights are reserved by Imah-Harry JU, et al.

### Abstract

Medicinal plants have been the cornerstone in folklore medicine practices since Neolithic, providing a wealth of magic molecules with therapeutic properties, in the prevention and management of various health conditions. *Sarcocephalus latifolius* (Sm.) E.A. Bruce (SL) is used in folkloric medicine for the treatment of a number of ailments including malaria, CVDs, cancer amongst others, however, this assertion is not supported by empirical evidence. The study assessed the phytochemical composition and antimicrobial activities of the solvent fractions of the fruits and stem bark of SL. These plant parts were harvested, washed, air-dried, pulverised and soaked in 100% methanol to obtain the crude methanol extracts (CMESL and CMESBSL). These were partitioned successively between n-hexane, chloroform, ethyl acetate and methanol to obtain their respective fractions, N-hexane (HFSL and HFSBSL), chloroform (CFSL and CFSBSL), ethyl acetate (EFSL and EFSBSL), and the methanol (MFSL and MFSBSL).

These extracts and fractions were subjected to qualitative and quantitative assays to evaluate their phytochemical composition and antimicrobial profile was done using typed bacteria and fungi strains. The solvent fractions obtained from the fruit and stem bark of *Sarcocephalus latifolius* were evaluated for their growth-inhibitory effects against Gram-positive bacteria, Gram-negative bacteria, and fungal species using the agar cup diffusion technique. Results of the phytochemical screening revealed that both fruit and stem bark extracts are phytochemical rich containing flavonoids, alkaloids, saponnins among others. It was observed that both crude and solvent fractions of the fruits and stem bark exhibited great bactericidal and fungicidal activity. For the minimum inhibition concentration (MIC) and Minimum bactericidal/ fungicidal concentration (MBC/ MFC) results, there seemed to be a synergistic activity between CFSL and EFSL, but CFSL revealed a higher antimicrobial potency. In conclusion, this validates the use of SL in traditional medicine and it might contain bioactive compounds that are rich sources of phytochemicals and antimicrobial agents.

**Keywords:** Medicinal Plants; *Sarcocephalus latifolius*; Phytochemical; Antimicrobial; Minimum Inhibition Concentration; Minimum Bacteriocidal Concentration

## Introduction

According to the World Health Organization, traditional medicine encompasses the collective knowledge, skills, and practices rooted in the beliefs, experiences, and theories of different cultures, whether scientifically explained or not, and applied in promoting health and in preventing, diagnosing, managing, or treating physical and mental disorders [1]. Traditional complementary medicine, on the other hand, continues to thrive in Nigeria, as it does in other African and Asian countries. Medicinal plants have been used for the management of various diseases since antiquity, and the therapeutic application of plant extracts gained considerable popularity in the late 1990s. Interestingly, plants continue to play a vital role as sources of drugs, especially in developing countries where new medicinal agents are actively being identified [2,3].

The medicinal properties present in plants perform an increasingly significant role in a lot of industries including the food and pharmaceutical industries due to their functions on disease prevention and management [4]. The reliance of not less than 80% of the African populace on medicinal plants for healthcare needs [5] has drawn the attention of research in recent times towards the study of these plants used traditionally in the management of several ailments and diseases in Africa (Nigeria inclusive). Furthermore, several reports have shown that these Nigerian medicinal plants have very potent bioactive compounds (phytochemicals), and have exhibited antioxidant [6], antimicrobial [7], and anticancer [8-10] activities among others. In fact, medicinal plants are considered a gift from nature [11]. These phytochemicals, which function as a natural protective machinery for host plants, while offering color, aroma and flavor are naturally occurring, non-nutritive physiologically dynamic biochemical compounds in medicinal plants loaded with a lot of health benefits [12].

The alarming rate of antibiotic resistance by pathogenic organisms in Africa has tremendously increased in recent times. It has been reported that multi-drug-resistant bacteria and fungi is the major cause of hospitalization, drug failure and increased mortality in the general populace [13]. Infectious diseases and antimicrobial resistance have unceasingly been identified as one of the most serious threats to world health [14]. Phytochemicals also called natural magic molecules (NMMs) present in several plant parts, have been linked to their ability to suppress the growth of pathogenic microbes causing many diseases or infections. In

addition, understanding the molecular mechanism of action of how each phytochemical inhibit the pathogenic protein is important [15]. Most importantly, plant extracts represent a continuous effort to find new compounds with the potential to act against multi-resistant bacteria [16].

Plant extracts are of particular interest due to the ongoing search for novel compounds capable of combating multi-drug-resistant bacteria [16]. Medicinal plants are classified based on the distribution of their active constituents within specific storage organs such as roots, leaves, flowers, seeds, and other plant parts. These bioactive compounds are of significant therapeutic value in disease management [17]. Additionally, Quinlan reported that medicinal properties may be obtained from various plant parts, including fruits, leaves, roots or stem bark, flowers, and seeds. Notably, different parts of the same plant may contain distinct bioactive substances hence, one part of a plant might be potent and non-toxic while another portion will exhibit potency with high toxicity [17]. Most studies report dose-dependent antimicrobial effects, with activity varying by solvent polarity and microbial species. Non-polar (e.g., chloroform) and intermediate polarity fractions often show higher zones of inhibition than aqueous fractions, indicating the presence of more potent antimicrobial compounds in those fractions.

*Sarcocephalus latifolius* [Synonyms: *Nauclea esculenta*, *Nauclea latifolia*, *Sarcocephalus esculentus*, *Sarcocephalus russeggeri*].

*Sarcocephalus latifolius* (synonym *Nauclea latifolia*) is a medicinal shrub/tree traditionally used in African folk medicine to treat infections (e.g., diarrhea, malaria, typhoid), pain, and other ailments, often attributed to its rich phytochemical profile. It is known by various local and regional names, including African cinchona, African peach, African quinine, country fig, Doundake or Dundaki (Hausa, Nigeria), Egbesi or Ogbesi (Yoruba, Nigeria), and Ubuluinu (Igbo, Nigeria) [10]. Additional names include Guinea peach, 'Igbeshi' (Sierra Leone), "Liane à fraise" or "Pêcher africain" (French), *Nauclea*, "Negro peach", "peach root", "pincushion fruit" or tree, "Rata-bakmi" (Singhalese), Sierra Leone "peach", and "strawberry tree", reflecting its wide distribution across West Africa. The fleshy, warty fruits (Figure 1a and b), with a sweet, apple-like flavor are commonly consumed, while the flower heads are used as vegetables in local markets.

Medicinally, the root and stem bark (Figure 2) have been effectively used in the management of several ailments in Africa. *Sarcocephalus latifolius* has traditionally been employed in the treatment of pyrexia and febrile conditions, particularly malaria, as well as jaundice, dysentery, diarrhea, and indigestion. Its root and stem bark are also used in the preparation of health tonics and as cleansing agents for oral ailments. In the Democratic Republic of the Congo, the plant is utilized in diabetes management, while in Nigeria its twigs are commonly used as chewing sticks and toothbrushes [18]. *S. latifolius* fruit and stem bark extract has been reported to exhibit antimicrobial activities however, there was no available scientific report to substantiate this claim.



**Figure 1 a, b & 2:** Full-blown Fruits Hanging on a Fully Grown Shrub Prior Harvest, Post Harvested Matured Fruits Stacked After Collection and Stem-bark of *Sarcocephalus latifolius* (SMITH) Bruce, at Iddo L.G.A. Oyo State, Nigeria (Original pictures taken at Oyo town, November 2024).

### Mechanism and bioactive components

While exact active molecules are often not fully isolated, the antimicrobial activity is typically attributed to the following classes of phytochemicals: Flavonoids – membrane disruption, enzyme inhibition, Phenolics and tannins – protein binding, microbial cell wall disruption, Alkaloids and terpenoids – interference with microbial growth pathways. These mechanisms are consistent with general phytochemical bioactivity knowledge.

This study aims at addressing this by identifying and classifying the secondary metabolites (phytochemical composition) and the antimicrobial activities in the solvent fractions of the fruits and stem bark of *Sarcocephalus latifolius* SMITH (Bruce) plant, towards the innovation and discovery of prospective origin of new antimicrobial agents. To date, there is no documentation according

to literature on the comparative evaluation of the phytochemical composition and antimicrobial activities of various plant parts of *Sarcocephalus latifolius*.

### Materials and Methods

#### Reagents and organic solvents used

Organic solvents and reagents used for extraction and the vacuum liquid chromatography to get the solvent fractions (Sigma-Aldrich Chemical) were of a high analytical grade.

#### Plant material collection and authentication

Fresh, mature fruits and stem bark of *Sarcocephalus latifolius* (Smith) Bruce were collected during the dry season (November–December 2024) from forested areas and adjoining forest paths in Eruwa, Iddo Local Government Area, Oyo State, Nigeria. The stem bark was harvested from a single shrub, while fruits were collected from several shrubs in small batches. Botanical identification and authentication were carried out at the Forestry Research Institute of Nigeria (FRIN), Ibadan, where three whole-plant specimens were examined and voucher number FHI 110092 was assigned to the fruit sample. The stem bark was independently authenticated at the Department of Botany, University of Ibadan, and assigned voucher number UIH 23096. Voucher specimens were deposited in the Herbarium of the Department of Pharmacognosy, University of Ibadan, for future reference.

#### Preparation of crude methanolic extract

The collected fruits and stem bark were thoroughly washed with distilled water and air-dried at room temperature. The dried materials were separately pulverized into fine powder using a mortar and pestle. Each powdered sample (50 g) was macerated in 500 mL of absolute methanol (Sigma-Aldrich, St. Louis, USA) for 72 h with intermittent stirring. The mixtures were filtered through Whatman No. 1 filter paper, and the filtrates were concentrated under reduced pressure at 40 °C using a rotary evaporator (Stuart Rotavapor, UK). The resulting extracts yielded a dark brown residue for the fruit and a black residue for the stem bark. Final drying was carried out in a water bath at 37°C for four days to ensure complete removal of residual solvent. The percentage yield were calculated and the crude methanol extracts (CMESL and CMESBSL) was freeze-dried using the lyophilizer and stored at 4°C. This was used to obtain N– Hexane (HFSL, HFSBSL), chloroform (CFSL, CFSBSL),

ethyl acetate (EFSL, EFSBSL), and the methanol (MFSL, MFSBSL) fractions using VLC technique and the antithetic solvents systems in an acceleratory polarity order.

### Phytochemical composition

Preliminary qualitative phytochemical analyses were carried out on the test samples using standard procedures as described by [19], to detect the presence of major secondary metabolites.

### Test for anthraquinones

Approximately 0.5 g of each sample was boiled with 10 mL of dilute sulfuric acid ( $H_2SO_4$ ) and filtered while hot. The filtrate was shaken with 5 mL of chloroform, after which the chloroform layer was transferred into a separate test tube. One millilitre of dilute ammonia solution was added, and the development of a color change was taken as an indication of the presence of anthraquinones.

### Test for terpenoids

About 0.5 g of the sample was dissolved in 2 mL of chloroform, followed by the careful addition of 3 mL of concentrated sulfuric acid along the side of the test tube to form a distinct layer. The appearance of a reddish-brown coloration at the interface indicated a positive result for terpenoids.

### Test for flavonoids [20]

Five millilitres of dilute ammonia solution was added to the sample in a test tube, followed by the gradual addition of 1 mL of concentrated sulfuric acid. The formation of a yellow coloration that disappeared on standing was considered indicative of flavonoids.

### Test for saponins

A quantity of 0.5 g of the sample was added to 5 mL of distilled water and shaken vigorously. The formation of a stable and persistent froth was observed as a preliminary indication of saponins. Confirmation was carried out by adding three drops of olive oil and observing the gradual formation of an emulsion.

### Test for tannins

The sample (0.5 g) was boiled in 10 mL of distilled water and filtered through Whatman No. 1 filter paper. A few drops of 0.1% ferric chloride ( $FeCl_3$ ) solution were added to the filtrate, and the development of a brownish-green coloration indicated the presence of tannins.

### Test for alkaloids

Approximately 0.5 g of the sample was boiled in 10 mL of acidified alcohol and filtered. To 5 mL of the filtrate, 2 mL of dilute ammonia solution and 5 mL of chloroform were gently added. The chloroform layer was separated and treated with 10 mL of acetic acid, followed by the addition of a few drops of Dragendorff's reagent. The formation of an orange or reddish-brown precipitate was considered a positive test for alkaloids.

### Test for cardiac glycosides

Approximately 0.5 g of each sample was dissolved in 5 mL of distilled water. To this, 2 mL of glacial acetic acid containing a few drops of ferric chloride solution was added. Subsequently, 1 mL of concentrated sulfuric acid was carefully introduced along the wall of the test tube. The appearance of a brown or violet ring at the interface was taken as evidence of the presence of cardiac glycosides.

### Quantitative phytochemical analysis

#### Determination of total flavonoid content (TFC)

Total flavonoid content was determined using the aluminum chloride colorimetric assay as described by [21] and [22] with slight modifications. An aliquot of 0.3 mL of the crude methanolic extract of *Sarcocephalus latifolius* (CMESL) and its solvent fractions was mixed with 3.4 mL of 30% methanol and 0.15 mL of aluminum chloride solution (0.3M). After incubation for 5 min, 1.0 mL of sodium hydroxide (1M) was added, and the mixture was thoroughly mixed. Absorbance was measured at 560 nm using a UV-visible spectrophotometer. Quercetin served as the reference standard, and total flavonoid content was expressed as Quercetin equivalent antioxidant (QEA) in  $\mu\text{g/mL}$ , derived from a Quercetin calibration curve (16 mg/16 mL).

#### Determination of total phenolic content (TPC)

The total phenolic content of the crude methanolic extracts of *S. latifolius* fruit (CMESL), stem bark (CMESBSL), and their solvent fractions was determined using the Folin-Ciocalteu method as described by [23]. Briefly, 0.1 mL of each sample was diluted with 0.9 mL of distilled water, followed by the addition of 0.1 mL of 0.1% (v/v) Folin-Ciocalteu reagent. After 5 min, the reaction was neutralized with 0.1 mL of 7% sodium carbonate solution and 0.4 mL of distilled water. The mixture was incubated in the dark at 25 °C for 90 min, after which absorbance was recorded at 750 nm.

Gallic acid was used as the standard, and results were expressed as Gallic acid equivalents (GAE).

#### Determination of total saponin content (TSC)

Total saponin content of CMESL, CMESBSL, and their respective solvent fractions was quantified using the vanillin-sulfuric acid colorimetric method as described by [19]. Approximately 0.25 g of each sample was weighed into a test tube and mixed with 5 mL of distilled water. The mixture was vigorously shaken and allowed to stand for 1 h to ensure complete extraction. Thereafter, 1 mL of the extract was transferred into another test tube containing 5 mL of distilled water. To this, 0.5 mL of 8% vanillin solution was added, followed by 5 mL of 72% sulfuric acid. The mixture was incubated in a water bath at 60°C for 10 min and subsequently cooled in an ice bath. Absorbance was measured at 544nm using a spectrophotometer. The quantity of saponins in the CMESL, CMESBSL and other fractions was thus calculated using the equation:

$$Ps = (Ab \times S \times Df) \times 100 \text{ (mg g}^{-1} \text{ /saponin)}$$

Where Ps is the percentage of saponin, Ab is the absorbance of samples at 620nm,

S = slope of the standard curve

Df = dilution factor.

#### Determination of total tannin content (TTC)

Total tannin content of the crude methanolic extracts of *Sarcocephalus latifolius* fruit (CMESL), stem bark (CMESBSL), and their solvent fractions was determined using the ferric chloride-potassium ferrocyanide method as described by [24]. Briefly, 0.1 g of each sample was homogenized in 10 mL of distilled water in a test tube and vigorously mixed on a vortex mixer for 1h. The mixture was centrifuged at 3000rpm for 10 min, and 1.0 mL of the supernatant was transferred into a clean test tube. To this, 0.2 mL of 0.1M ferric chloride prepared in 0.1M hydrochloric acid and 0.008M potassium ferrocyanide solution were added. The reaction mixture was allowed to stand, and absorbance was measured at 670nm within 10 min. against a reagent blank containing distilled water. Tannin content was expressed as standard equivalents following calibration.

#### Qualitative test for alkaloids

Qualitative detection of alkaloids in CMESL, CMESBSL, and their solvent fractions was carried out using Mayer's and Dragendorff's reagents. Approximately 0.2g of each sample was dissolved in 4 mL of acidified alcohol (ethyl acetate) and heated to boiling. After cooling, the mixture was filtered, and 2 mL of the filtrate was treated with 1 mL of dilute ammonia solution, followed by the addition of 5 mL of chloroform with gentle mixing. The chloroform layer was separated and extracted with 10 mL of acetic acid. The resulting extract was divided into two portions: one treated with Mayer's reagent and the other with Dragendorff's reagent. The formation of a cream-colored precipitate with Mayer's reagent or a reddish-brown precipitate with Dragendorff's reagent indicated the presence of alkaloids.

#### Quantification of total alkaloid content (TAC)

Total alkaloid content of CMESL, CMESBSL, and their respective solvent fractions was determined using a spectrophotometric method based on sulfuric acid-formaldehyde reaction. Briefly, 0.1 g of each sample was dissolved in a mixture of 96% ethanol and 20% sulfuric acid (1:1, v/v) and filtered. An aliquot (1.0 mL) of the filtrate was transferred into a clean test tube and mixed with 5.0 mL of 60% sulfuric acid. After 5 min, 5.0 mL of 0.5% formaldehyde prepared in 60% sulfuric acid was added. The reaction mixture was allowed to stand at room temperature for 3h for color development. Absorbance was subsequently measured at an appropriate wavelength against a reagent blank, and alkaloid content was calculated using a standard calibration curve and expressed as alkaloid equivalents. The absorbance was read at 568nm. A sample of "Pure alkaloid" was used as standard and were similarly treated and used in plotting a standard alkaloid curve.

#### Microbiological screening of plant extracts and solvent fractions

##### Collection of the microbial sample and culture preparation

All the organisms tested were mostly typed bacteria/fungal strains/species. *Escherichia coli* G<sup>-</sup> (ATCC 8739), *Pseudomonas auriginosa* G<sup>-</sup> (ATCC 15442), *Staphylococcus aureus* G<sup>+</sup> (ATCC 6538), *Bacillus subtilis* G<sup>+</sup> (ATCC 14884), *Klebsella sp.* G<sup>-</sup> (ATCC 10702) and *Salmonella typhimurium* G<sup>-</sup> (ATCC 29930), *Aspergillus niger* (ATCC 27853), *Rhizopus stolonifer*, *Tricoptyton interdigitalis* and *Candida albicans* (ATCC 10231) strains were purchased from

the American Type Culture Collection (ATCC, Manassas, VA, USA). Gentamicin and Tioconazole (70%) were bought from Sigma Co (St Louis, MO, USA).

### Sterilization of working materials

All petri dishes and pipettes used for this assay, were properly washed with cleansing agent (Ariel), rinsed with running tap water and finally with distilled water and wrapped with aluminum foil prior sterilization at 100°C for about an hour using a hot air oven in a standard microbiology laboratory. The benches in the laboratory were cleaned with 70% alcohol beforehand and afterwards each investigation.

### Culture preparation

The culture media used in the assay were purchased in dry form. The Muller Hinton agar (MHA), (Oxide, England) medium was made by weighing out and mixing 38g of the MHA in 1 litre of distilled H<sub>2</sub>O, and the resulting suspension was then sterilized by autoclave at 121°C for fifteen minutes.

### Antimicrobial sensitivity assay (Agar-Cup Diffusion Method)

The antimicrobial activity of the extracts was evaluated using the agar-cup diffusion method as described by [25] and modified by [26]. Overnight broth cultures of the test microorganisms were prepared, and 0.5 mL of each culture was aseptically inoculated into appropriate volumes of sterile, molten, and cooled Mueller-Hinton agar (Oxoid). The inoculated agar was thoroughly mixed, poured into sterile 14 cm Petri dishes, and allowed to solidify. Six equidistant wells were bored into the solidified agar using a sterile stainless-steel cork borer (7 mm diameter). The plates were inverted, and the wells were appropriately labeled. Aliquots (40 µL) of the extracts at concentrations of 5, 10, and 20 mg/mL were introduced into the respective wells. The plates were allowed to stand at room temperature for 1h to facilitate diffusion of the extracts, followed by incubation at 37 °C for 24h. The procedure were tested against four fungi (*Aspergillus niger*, *Rhizopus stolonifer*, *Penicillium chrysogenum* and *Candida albicans*). Tioconazole (1%) was utilized as the comparative standard drug for fungal activities. The dishes seeded with bacteria were incubated at 37°C for twenty-four hours and other plates seeded with fungi were incubated at 28°C for five days.

Following incubation, the diameters of the zones of inhibition were measured in millimeters. All assays were performed in

duplicate. Gentamicin (10 µg/mL) was used as the positive control, while dimethyl sulfoxide (DMSO) served as the negative control.

### Determination of minimum inhibitory concentrations

The MIC was evaluated using the agar dilution technique of [27], with little alterations by [28]. The CMESL, CMESBSL and other fractions of SL at 20mg/mL were serially diluted in test tubes to provide a last concentration in the choice of 10.0, 5.0, 2.5 and 1.25 mg/mL.

The minimum inhibitory concentrations (MICs) of the extracts against each test microorganism were determined using a modified microtitre plate broth dilution method involving two-fold serial dilutions. Stock solutions of the extracts were prepared and serially diluted in dimethyl sulfoxide (DMSO) to obtain the desired working concentrations as previously described. Briefly, 10 µL of a 3 h-old broth culture of each test organism, grown in sterile nutrient broth at 37 °C, was aseptically dispensed into each well of a 48-well microtitre plate containing the diluted extracts. The plates were covered and incubated at 37 °C for 24 h for bacterial species and at 28°C for five days, for the fungi species. To provide reference MIC values for each test organism, appropriate control wells containing standard antimicrobial agents were included in each assay, while wells containing only dimethyl sulfoxide (DMSO) served as negative controls. Following incubation, the wells were examined for visible turbidity, the minimum inhibitory concentration (MIC) was defined and recorded as the lowest extract concentration that completely inhibited visible growth of the bacterial or fungal organism after incubation, when compared with the control wells.

### Determination of minimum bactericidal and fungicidal concentrations (MBC/MFC)

The minimum bactericidal concentration (MBC) and minimum fungicidal concentration (MFC) of the extracts were determined following the method described by [29]. After MIC determination, all tubes or wells showing no visible microbial growth were selected for sub-culturing. Each clear tube was gently mixed using a sterile pipette to ensure homogeneity, and a 100 µL aliquot was aseptically withdrawn. The aliquots were inoculated onto antibiotic-free nutrient agar plates by streaking along the center of each plate. The inoculated plates were allowed to stand for approximately 30 min to permit absorption of the inoculum and drying of the agar surface. Thereafter, the inoculum was evenly

spread over the agar surface using a sterile cotton swab to obtain a uniform lawn culture.

The plates were incubated under appropriate conditions, and microbial growth was subsequently assessed. The MBC or MFC was defined as the lowest concentration of the extract that resulted in no visible growth on the agar plates, indicating complete bactericidal or fungicidal activity. This subculture technique has been widely employed in antimicrobial susceptibility studies and is effective in eliminating the carry-over effects of residual antimicrobial agents from the original test aliquots [30]. The growing and sterility controls were tested in the similar way. The minimum bacteriocidal concentration (MBC) evaluating lawned dishes were incubated for twenty-four hours at 37°C. At the lapse of this time, the minimum/least concentrations of the CMESL, CMESBSL and other fractions of SL that did not show any bacterial/fungal growth on the set media were selected and documented as the MBC values for each of the test samples [31]. This was further harmonized with the test tube noted for MIC that was void of any indication of growth after forty-eight hours of incubation as a confirmation.

### Statistical analysis

Statistical analysis was performed using SPSS Statistics software (version 20; SPSS Inc., Chicago, IL, USA). All experiments

were conducted in triplicate, and results were expressed as mean ± standard deviation (SD). Differences among groups were analyzed using one-way analysis of variance (ANOVA), followed by Duncan’s Multiple Range Test (DMRT) for post-hoc comparisons. Values of  $p < 0.05$  were considered statistically significant.

## Results

### Phytochemical screening of *Sarcocephalus latifolius* extracts

The percentage yield for the crude methanol extract of both fruits and the stem bark was 6.4% and 10% respectively.

These extracts and their solvent fractions were subjected to preliminary qualitative and quantitative testing for the presence of phytochemical compounds. The results designate that both the fruit and stem extracts along with their solvent fractions, are phytochemical rich (Table 1-4). This study reveals that the fruit and stem bark contains Anthraquinones, Terpenoids, Flavonoids, Alkaloids, Saponnins, Tannins, and cardiac glycosides depending on the solvent fractions from the crude methanol extract used for the analysis. It was also observed that the CFSL and EFSL possess all the above mentioned phytochemicals compared to the MFSL. On quantification of the phytochemicals identified in the fruits, CFSL was rich in flavonoids and phenolics, EFSL was rich in saponnins, while the MFSL was rich in alkaloids and tannins (Table 2).

Phytochemicals	Fractions for test				
	CMESL	HFSL	CFSL	EFSL	MFSL
Anthraquinones	+	+	+	+	+
Terpenoids	+	+	+	++	+
Flavonoids	+	+	++	+	-
Alkaloids	+	+	+	+	+
Saponnins	++	-	+	++	+
Tannins	+	-	+	+	+
Cardiac Glycosides	+	-	+	+	-

**Table 1:** Phytochemical Screening of the Crude and All the Solvent Fractions of the fruit of SL.

Key: CMESL- Crude methanol extract, HFSL- Hexane fraction, CFSL- Chloroform fraction, EFSL- Ethyl acetate fraction, MFSL- Methanol fraction of the fruits of *Sarcocephalus latifolius*.

Secondary metabolites	Equivalent amount in CFSL	Equivalent amount in EFSL	Equivalent amount in MFSL
Total flavonoid	*1.990 QUE mg/g	0.041 QUE mg/g	0.021 QUE mg/g
Total phenolic	*0.078 GAE mg/g	0.052 GAE mg/g	0.020 GAE mg/g
Tannins	0.069 mg/g	0.063 mg/g	*0.114 mg/g
Saponnins	0.015 mg/g	*0.214 mg/g	0.024 mg/g
Alkaloid	0.014 mg/g	0.015 mg/g	*0.368 mg/g

**Table 2:** Quantitative Analysis of CFSL, EFSL and MFSL.

KEY: \*indicates the fraction containing the highest amount of the concerned secondary metabolite. CFSL was rich in flavonoids and phenolics, EFSL was rich in saponnins, while the MFSL was rich in alkaloids and tannins.

The phytochemical screening of the stem bark of *Sarcocephalus latifolius* plant extract and its respective solvent fractions revealed presence of secondary metabolites, like anthraquinone, terpenoids, saponins, tannins, alkaloids, cardiac glycosides in antithetic strength as earlier mentioned. Additionally, on quantification of

the identified phytochemicals, CFSBSL was observed to be rich in alkaloids and terpenoids, EFSBSL and MFSBSL was very rich in flavonoids, while the CMESBSL was observed to be rich in saponnins (Table 4).

Phytochemicals	Fractions for test				
	CMESBSL	HFSBSL	CFSBSL	EFSBSL	MFSBSL
Anthraquinones	+	+	+	+	+
Terpenoids	+	+	+	+	++
Flavonoids	+	-	+	-	-
Alkaloids	+++	+	++	++	+
Saponnins	+	-	+	+	+
Tannins	+	-	+	+	+
Cardiac Glycosides	+	-	+	+	+

**Table 3:** Phytochemical Screening of the Extract and Solvent Fractions of the Stem Bark of SL.

Sample	% alkaloids content (%w/w)	% flavonoids content (%w/w)	% saponins content (%w/w)	% tannins content (%w/w)	% terpenoids content (%w/w)
CFSBSL	18.8	8.1	1.5	0.97	7.6
EFSBSL	3.0	14.6	5.4	0.95	2.1
MFSBSL	16.0	14.2	2.2	1.0	0.3
CMESBSL	1.0	9.4	7.8	0.95	0.5

**Table 4:** Summary of Results of Quantitative Phytochemical Screening of the Extract and Solvent Fractions of the Stem Bark of SL.

Additionally, while antimicrobial profile assay was done for extract and solvent fraction of both the fruit and stem bark, showed similar strength hence the antimicrobial strength of the fruit is portrayed in the tables (5-8) below.

EXTRACT at 20 mg/ml	CMESL 20 mg/ml	MFSL 20 mg/ml	CFSL 20 mg/ml	EFSL 20 mg/ml	AFSL 20 mg/ml	Gentamycin 10 µg/ml	1% Tioconazole
<i>Pseudomonas aeruginosa</i> ATCC 15442	17	6	18	16	15	36	-
<i>Escherichia coli</i> ATCC 8739	18	6	16	18	19	36	-
<i>Klebsella spp.</i> ATCC 10702	14	6	16	12	18	36	-
<i>Staphylococcus aureus</i> ATCC 6538	18	12	18	15	20	34	-
<i>Salmonella typhi.</i> ATCC 29930	17	6	18	10	20	38	-
<i>Bacillus subtilis</i> ATCC 14884	20	6	14	6	6	34	-
<i>Aspergillus niger</i>	16	6	6	6	6	28	-
<i>Rhizopus stolonifera</i>	18	6	24	14	6	26	-
<i>Penicillium chrysogenum</i>	14	6	6	24	18	26	-
<i>Candida albicans</i>	16	6	16	6	14	26	-

**Table 5:** Zone of Inhibition for Antimicrobial Activity at 20mg/ml of *Sarcocephalus latifolius* (SL) Fruit Extract.

Diameter (mm) of Zones of Inhibition of fractions on test organisms.

EXTRACT at 10 mg/ml	CMESL 10 mg/ml	MFSL 10 mg/ml	CFSL 10 mg/ml	EFSL 10 mg/ml	AFSL 10 mg/ml	Gentamycin 10 µg/ml	1% Tioconazole
<i>Pseudomonas aeruginosa</i> ATCC 15442	15	6	16	13	13	36	-
<i>Escherichia coli</i> ATCC 8739	16	6	15	15	17	36	-
<i>Klebsella spp.</i> ATCC 10702	12	6	14	10	16	36	-
<i>Staphylococcus aureus</i> ATCC 6538	14	6	14	14	18	34	-
<i>Salmonella typhi.</i> ATCC 29930	16	6	16	6	18	38	-
<i>Bacillus subtilis</i> ATCC 14884	14	6	14	12	14	34	-

<i>Aspergillus niger</i>	14	10	6	6	6	28	-
<i>Rhizopus stolonifera</i>	14	18	20	6	6	26	-
<i>Penicillium chrysogenum</i>	12	16	20	6	14	26	-
<i>Candida albicans</i>	14	10	14	6	12	26	-

**Table 6:** Zone of Inhibition for Antimicrobial Activity at 10mg/ml of *Sarcocephalus latifolius* (SL) Fruit Extract.

Diameter (mm) of Zones of Inhibition of fractions on test organisms.

Diameter of borer = 8 mm, negative control is DMSO (Dimethyl sulfoxide), Positive control is Gentamycin 10 µg/ml and for fungi 1% Tioconazole. No growth/ activity at the zone of inhibition is recorded as 6 mm.

EXTRACT at 5 mg/ml	CMESL 5 mg/ml	MFSL 5 mg/ml	CFSL 5 mg/ml	EFSL 5 mg/ml	AFSL 5 mg/ml	Gentamycin 10 µg/ml	1% Tioconazole
<i>Pseudomonas aeruginosa</i> ATCC 15442	14	6	6	6	12	36	-
<i>Escherichia coli</i> ATCC 8739	15	6	12	12	14	36	-
<i>Klebsella spp.</i> ATCC 10702	16	6	14	10	14	36	-
<i>Staphylococcus aureus</i> ATCC 6538	14	6	14	12	16	34	-
<i>Salmonella typhi</i> . ATCC 29930	14	6	14	6	16	38	-
<i>Bacillus subtilis</i> ATCC 14884	16	6	16	6	13	34	-
<i>Aspergillus niger</i>	6	6	6	6	6	28	-
<i>Rhizopus stolonifera</i>	6	14	12	6	6	26	-
<i>Penicillium chrysogenum</i>	6	6	12	6	6	26	-
<i>Candida albicans</i>	6	14	18	6	6	26	-

**Table 7:** Zone of Inhibition for Antimicrobial Activity at 5 mg/ml of *Sarcocephalus latifolius* (SL) Fruit Extract.

Diameter (mm) of Zones of Inhibition of fractions on test organisms.

Diameter of borer = 8 mm, negative control is DMSO (Dimethyl sulfoxide), Positive control is Gentamycin 10 µg/ml and for fungi 1% Tioconazole. No growth/ activity at the zone of inhibition is recorded as 6 mm.

EXTRACT at 2.5 mg/ml	CMESL 2.5 mg/ml	MFSL 2.5 mg/ml	CFSL 2.5 mg/ml	EFSL 2.5 mg/ml	AFSL 2.5 mg/ml	Gentamycin 10 µg/ml	1% Tioconazole
<i>Pseudomonas aeruginosa</i> ATCC 15442	13	6	12	10	6	36	-
<i>Escherichia coli</i> ATCC 8739	13	6	10	10	12	36	-
<i>Klebsella spp.</i> ATCC 10702	6	6	10	6	6	36	-
<i>Staphylococcus aureus</i> ATCC 6538	10	6	12	13	14	34	-
<i>Salmonella typhi.</i> ATCC 29930	12	6	12	6	6	38	-
<i>Bacillus subtilis</i> ATCC 14884	14	6	12	6	6	34	-
<i>Aspergillus niger</i>	6	12	6	6	6	28	-
<i>Rhizopus stolonifera</i>	6	6	6	6	6	26	-
<i>Penicillium chrysogenum</i>	6	10	6	6	6	26	-
<i>Candida albicans</i>	6	6	14	6	6	26	-

**Table 8:** Zone of Inhibition for Antimicrobial Activity at 2.5mg/ml of *Sarcocephalus latifolius* (SL) Fruit Extract.

Diameter (mm) of Zones of Inhibition of fractions on test organisms.

Diameter of borer = 8mm, negative control is DMSO (Dimethyl sulfoxide), Positive control is Gentamycin 10 µg/ml and for fungi 1% Tioconazole. No growth/ activity at the zone of inhibition is recorded as 6 mm.

The MIC and MBC/MFC for both bacteria and fungi species were accessed and the results were as revealed in the tables (9-10) below.

Organism type	CMESL (mg/ml)	MFSL (mg/ml)	CFSL (mg/ml)	EFSL (mg/ml)	AFSL (mg/ml)
<i>Bacillus subtilis</i> ATCC 14884	10	5	5	10	10
<i>Escherichia coli</i> ATCC 8739	10	5	5	10	10
<i>Klebsella sp.</i> ATCC 10702	5	2.5	10	5	5
<i>Pseudomonas aeruginosa</i> ATCC 15442	5	5	5	10	10
<i>Salmonella Typhimurium</i> ATCC 29930	2.5	5	10	2.5	2.5
<i>Staphylococcus aureus</i> ATCC 6538	5	5	5	2.5	2.5
<i>Aspergillus niger</i>	10	10	10	10	5
<i>Rhizopus stolonifera</i>	10	10	-	10	5
<i>Penicillium chrysogenum</i>	10	2.5	-	10	10
<i>Candida albicans</i>	5	2.5	10	5	2.5

**Table 9:** Minimum Inhibition Concentration for Bacteria and Fungi.

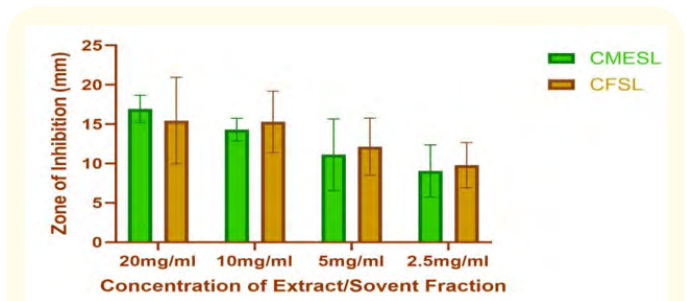
Organism type	CMESL (mg/ml)	MFSL (mg/ml)	CFSL (mg/ml)	EFSL (mg/ml)	AFSL (mg/ml)
<i>Bacillus subtilis</i> ATCC 14884	5	5	5	5	-
<i>Escherichia coli</i> ATCC 8739	5	5	5	5	-
<i>Klebsella spp.</i> ATCC 10702	20	-	10	-	-
<i>Pseudomonas aeruginosa</i> ATCC 15442	5	5	5	5	-
<i>Salmonella typhimurium</i> ATCC 29930	5	-	5	5	-
<i>Staphylococcus aureus</i> ATCC 6538	5	-	5	5	-
<i>Aspergillus niger</i>	20	20	20	10	10
<i>Rhizopus stolonifera</i>	20	10	20	10	10
<i>Penicillium chrysogenum</i>	20	10	20	10	20
<i>Candida albicans</i>	20	5	20	10	5

**Table 10:** Minimum Bactericidal Concentration (MBC) and Minimum Fungicidal Concentration (MFC).

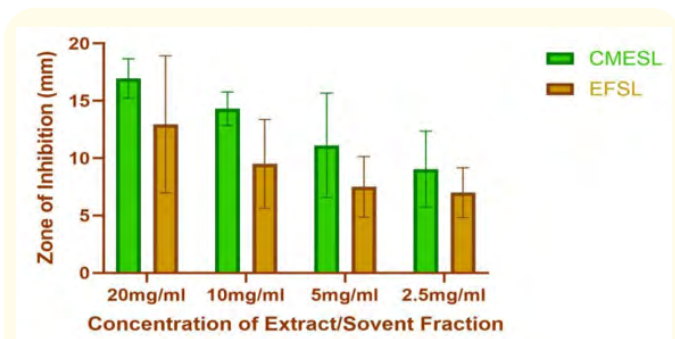
The results of the MIC reveal the outstanding strength of the CFSL compared to the other solvent fractions, but there seems to be a strong synergy of activity between the CFSL and EFSL. In the MIC table CFSL had an MIC at 5 mg/ml for *Escherichia coli* ATCC 8739, *Klebsiella spp.* ATCC 10702, *Pseudomonas aeruginosa* ATCC 15442, and *Staphylococcus aureus* ATCC 653. This trend was seen in the EFSL at same concentration for *Staphylococcus aureus* ATCC 653 and *Salmonella typhi*, even though there were organisms with MIC of 2.5 mg/ml with respect to CFSL and EFSL.

For the MBC/MFC for bacteria and fungi species encompassing *Aspergillus niger*, *Rhizopus stolonifera*, *Penicillium chrysogenum*, and *Candida albicans*, CFSL had MBC at concentration, 5 mg/ml for *Escherichia coli* ATCC 8739, *Pseudomonas aeruginosa* ATCC 15442, *Staphylococcus aureus* ATCC 653 and *Salmonella typhi*. This trend was also repeated by the EFSL to buttress the likely synergistic activity between the two solvent fractions, CFSL and EFSL. All put together, it is seen that CFSL caused the death of more organisms at this concentration compared to EFSL.

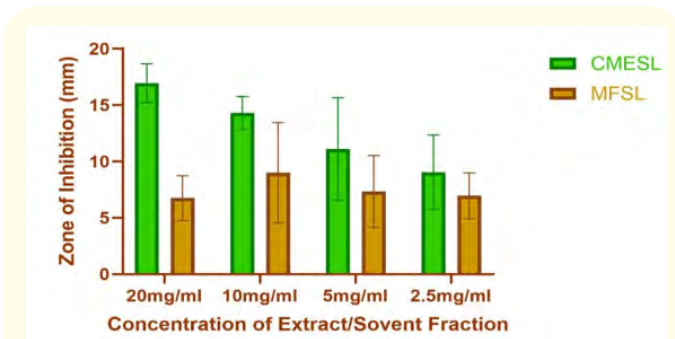
In these results there was a statistical comparison between the crude methanol extract (CMESL) and all the solvent fractions (CFSL, EFSL and MFSL), the chloroform, ethyl acetate fraction and the methanol fraction respectively, as well as the standard drug, Gentamycin used.



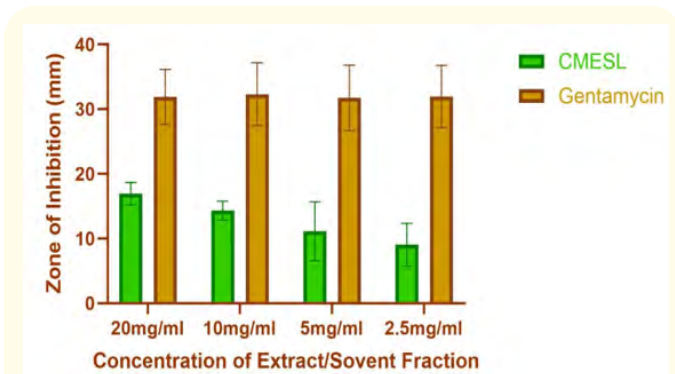
**Figure 3:** Comparison between the CMESL (crude methanol extract of *Sarcocephalus latifolius* fruits) and CFSL (chloroform fraction of *Sarcocephalus latifolius* fruits).



**Figure 4:** Comparison between the CMESL (crude methanol extract of *Sarcocephalus latifolius* fruits) and EFSL (Ethyl acetate fraction of *Sarcocephalus latifolius* fruits).



**Figure 5:** Comparison between the CMESL (crude methanol extract of *Sarcocephalus latifolius* fruits) and MFSL (Methanol Fraction of *Sarcocephalus latifolius* fruits).



**Figure 6:** Comparison between the CMESL (crude methanol extract of *Sarcocephalus latifolius* fruits) and Gentamycin (A standard antibiotic used during the antimicrobial screening).

Figure 3-6 shows the comparative analysis between the crude methanol extract and all the solvent fractions from it, chloroform, ethyl acetate and methanol fractions of *Sarcocephalus latifolius* fruits (CFSL, EFSL and MFSL respectively) and finally compared with a standard antibiotics, gentamycin. The results reveal that the CFSL performed better than the crude methanol extract (Figure 3) and any other solvent fraction, when compared with the crude methanol extract. Additionally, on a closer look, it did not seem to have a stronger antibiotic activity in comparison with the standard drug, Gentamycin.

Statistically, on the comparison of the CMESL with CFSL, in terms of the effect of antibacterial activity on values, interaction accounts for 1.408% of the total variance.  $F = 1.13$ .  $DFn = 3$ ,  $DFd = 151$  and the  $P$  value = 0.3387. Furthermore, on the effect of antimicrobial activity on the results of this comparison of antimicrobial strength, antimicrobial activity accounts for 0.1253% of the total variance,  $F = 0.30$ .  $DFn = 1$ ,  $DFd = 151$  and  $P$  value = 0.5835. both are considered not significant. On the other hand, on considering how the solvent fraction, CFSL affects the result of the comparison of CMESL and CFSL, it accounts for 35.72% of the total variance.  $F = 28.68$ .  $DFn = 3$ ,  $DFd = 151$  and the  $P$  value is  $< 0.0001$ . Therefore, if CFSL has no effect overall, there is a less than 0.01% chance of randomly observing an effect this big (or bigger) in an experiment of this size. The effect is considered extremely significant. A similar trend was seen on the comparison of CMESL and EFSL or MFSL, where  $P$  value is  $< 0.0001$  for both tests.

## Discussion

Phytochemicals are bioactive compounds or ‘magic molecules’ as I often refer to them, are usually plant-based either for the protection of these plants, production of novel drugs in the management of many diseases, enhancement of foods as functional foods and nutraceutical and more [12]. Documentations from recent scientific studies have recognized an association between the ingestion of these phytochemicals, for their contribution in the prevention and management of diseases like diabetes, obesity, cancer, CVDs etc. These magic molecules include anthraquinones, carotenoids, dietary fibers, flavonoids, polyphenols, isoprenoids, phytosterols, saponins, tannins, terpenoids etc., with health benefits. They can be sourced from various plant parts and sources like seeds, whole grains, fruits, vegetables, nuts, and more than a thousand magic molecules with a lot of significance

have been discovered to date [12]. Phytochemicals are known to be loaded with a lot of health benefits and properties including anticancer, antioxidant, antimalarial, anthelmintic, antiallergic, antiviral activities, just to mention a few. Additionally, these magic molecules that are plant-based can be ingested as supplements or nutraceuticals to help in the regulation of gene transcription, general improvement of immunity and well-being, the improvement of gap communication and given a lot of hope in various human cancer therapy [12,32,33].

Researchers have analyzed various solvent extracts (crude and fractionated) of *S. latifolius* plant parts (fruit, stem bark, roots, leaves). Commonly reported phytochemical classes: Alkaloids, Flavonoids, Tannins, Phenolic compounds, Saponins, Terpenoids/glycosides and Resins. These secondary metabolites are consistently identified across different parts and solvent fractions, and are considered responsible for biological activity [34]. It is however note worthy to know that different parts of the plants and diverse extraction methods are determinant of the particular compounds identified or isolated and their concentrations. Specific findings documented: Fruit fractions (e.g., hexane, chloroform, acetone, aqueous) contain multiple classes of secondary metabolites. Stem bark extracts show flavonoids, alkaloids, glycosides, anthraquinones, terpenes, phenols, saponins and resins [26], this was in correlation with our findings, but the intensity of each phytochemical was dependent on the solvent fraction of the stem bark used for the analysis.

### Antimicrobial activities

It is documented that *Sarcocephalus latifolius* as a plant exhibits significant antimicrobial properties, which supports its conventional use in treating diverse infections. The antimicrobial activity varies with reference to plant part, the solvent used for extraction, and the specific microbial strains tested. It was indicated that the stem bark extracts of *Sarcocephalus latifolius* was so strong in a manner that indicates a significant antimicrobial activity comparable to that of standard antibiotic (Oluremi, *et al.* 2018). Generally, speaking extracts and solvent fractions from plant parts of *S. latifolius* have demonstrated activity against both Gram-positive and Gram-negative bacteria, and a range of microorganisms, fungi inclusive. This broad-spectrum activity is often attributed to the presence of magic molecules like phenolics,

tannins, and flavonoids [13,35]. In this study, the ethanolic fruits extract of *S. latifolius* and fractions was used. Solvent fractions from fruits exhibit antimicrobial activity in disk diffusion assays. Chloroform fraction frequently shows strongest activity against both Gram-positive and Gram-negative bacteria (e.g., *Bacillus subtilis*, *Staphylococcus aureus*, *Escherichia coli*, *Pseudomonas aeruginosa*) and yeast (*Candida albicans*) [13,35]. This suggests that compounds extractable with moderately non-polar solvents may carry potent antimicrobial agents. Furthermore, in the Stem Bark and Leaf Extracts, Ethanol and other solvent extracts from stem bark show inhibitory effects against bacteria such as *E. coli* and *B. subtilis*.

The same trend was seen in our study using the methanolic crude extract of the fruits of *S. latifolius* and its fractions, where the chloroform fraction, CFSL topped the activity as an antimicrobial agent, showing significant zones of inhibition against *Pseudomonas aeruginosa* ATCC 15442, *Escherichia coli* ATCC 8739, *Klebsella spp.* ATCC 10702, *Staphylococcus aureus* ATCC 653, *Salmonella typhi*. ATCC 29930, *Bacillus subtilis* ATCC 14884, and fungi species encompassing *Aspergillus niger*, *Rhizopus stolonifera*, *Penicillium chrysogenum*, and *Candida albicans* at concentrations of 20, 10, 5 and 2.5 mg/ml (Table 5-8). Furthermore, the CFSL and EFSL exhibited almost same strength in both MIC and MBC/MFC at very low concentrations, indicating its degree of potency and synergistic activity mode as antimicrobial agents. Qualitative screening correlates presence of bioactive phytochemicals (flavonoids, tannins, etc.) with antimicrobial effects.

### Conclusion

This study therefore spotlights *S. latifolius* as an auspicious source for natural antimicrobial and indispensable nourishing agents. This plant is known to be a rich reservoir of natural bioactive compounds that exhibits powerful pharmacologic effects and explains its diverse use in traditional medicine in the management of several ailments including cases of infections. This validates the use of SL in traditional medicine and it might contain bioactive compounds that are rich sources of phytochemicals and antimicrobial agents.

## Bibliography

1. Kuete V. In the book: Medicinal plant research in Africa. Pharmacology and Chemistry (2013).
2. Pale S., et al. "Anticonvulsant effects of *Cymbopogon giganteus* extracts with possible effects on fully kindled seizures and anxiety in experimental rodent model of mesio-temporal epilepsy induced by pilocarpine". *Journal of Ethnopharmacology* 286 (2022): 114863.
3. Shukla SK. "Conservation of medicinal plants: challenges and opportunities". *Journal of Medicinal Botany* 7 (2023): 5-10.
4. Yu M., et al. "Phytochemical and antioxidant analysis of medicinal and food plants towards bioactive food and pharmaceutical resources". *Scientific Reports* 11 (2021): 10041.
5. Oguntimehin SA., et al. "Evaluation of Selected Nigerian Medicinal Plants for Phenolic Content, Antimicrobial, and Cytotoxic Activities". *Current Research in Complementary and Alternative Medicine* 6 (2022): 158.
6. Akinmoladun AC., et al. "Evaluation of antioxidant and free radical scavenging capacities of some Nigerian indigenous medicinal plants". *Journal of Medicinal Food* 13 (2010): 444-451.
7. Ugboko HU., et al. "Antimicrobial importance of medicinal plants in Nigeria". *The Scientific World Journal* (2020): 7059323.
8. Fadeyi SA., et al. "In vitro anticancer screening of 24 locally used Nigerian medicinal plants". *BMC Complement Alternative Medicine* 13 (2013): 79.
9. Segun PA., et al. "Medicinal plants used in the management of cancer among the Ijebus of Southwestern Nigeria". *Journal of Herbal Medicine* 14 (2018): 68-75.
10. Charles-Okhe O., et al. "Cytotoxic activity of crude extracts and fractions of African peach (*nauclea latifolia smith*) stem bark on two cancer cell lines". *Phytomedicine Plus* 2.1 (2022): 100212.
11. Siddiqui A J., et al. "Plants in Anticancer Drug Discovery: From Molecular Mechanism to Chemoprevention". *BioMed Research International* (2022).
12. Kumar A., et al. "Major Phytochemicals: Recent Advances in Health Benefits and Extraction Method". *Molecules* 28 (2023): 887.
13. Osama A., et al. "Antimicrobial Activity and Elemental Composition of *Sarcocephalus latifolius* Fruits: An Ethnopharmacological Based Evaluation". *Journal of Advances in Microbiology* 3.2 (2017): 1-5.
14. Gow AR., et al. "The importance of antimicrobial resistance in medical mycology". *Nature Communications* 13.1 (2022): 1-12.
15. Dhama K., et al. "A comprehensive review on chemical profile and pharmacological activities of *Ocimum basilicum*". *Food Reviews International* (2021): 1-29.
16. Oloche J J., et al. "Review of phytochemical, pharmacological and toxicological profile of *Stereospermum kunthianum*". *Journal of Advances in Medical and Pharmaceutical Sciences* 5.1 (2016): 1-10.
17. Quinlan M B. "Ethnomedicines: Traditions of Medicinal Knowledge". In book: A companion to medicinal anthropology (2022): 315-341.
18. Badiaga M. "Etude ethnobotanique, phytochimique et activités biologiques de *Nauclea latifolia smith* une plante médicinale africaine récoltée au Mali". Thèse de Doctorat unique. Université de Bamako, Mali et Université Blaise Pascal - Clermont-Ferrand II (2021).
19. Ayoola G A., et al. "Phytochemical Screening and Antioxidant Activities of Some Selected Medicinal Plants Used for Malaria Therapy in Southwestern Nigeria". *Tropical Journal of Pharmaceutical Research* 7.3 (2008): 1019-1024.
20. Sofowora A. "Medicinal Plants and Traditional Medicine in Africa". 3<sup>rd</sup> Edn. Spectrum Books Ltd, Ibadan Nigeria (2008): 1- 393.
21. Chatattikun M and Choabchalard A. "Phytochemical screening and free radical scavenging activities of orange baby carrot and carrot (*Daucus carota* Linn) root crude extracts". *Journal of Chemical and Pharmaceutical Research* 5.4 (2013): 97-102.
22. Sandip P., et al. "Phytochemical evaluation and free radical scavenging potential of *Hugonia Mystax* (L) Leaf Extract". *Bionano Frontier* 7.2 (2014).
23. Kim H., et al. "Hierarchical regulation of mitochondrion dependent apoptosis by BCL-2 subfamilies". *Nature Cell Biology* 8 (2006): 1348-1358.
24. Ayoola G A., et al. "Phytochemical screening and free radical scavenging activity of some Nigerian medicinal plants". *JAPhA Practice Innovations* 8 (2006): 133-136.

25. Coico R. "Gram staining". Current protocol in microbiology, Appendix 3: appendix 3C (2005).
26. Oluremi B., *et al.* "Evaluation of Phytochemical Constituents and Antimicrobial Activity of Leaves and Stem Bark Extracts of *Sarcocephalus latifolius*". *Microbiology Research Journal International* 24.2 (2018): 1-10.
27. Adeniyi B A., *et al.* "Antibacterial activity of Diospyrin, isodiospyrin and bisidiospyrin from the root of *Diospyros piscatorial* (Gurke) (Ebenaceae)". *Phytotherapy Research* 14 (2000): 112-117.
28. Adeniyi B A and Ayepola OO. "The phytochemical screening and antimicrobial activity of leaf extracts of *Eucalyptus camaldulensis* and *Eucalyptus torelliana*". *Research Journal of Medical Plant* 2.1 (2008): 34-38.
29. Shanholtzer CJ., *et al.* "MBCs for *Staphylococcus aureus* as determined by macrodilution and microdilution techniques". *Antimicrobe Agents Chemotherapy* 26 (1984): 214-219.
30. Fasching CE., *et al.* "Treatment evaluation of experimental staphylococcal infections comparing  $\beta$ -lactam, lipopeptide, and glycopeptide antimicrobial therapy." *Journal of Laboratory and Clinical Medicine* 116 (1990): 697-706.
31. Irkin R and Korukluoglu M. "Control of *Aspergillus niger* with garlic, onion and leek extracts". *African Journal of Biotechnology* 6 (2007): 384-387.
32. Cooperstone JL and Schwartz SJ. "Recent insights into health benefits of carotenoids". In *Handbook on Natural Pigments in Food and Beverages*; Carle, R., Schweigget, R.M., Eds.; Woodhead Publishing: Cambridge, UK (2016): 473-497.
33. Rowles JL. 3<sup>rd</sup>; Erdman, J.W., Jr. Carotenoids and their role in cancer prevention". *Biochimica et Biophysica Acta* 1865 (2020): 158613.
34. Imah-Harry J U., *et al.* "The Evaluation of the Solvent Fractions of the Fruits, Leaves, and the Stem Bark of *Sarcocephalus latifolius* (SM.) E. A. Bruce for Cytotoxicity and Antioxidant Activities. Organization for Women in Science for the Developing World (OWSD). Table of contents of Proceedings - The 7<sup>th</sup> Biennial International Conference of OWSD Nigeria National Chapter". In 7<sup>th</sup> Biennial International Conference of Organization for Women in Science for the developing World (OWSD) Nigeria National Chapter — Hosted by OWSD FUTA Chapter. Fostering a Smarter Scientific and Technological Ecosystem, Federal University of Technology Akure (FUTA), Ondo State, Nigeria. Zenodo (2025).
35. Tlhapi D., *et al.* "A Review of Medicinal Plants Used in the Management of Microbial Infections in Angola (2024)". *Plants* 13.21 (2024): 2991.