



**Veritatis Gaudium:**  
*Multidisciplinary Journal of Postgraduate Studies*

College of Postgraduate Studies,  
Veritas University, Abuja, Nigeria

ISSN: 3043 - 5285

Volume 1, Number 4, August Special Edition, 2026

DOI: 10.13140/RG.2.2.17243.12321

**PHYTOCHEMICAL COMPOSITION AND ANTIBACTERIAL  
ACTIVITY OF *SARCOCEPHALUS LATIFOLIUS* EXTRACTS  
AGAINST CLINICAL ISOLATES ASSOCIATED WITH  
AUTOIMMUNE-RELATED INFECTIONS**

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**Abstract**

*Autoimmune diseases are commonly managed with immunosuppressive therapies that increase patients' susceptibility to bacterial infections, a problem compounded by the growing burden of antimicrobial resistance. This study evaluated the phytochemical composition and antibacterial activity of *Sarcocephalus latifolius* extracts against selected clinical bacterial isolates associated with autoimmune-related infections. Leaf, stem, root, and bark samples were extracted using aqueous and ethanol solvents. Qualitative and quantitative phytochemical analyses were performed using standard methods, while antibacterial activity against *Escherichia coli*, *Staphylococcus aureus*, *Salmonella typhi*, and *Streptococcus pyogenes* was determined by agar well diffusion, minimum inhibitory concentration (MIC), and minimum bactericidal concentration (MBC) assays. Aqueous extracts produced higher extraction yields, whereas ethanolic extracts exhibited significantly greater antibacterial activity. Phytochemical screening confirmed the presence of alkaloids, flavonoids, tannins, phenols, glycosides, terpenoids, steroids, and other bioactive compounds, with bark containing the highest concentrations of most metabolites. Ethanolic bark and leaf extracts produced the largest inhibition zones and the lowest MIC and MBC values. Two-way ANOVA showed that solvent type, plant part, and their interaction significantly influenced antibacterial activity ( $p < 0.0001$ ). These findings demonstrate that *S. latifolius* possesses promising*

*antibacterial properties and may serve as a potential source of affordable antimicrobial agents for managing bacterial infections in immunocompromised patients.*

**Keywords:** *Sarcocephalus latifolius*, antibacterial activity, phytochemicals, autoimmune diseases, medicinal plants, clinical isolates

## Introduction

Antimicrobial resistance is a major global public health challenge, particularly among immunocompromised individuals who are highly susceptible to recurrent bacterial infections (GBD 2021 Antimicrobial Resistance Collaborators, 2024; Ugbo *et al.*, 2025). Patients with autoimmune diseases are especially vulnerable because immune dysregulation and prolonged use of immunosuppressive drugs increase the risk of opportunistic infections, leading to increased morbidity and mortality. Consequently, there is growing interest in identifying safe and effective antimicrobial agents from natural sources (Tiwari *et al.*, 2020; Newman & Cragg, 2020; Alves *et al.*, 2022; Singh & Kim, 2023).

Medicinal plants remain valuable sources of bioactive compounds with antimicrobial, antioxidant, and anti-inflammatory properties. These activities are attributed to secondary metabolites such as alkaloids, flavonoids, phenolics, tannins, terpenoids, and glycosides, which continue to play important roles in drug discovery (Vaou *et al.*, 2021; Shah *et al.*, 2023; Stavropoulou *et al.*, 2023; Breijyeh & Karaman, 2024).

*Sarcocephalus latifolius* (formerly *Nauclea latifolia*) is widely distributed in tropical Africa and has long been used in traditional medicine for treating malaria, diarrhoea, dysentery, diabetes, hypertension, tuberculosis, and other infectious diseases. Previous studies have demonstrated its antibacterial, antioxidant, anti-inflammatory, antidiabetic, and antimalarial activities, largely attributed to its rich phytochemical composition (Iheagwam *et al.*, 2020; Chabi-Sika *et al.*, 2022; Kuete, 2023; Bekoe *et al.*, 2024).

Although bacterial infections are common complications in patients with autoimmune diseases, information on the antibacterial activity of *S. latifolius* against clinical bacterial isolates associated with autoimmune-related infections remains limited (Henao-Martínez *et al.*, 2024; Bekoe *et al.*, 2024). Therefore, this study investigated the phytochemical composition and antibacterial activity of aqueous and ethanolic extracts from the leaf, stem, root, and bark of *S. latifolius* against selected clinical bacterial isolates recovered from autoimmune disease patients. The study further determined the minimum inhibitory concentration (MIC) and minimum bactericidal concentration (MBC) of the extracts to provide scientific evidence supporting their potential as plant-derived antimicrobial agents.

## Statement of the Research Problem

Autoimmune diseases (ADs) are increasingly linked to microbial infections and intestinal dysbiosis in genetically predisposed individuals (Martinelli *et al.* 2024). Present immunosuppressive treatments are vital for management of ADs but worsen patients' vulnerability to microbial infections causing disruption of gut microbiota and heightening immune dysregulation, morbidity, and mortality (Henao-Martínez *et al.*, 2024). However, available drugs often produce significant adverse effects, creating an urgent need for safer and more effective therapeutic options (Henao-Martínez *et al.*, 2024). *Sarcocephalus latifolius*, a plant with reported multi-therapeutic properties and minimal toxicity, remains underexplored for its potential in autoimmune disease management (Kuete, 2023; Bekoe *et al.*, 2024). Investigating its bioactive components may provide promising alternative treatment and contribute to achieving Sustainable Development Goal 3 on good health and well-being.

## Materials and Methods

### Study Area and Design

This laboratory-based experimental study was conducted between June 2025 and April 2026 in the Department of Microbiology, Veritas University, Abuja, in collaboration with the Microbiology Unit of Bwari General Hospital, Federal Capital Territory (FCT), Nigeria. The study evaluated the phytochemical composition and antibacterial activity of aqueous and ethanolic extracts of *Sarcocephalus latifolius* against clinical bacterial isolates associated with autoimmune-related infections. Ethical approval was obtained from the Health Research Ethics Committee (Approval No. FHREC/2025/01/186/26-06-25).

### **Collection and Preparation of Plant Materials**

Fresh leaves, stem, bark, and roots of *Sarcocephalus latifolius* were collected from Ezza North Local Government Area, Ebonyi State, Nigeria, and authenticated at the National Institute for Pharmaceutical Research and Development (NIPRD), Abuja (Voucher No. NIPRD/H/7320). The plant materials were washed, shade-dried, pulverized into powder, and stored in sterile airtight containers until extraction.

### **Preparation of Extracts**

Powdered samples (300 g) of each plant part were separately extracted with distilled water and 95% ethanol (3:10 w/v) by maceration for 72 hrs. The filtrates were concentrated using a water bath for both aqueous extracts and ethanolic extracts, and percentage extraction yields were determined using standard procedures (Azwanida, 2015; Okhale *et al.*, 2024).

### **Test Organisms**

Clinical isolates of *Escherichia coli*, *Staphylococcus aureus*, *Salmonella typhi*, and *Streptococcus pyogenes* were obtained from patients with autoimmune diseases attending Bwari General Hospital. The isolates were identified by standard microbiological techniques, including Gram staining, colonial morphology, and biochemical tests (Dunn, 2023). Bacterial suspensions were standardized to 0.5 McFarland turbidity before antimicrobial testing following CLSI M100 guidelines (CLSI, 2024).

### **Phytochemical Analysis**

Qualitative phytochemical screening was performed to detect major secondary metabolites, while quantitative analysis of selected phytochemicals was carried out using standard spectrophotometric and gravimetric methods as previously described (Sofowora *et al.*, 2013; Chabi-Sika *et al.*, 2022).

### **Antibacterial Assay**

Antibacterial activity of the extracts was evaluated using the agar well diffusion method as previously described by (Mia *et al.*, 2024). Standardized bacterial inocula were cultured on Mueller-Hinton agar, and 6-mm wells were filled with 50  $\mu$ L of each extract. Ciprofloxacin and dimethyl sulfoxide (DMSO) served as positive and negative controls, respectively. Zones of inhibition were measured after incubation at 37°C for 18–24 h (Mia *et al.*, 2024; CLSI, 2024).

### **Determination of MIC and MBC**

Minimum inhibitory concentration (MIC) and minimum bactericidal concentration (MBC) were determined using the broth dilution technique according to CLSI M07 guidelines (CLSI, 2024). MIC was defined as the lowest concentration preventing visible bacterial growth, while MBC was the lowest concentration producing no bacterial growth following subculture.

### **Statistical Analysis**

Experiments were performed in triplicate, and results were expressed as mean  $\pm$  standard deviation. Data were analysed using IBM SPSS Statistics version 31. Two-way analysis of variance (ANOVA) was used to determine the effects of solvent type and plant part on antibacterial activity, with statistical significance set at  $p < 0.05$ .

## Results

### 3.1 Extraction Yield of *Sarcocephalus latifolius* Extracts

The percentage extraction yield varied according to solvent and plant part. Aqueous extraction mostly produced higher yields than ethanolic extraction, except for the stem. The bark of ethanolic extracts produced the highest yield, while leaf gave the highest yield among the aqueous extracts. Differences were also observed in the colour, texture, consistency, and odour of the extracts.

**Table 1: Percentage yield and physical characteristics ethanolic and aqueous extracts of *Sarcocephalus latifolius***

| Sol. Type               | PP<br>Texture | PW<br>Odour            | Sol.<br>(mL) | EW<br>(g) | Yield<br>(%) | Colour          | Consistency        |
|-------------------------|---------------|------------------------|--------------|-----------|--------------|-----------------|--------------------|
| Ethanolic<br>Extraction | Leaf          | 300<br>Mild-herbal     | 1000         | 23        | 7.7          | Dark green      | Thick paste        |
|                         | Stem          | 300<br>Slightly coarse | 1000         | 24        | 8.0          | Dark brown      | Semi-solid         |
|                         | Root          | 300<br>Slightly gritty | 1000         | 13        | 4.3          | Yellowish-Brown | Thick paste        |
|                         | Bark          | 300<br>Sticky-coarse   | 1000         | 31        | 10.3         | Reddish-brown   | Gummy-resinous     |
|                         |               |                        |              |           |              |                 |                    |
| Aqueous<br>Extraction   | Leaf          | 300<br>Smooth          | 1000         | 30.1      | 12.4         | Greenish brown  | Slightly thick     |
|                         | Stem          | 300<br>Smooth          | 1000         | 10        | 4.0          | Light brown     | Slightly viscous   |
|                         | Root          | 300<br>Slightly coarse | 1000         | 27        | 10.8         | Brownish        | Moderately thick   |
|                         | Bark          | 300<br>Slightly sticky | 1000         | 25        | 10.0         | Dark-brown      | Moderately viscous |
|                         |               |                        |              |           |              |                 |                    |

#### Key:

Sol. Type = Solvent type; PP = Plant part, PW = Powder weight, Sol. = Solvent (milliliter), EW = Extract weight (gram), yield= percentage yield (%)

### 3.2 Qualitative Phytochemical Composition

Qualitative phytochemical screening revealed the presence of fifteen bioactive constituents across the different plant parts of *S. latifolius*. Nine phytochemicals—alkaloids, tannins, phenols, steroids, terpenoids, balsams, glycosides, cardenolides, and resin—were detected in all plant parts. Saponins, phlobatannins, anthraquinones, volatile oils, flavonoids, and triterpenoids showed variation among the leaf, stem, root, and bark extracts. Bark exhibited the widest distribution of phytochemical constituents, whereas stem lacked saponins, phlobatannins, and anthraquinones.

**Table 2: Qualitative phytochemical constituents of *S. latifolius* extracts**

| Parameter  | Stem | Root | Leaf | Bark |
|------------|------|------|------|------|
| Alkaloids  | +    | +    | +    | +    |
| Saponins   | -    | +    | +    | +    |
| Flavonoids | +    | -    | +    | +    |
| Tannins    | +    | +    | +    | +    |
| Phenols    | +    | +    | +    | +    |
| Steroid    | +    | +    | +    | +    |
| Terpenoids | +    | +    | +    | +    |

|                |   |   |   |   |
|----------------|---|---|---|---|
| Balsams        | + | + | + | + |
| Glycosides     | + | + | + | + |
| Phlobatanins   | - | + | - | + |
| Volatile Oil   | + | - | + | + |
| Triterpenoids  | + | - | + | + |
| Anthraquinones | - | + | - | + |
| Cardenolides   | + | + | + | + |
| Resins         | + | + | + | + |

**Keynote:**

(+) = positive, (-) = Negative

### 3.3 Quantitative Phytochemical Composition

Quantitative phytochemical analysis revealed significant variation in metabolite concentrations among the different plant parts (Table 3). Bark contained the highest levels of most phytochemicals, whereas leaf possessed the highest total phenol and flavonoid contents. One-way ANOVA showed significant differences among plant parts for all quantified metabolites ( $p < 0.05$ ).

**Table 3: Quantitative phytochemical composition of *S. latifolius* extracts**

| Phytochemical                           | Leaf         | Root         | Stem         | Bark         |
|-----------------------------------------|--------------|--------------|--------------|--------------|
| <b>Gravimetric method (%)</b>           |              |              |              |              |
| Alkaloids                               | 3.82 ± 0.11  | 6.14 ± 0.18  | 3.26 ± 0.09  | 7.02 ± 0.20  |
| Saponins                                | 4.26 ± 0.12  | 5.87 ± 0.16  | 0.00 ± 0.00  | 6.41 ± 0.19  |
| Phlobatannins                           | 0.00 ± 0.00  | 2.46 ± 0.06  | 0.00 ± 0.00  | 2.81 ± 0.08  |
| Balsam                                  | 2.14 ± 0.05  | 3.42 ± 0.09  | 1.88 ± 0.05  | 4.06 ± 0.12  |
| Resins                                  | 2.91 ± 0.07  | 3.88 ± 0.11  | 2.57 ± 0.06  | 4.29 ± 0.14  |
| Volatile oils                           | 1.72 ± 0.05  | 0.00 ± 0.00  | 1.10 ± 0.04  | 2.04 ± 0.06  |
| <b>Spectrophotometric method (mg/g)</b> |              |              |              |              |
| Total Phenols                           | 32.55 ± 0.47 | 21.84 ± 0.36 | 26.19 ± 0.41 | 29.72 ± 0.48 |
| Tannins                                 | 18.42 ± 0.31 | 24.18 ± 0.44 | 15.07 ± 0.29 | 28.36 ± 0.52 |
| Flavonoids                              | 27.63 ± 0.38 | 0.00 ± 0.00  | 22.48 ± 0.34 | 25.16 ± 0.39 |
| Steroids                                | 9.60 ± 0.21  | 12.10 ± 0.30 | 8.50 ± 0.19  | 14.80 ± 0.36 |
| Terpenoids                              | 19.40 ± 0.39 | 8.60 ± 0.25  | 14.90 ± 0.31 | 22.70 ± 0.44 |
| Triterpenoids                           | 12.80 ± 0.30 | 0.00 ± 0.00  | 7.40 ± 0.20  | 15.20 ± 0.34 |
| Glycosides                              | 9.54 ± 0.20  | 12.73 ± 0.26 | 10.11 ± 0.23 | 14.36 ± 0.28 |
| Anthraquinones                          | 0.00 ± 0.00  | 3.70 ± 0.12  | 0.00 ± 0.00  | 4.10 ± 0.13  |
| Cardenolides                            | 8.30 ± 0.17  | 11.20 ± 0.22 | 10.00 ± 0.19 | 13.00 ± 0.25 |

**Note:** Data were presented as mean ± standard error (SE). Gravimetric values were expressed in percentage (%), while spectrophotometric values were expressed in mg/g of extract. n = number of replicates.

### 3.4 Identification and Characterization of Test Organisms

Four clinical bacterial isolates namely *Escherichia coli*, *Staphylococcus aureus*, *Salmonella typhi*, and *Streptococcus pyrogens* were identified using colonial morphology, Gram staining, and biochemical characteristics before antibacterial susceptibility testing (Bolaji *et al.*, 2018; CLSI 2024).

### 3.5 Antibacterial Activity of *Sarcocephalus latifolius* Extracts

Both aqueous and ethanolic extracts inhibited the growth of all bacterial isolates (Table 5). Overall, ethanolic extracts produced significantly larger inhibition zones and lower MIC and MBC values than aqueous extracts. Bark extracts showed the greatest antibacterial activity against all organisms tested, whereas stem extracts exhibited the lowest activity. Ciprofloxacin demonstrated the highest antibacterial activity, while DMSO showed no inhibitory effect.

### 3.6 Statistical Analysis

Two-way ANOVA revealed that solvent type, plant part, and their interaction significantly influenced the antibacterial activity of *S. latifolius* extracts against all test organisms for zones of inhibition, MIC, and MBC ( $p < 0.001$ ) (Table 6).

**Table 5: Antibacterial Activities of *Sarcocephalus latifolius* Extracts**

| Extracts (M ± SD) |               | Ethanolic Extracts (M ± SD) |             |             | Aqueous      |      |
|-------------------|---------------|-----------------------------|-------------|-------------|--------------|------|
| Isolates          | Sample        | ZOI (mm)                    | MIC (mg/mL) | MBC (mg/mL) | ZOI          | (mm) |
|                   | MIC (mm)      | MBC (mm)                    |             |             |              |      |
| <i>E. coli</i>    | Leaf          | 22.17 ± 0.09                | 2.08 ± 0.74 | 1.04 ± 0.37 | 20.13 ± 0.05 |      |
|                   | 2.6 ± 0.74    | 10.42 ± 2.95                |             |             |              |      |
|                   | Stem          | 18.1 ± 0.08                 | 6.25 ± 0    | 3.12 ± 0    | 16.13 ± 0.09 |      |
|                   | 10.42 ± 2.95  | 25 ± 0                      |             |             |              |      |
|                   | Root          | 19.13 ± 0.05                | 2.6 ± 0.74  | 1.3 ± 0.37  | 17 ± 0       |      |
|                   | 5.21 ± 1.48   | 10.42 ± 2.95                |             |             |              |      |
|                   | Bark          | 23.17 ± 0.05                | 2.08 ± 0.74 | 1.04 ± 0.37 | 21.03 ± 0.05 |      |
|                   | 3.12 ± 0      | 6.25 ± 0                    |             |             |              |      |
| <i>S. aureus</i>  | DMSO          | 0 ± 0                       | 0 ± 0       | 0 ± 0       | 0 ± 0        | 0    |
|                   | ± 0           | 0 ± 0                       |             |             |              |      |
|                   | Cipro (µg/mL) | 29.13 ± 0.05                | 0.03 ± 0.01 | 0.03 ± 0.01 | 29.13 ± 0.05 |      |
|                   | 0.03 ± 0.01   | 0.03 ± 0.01                 |             |             |              |      |
|                   | Leaf          | 23.17 ± 0.12                | 1.56 ± 0    | 0.78 ± 0    | 20.03 ± 0.05 |      |
|                   | 2.6 ± 0.74    | 5.21 ± 1.48                 |             |             |              |      |
|                   | Stem          | 18.13 ± 0.05                | 4.16 ± 1.48 | 2.08 ± 0.74 | 17 ± 0       |      |
|                   | 5.21 ± 1.48   | 10.42 ± 2.95                |             |             |              |      |
| <i>S. typhi</i>   | Root          | 20.2 ± 0.08                 | 2.08 ± 0.74 | 1.04 ± 0.37 | 18.1 ± 0.08  |      |
|                   | 2.6 ± 0.74    | 5.21 ± 1.48                 |             |             |              |      |
|                   | Bark          | 25.13 ± 0.05                | 2.08 ± 0.74 | 1.04 ± 0.37 | 23.13 ± 0.05 |      |
|                   | 4.16 ± 1.48   | 5.21 ± 1.48                 |             |             |              |      |
|                   | DMSO          | 0 ± 0                       | 0 ± 0       | 0 ± 0       | 0 ± 0        | 0    |
|                   | ± 0           | 0 ± 0                       |             |             |              |      |
|                   | Cipro (µg/mL) | 27.2 ± 0.08                 | 0.03 ± 0.01 | 0.03 ± 0.01 | 27.2 ± 0.08  |      |
|                   | 0.03 ± 0.01   | 0.03 ± 0.01                 |             |             |              |      |
| <i>S. typhi</i>   | Leaf          | 20.13 ± 0.12                | 2.08 ± 0.74 | 1.04 ± 0.37 | 18.13 ± 0.19 |      |
|                   | 2.6 ± 0.74    | 5.21 ± 1.48                 |             |             |              |      |
|                   | Stem          | 17.2 ± 0.08                 | 6.25 ± 0    | 3.12 ± 0    | 15.17 ± 0.12 |      |
|                   | 12.5 ± 0      | 20.83 ± 5.89                |             |             |              |      |
|                   | Root          | 18.17 ± 0.05                | 4.16 ± 1.48 | 2.08 ± 0.74 | 16.03 ± 0.05 |      |
|                   | 6.25 ± 0      | 12.5 ± 0                    |             |             |              |      |
|                   | Bark          | 21.2 ± 0.08                 | 2.6 ± 0.74  | 1.3 ± 0.37  | 19.1 ± 0     |      |
|                   | 6.25 ± 0      | 10.42 ± 2.95                |             |             |              |      |
| <i>S. typhi</i>   | DMSO          | 0 ± 0                       | 0 ± 0       | 0 ± 0       | 0 ± 0        | 0    |
|                   | ± 0           | 0 ± 0                       |             |             |              |      |
|                   | Cipro (µg/mL) | 30.17 ± 0.05                | 0.04 ± 0.02 | 0.04 ± 0.02 | 30.17 ± 0.05 |      |
|                   | 0.04 ± 0.02   | 0.04 ± 0.02                 |             |             |              |      |

|               |                                                                                |              |               |              |             |              |              |  |
|---------------|--------------------------------------------------------------------------------|--------------|---------------|--------------|-------------|--------------|--------------|--|
| <i>Strep.</i> | <div><div></div><div>10.42 ± 2.95</div><div>25 ± 0</div><div>0 ± 0</div></div> | Leaf         | 18.2 ± 0.08   | 2.6 ± 0.74   | 1.3 ± 0.37  | 16 ± 0       |              |  |
|               |                                                                                | 5.21 ± 1.48  | 10.42 ± 2.95  |              |             |              |              |  |
|               |                                                                                | Stem         | 16.83 ± 0.47  | 6.25 ± 0     | 3.12 ± 0    | 14.13 ± 0.09 |              |  |
|               |                                                                                | 10.42 ± 2.95 | 20.83 ± 5.89  |              |             |              |              |  |
|               |                                                                                | Root         | 17.17 ± 0.12  | 6.25 ± 0     | 3.12 ± 0    | 15.1 ± 0     |              |  |
|               |                                                                                |              |               |              |             |              |              |  |
|               |                                                                                | Bark         | 20.23 ± 0.17  | 2.08 ± 0.74  | 1.04 ± 0.37 | 19.17 ± 0.09 |              |  |
|               |                                                                                | 3.12 ± 0     | 5.21 ± 1.48   |              |             |              |              |  |
|               |                                                                                | DMSO         | 0 ± 0         | 0 ± 0        | 0 ± 0       | 0 ± 0        | 0            |  |
|               |                                                                                | ± 0          | 0 ± 0         |              |             |              |              |  |
|               |                                                                                |              | Cipro (µg/mL) | 25.07 ± 0.05 | 0.33 ± 0.12 | 0.33 ± 0.12  | 25.07 ± 0.05 |  |
|               |                                                                                |              | 0.33 ± 0.12   | 0.33 ± 0.12  |             |              |              |  |

**Key:** *E. coli* = *Escherichia coli*; *S. aureus* = *Staphylococcus aureus*; *S. typhi* = *Salmonella typhi*; *Strep.* = *Streptococcus* spp; M ± SD = Mean Standard Deviation; ZOI = Zone of Inhibition; Cipro. = Ciprofloxacin; DMSO = Dimethyl sulfoxide; MIC = Minimum Inhibitory Concentration [The lowest concentration of an antimicrobial agent (the plant extracts) that prevented visible growth of the bacterial isolates after incubation]; MBC = Minimum Bactericidal Concentration [The lowest concentration of an antimicrobial agent (the plant extracts) that killed 99.9% of the bacterial isolates after incubation].

**Note:** Interpretation guide for the MIC: Strong = ≥ 20 mm strong for plant extract and susceptible for antibiotic, Moderate = 15 – 19 mm, Weak = 10 – 14, Inactive = ≤ 9 mm.

**Table 6: Effect of solvent and treatment on ZOI, MIC and MBC for all Isolates tested (Two-way ANOVA)**

|                   |    | ZOI           |               |          |          | MIC |         |          |
|-------------------|----|---------------|---------------|----------|----------|-----|---------|----------|
|                   |    | MBC           |               |          |          |     |         |          |
| Organism          | df | SV<br>F-value | df<br>p-value | F-value  | p-value  | df  | F-value | p-value  |
| <i>E. coli</i>    | 1  | Solvent       | 1             | 118.25   | < 0.0001 | 1   | 42.15   | < 0.0001 |
|                   |    | 185.41        | < 0.0001      |          |          |     |         |          |
|                   | 5  | Sample        | 5             | 1585.27  | < 0.0001 | 5   | 230.72  | < 0.0001 |
|                   |    | 84.53         | < 0.0001      |          |          |     |         |          |
| <i>S. aureus</i>  | 5  | Interaction   | 5             | 26.57    | < 0.0001 | 5   | 9.50    | < 0.0001 |
|                   |    | 26.91         | < 0.0001      |          |          |     |         |          |
|                   | 1  | Solvent       | 1             | 102.14   | < 0.0001 | 1   | 41.9    | < 0.0001 |
|                   |    | 160.4         | < 0.0001      |          |          |     |         |          |
| <i>S. typhi</i>   | 5  | Sample        | 5             | 1589.20  | < 0.0001 | 5   | 58.2    | < 0.0001 |
|                   |    | 53.6          | < 0.0001      |          |          |     |         |          |
|                   | 5  | Interaction   | 5             | 21.83    | < 0.0001 | 5   | 8.9     | < 0.0001 |
|                   |    | 17.9          | < 0.0001      |          |          |     |         |          |
| <i>Strep. spp</i> | 1  | Solvent       | 1             | 1537.60  | < 0.0001 | 1   | 82.32   | < 0.0001 |
|                   |    | 73.95         | < 0.0001      |          |          |     |         |          |
|                   | 5  | Sample        | 5             | 51561.58 | < 0.0001 | 5   | 161.33  | < 0.0001 |
|                   |    | 22.21         | < 0.0003      |          |          |     |         |          |
|                   | 5  | Interaction   | 5             | 154.06   | < 0.0001 | 5   | 19.54   | < 0.001  |
|                   |    | 12.26         | < 0.0001      |          |          |     |         |          |
|                   | 1  | Solvent       | 1             | 296.1    | < 0.0001 | 1   | 124.1   | < 0.0001 |
|                   |    | 121.89        | < 0.0001      |          |          |     |         |          |
|                   | 5  | Sample        | 5             | 210.3    | < 0.0001 | 5   | 88.2    | < 0.0001 |
|                   |    | 37.04         | < 0.0002      |          |          |     |         |          |

|   |              |          |      |          |   |      |          |
|---|--------------|----------|------|----------|---|------|----------|
|   | Interactions | 5        | 10.1 | < 0.0001 | 5 | 13.8 | < 0.0001 |
| 5 | 22.34        | < 0.0001 |      |          |   |      |          |

#### Key:

ZOI = Zone of inhibition, MIC = Minimum Inhibitory Concentration, MBC = Minimum Bactericidal Concentration

*E. coli* = *Escherichia coli*, *S. auerus* = *Staphylococcus auerus*, *S. typhi* = *Salmonella typhi*, *Strep.* = *Streptococcus* spp, SV = source of variation, df = degree of freedom, F-value (strength of effect) = measurements of how much variation exists between groups compared to within groups, p-value (statistical certainty) = The probability that the observed differences occurred by chance under the null hypothesis.

#### Discussion

The present study demonstrated that *Sarcocephalus latifolius* possesses significant antibacterial activity against clinical bacterial isolates associated with autoimmune-related infections. The observed activity is attributable to its rich phytochemical composition and varied according to plant part and extraction solvent. These findings support the traditional medicinal use of *S. Latifolius* and highlight its potential as a source of plant-derived antimicrobial agents (Ogunyemi *et al.*, 2023; Rahman *et al.*, 2024).

Although aqueous extraction generally produced higher extraction yields, ethanolic extracts exhibited superior antibacterial activity. This suggests that ethanol was more effective in extracting bioactive antimicrobial compounds despite lower overall yields, consistent with previous reports that solvent polarity influences phytochemical recovery and biological activity (Azwanida, 2015; Okhale *et al.*, 2024).

Qualitative and quantitative analyses confirmed the presence of several bioactive metabolites, including alkaloids, flavonoids, tannins, phenolics, terpenoids, glycosides, steroids, cardenolides and others. Bark contained the highest concentrations of most phytochemicals, whereas leaves had the highest phenolic and flavonoid contents. Similar phytochemical profiles have been reported by Chabi-Sika *et al.* (2022) and Imah-Harry *et al.* (2026), supporting the medicinal importance of *S. latifolius*. The greater antibacterial activity of the ethanolic bark extracts is likely due to the higher concentrations of antimicrobial metabolites, including tannins, terpenoids, steroids, glycosides, and cardenolides. These compounds have been reported to inhibit bacterial growth through membrane disruption, interference with protein synthesis, and inhibition of nucleic acid replication (Cushnie & Cushnie, 2021). Although leaves contained higher phenolic and flavonoid concentrations, bark exhibited greater antibacterial activity, suggesting that synergistic interactions among multiple phytochemicals contribute more to antibacterial efficacy than the abundance of a single metabolite. This observation agrees with Okeke *et al.* (2020), who reported enhanced antimicrobial activity resulting from phytochemical synergy.

The lower MIC and MBC values recorded for ethanolic extracts further confirmed their greater antibacterial potency. The consistency between agar diffusion, MIC, and MBC results strengthens the reliability of the antibacterial activity observed in this study and supports ethanol as the preferred extraction solvent for antimicrobial constituents.

Statistical analysis showed that solvent type, plant part, and their interaction significantly influenced antibacterial activity ( $p < 0.001$ ), confirming that the observed differences were attributable to experimental factors rather than random variation. Similar findings have been reported in comparative studies of medicinal plants, where solvent selection significantly affected phytochemical extraction and antimicrobial efficacy (Azwanida, 2015; Okhale *et al.*, 2024; Rahman *et al.*, 2024).

A major strength of this study is the use of clinical bacterial isolates recovered from autoimmune disease patients rather than laboratory reference strains, thereby enhancing the clinical relevance of the findings (CLSI, 2024; Henao-Martinez *et al.*, 2024; Schweitzer *et al.*, 2024). Overall, the results demonstrate that *S. latifolius*, particularly the bark extracted with ethanol, represents a promising source of natural antibacterial agents and provides a scientific basis for its traditional use. Further studies should focus on isolating the active compounds, evaluating toxicity, and assessing in vivo efficacy.

### Conclusion

This study demonstrated that *Sarcocephalus latifolius* is a rich source of bioactive phytochemicals with significant antibacterial activity against *Escherichia coli*, *Staphylococcus aureus*, *Salmonella typhi*, and *Streptococcus pyogenes* associated with autoimmune-related infections. Although aqueous extracts produced higher extraction yields, ethanolic extracts, particularly those from the bark, exhibited superior antibacterial activity, reflected by larger inhibition zones and lower MIC and MBC values. The findings provide scientific evidence supporting the traditional use of *S. latifolius* and highlight its potential as a source of natural antibacterial agents for managing infections in immunocompromised patients. Further studies are required to isolate the active compounds, evaluate their safety, and confirm their efficacy through in vivo investigations.

### Recommendations

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

1. The ethanolic extracts of *S. latifolius*, particularly bark and leaf extracts, showed the highest antibacterial activity and they are to be considered for further development as potential herbal antibacterial agents against bacterial infections associated with autoimmune diseases, although their clinical efficacy and safety require further investigation.
2. The therapeutic potential of *S. latifolius* is effective against *Escherichia coli*, *Staphylococcus aureus*, *Salmonella typhi*, and *Streptococcus pyogenes*. It is therefore suggested to be recognized by healthcare professionals and researchers as a complementary source of antibacterial agents, especially in the face of increasing antibacterial resistance, although standardized dosage and formulation have not yet been established.
3. The demonstrated antibacterial activity of *S. latifolius* tested in-vitro against clinical isolates suggests that it could serve as a promising alternative or complementary therapy for bacterial infections in immunocompromised patients, although in vivo efficacy and toxicity studies are still required before clinical application.
4. The zones of inhibition of *S. aureus* is 25.13 mm for bark extract recording the highest while *S. pyogenes* zone of inhibition is 16.83 mm for root extract is the lowest among ethanolic extracts it is therefore recommended that synergistic studies combining *S. latifolius* extracts with conventional antibiotics should be explored as a strategy to improve antimicrobial efficacy and reduce the emergence of antibiotic resistance.
5. This research promotes greater awareness and scientific validation of medicinal plants such as *S. latifolius* for managing bacterial infections, public health authorities and researchers are encouraged to do likewise, although additional studies involving a wider range of multidrug-resistant pathogens are necessary to strengthen the current evidence.

### Contribution to Knowledge

This study makes the following contributions to scientific knowledge:

1. It provides comprehensive qualitative and quantitative phytochemical profiles of the leaf, stem, root, and bark of *Sarcocephalus latifolius*, demonstrating significant variation in phytochemical distribution among plant parts.
2. It establishes that ethanolic extracts possess significantly greater antibacterial activity than aqueous extracts against the clinical isolates investigated.

3. It identifies the bark as the plant part with the greatest antibacterial potential, attributable to its higher concentrations of several antimicrobial phytochemicals.
4. It demonstrates that *Sarcocephalus latifolius* exhibits antibacterial activity against clinical bacterial isolates associated with autoimmune-related infections, thereby extending previous studies that primarily focused on laboratory reference strains.
5. It provides experimental evidence supporting the potential application of *S. latifolius* as a candidate source of novel antibacterial agents for the management of infections among immunocompromised patients.

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