Efficacy and Mechanism of Traditional Medicinal Plants and Bioactive Compounds against Clinically Important Pathogens

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Abstract: Traditional medicinal plants have been cultivated to treat various human illnesses and avert numerous infectious diseases. They display an extensive range of beneficial pharmacological and health effects for humans. These plants generally synthesize a diverse range of bioactive compounds which have been established to be potent antimicrobial agents against a wide range of pathogenic organisms. Various research studies have demonstrated the antimicrobial activity of traditional plants scientifically or experimentally measured with reports on pathogenic microorganisms resistant to antimicrobials. The antimicrobial activity of medicinal plants or their bioactive compounds arising from several functional activities may be capable of inhibiting virulence factors as well as targeting microbial cells. Some bioactive compounds derived from traditional plants manifest the ability to reverse antibiotic resistance and improve synergetic action with current antibiotic agents. Therefore, the advancement of bioactive-based pharmacological agents can be an auspicious method for treating antibiotic-resistant infections. This review considers the functional and molecular roles of medicinal plants and their bioactive compounds, focusing typically on their antimicrobial activities against clinically important pathogens.

Keywords: traditional medicinal plants; bioactive compounds; antimicrobial activities; mechanisms

1. Introduction

The incidence of microbial infectious diseases and their hitches consistently elevates, mostly due to microbial drug resistance to presently offered antimicrobial agents [1]. These multidrug-resistant microbes cause various infections globally and are connected with greater levels of morbidity and mortality [2]. These augmentations of antibiotic resistance and higher recurrence rates of such common infections have a great impact on our society [3–5]. Several investigations associated with antimicrobial resistance predict that the mortality toll owing to antimicrobial resistance may exceed 10 million by 2050, theoretically leading to greater mortality in the context of other infectious diseases and malignancies [6]. It is well known that infections are generally difficult to treat due to the development of biofilm in the host, which aids the proliferation of microbes as well as the aggressiveness of the infections [7]. Studies have also well-established that the physical structures of biofilm establishing organisms confer natural resistance to hostile environments, including antimicrobial agents [8]. Therefore, it is an urgent requirement to generate novel antimicrobial drugs which can inhibit the development of, or abolish the complete biofilms, and hence increase the vulnerability of microbes to antimicrobials. The requisite for new antimicrobials which could meritoriously fight against antimicrobial resistant clinical pathogens is extremely augmented.

Plant-derived antimicrobials have been established to be one of the most auspicious sources considered as safe due to their natural origin when compared with synthetic compounds [9,10]. There
is an accumulating interest in the practice of either crude extract of medicinal plants, as well as the screening plant-derived compounds as an alternative therapy for microbial infections [11]. Plants generally produce a diverse range of bioactive compounds which have been widely used in clinical practice [12]. Remarkably, a significant number of marketed drugs are obtained from nature or result in natural products through either chemical transformations or de novo synthesis [13]. Plant-derived compounds are a group of secondary metabolites that are used to treat chronic as well as infectious diseases. These traditional medicinal plants or active compounds remain included as part of the habitual treatment of various maladies [9]. These compounds could have other target sites than conventional antimicrobials as well as diverse mechanisms of action against pathogenic microbes.

An electronic search was performed using PubMed, Science Direct, and Google Scholar using the keywords “medicinal plants” AND “bioactive compounds” AND “antimicrobial activities” AND “antibiotic resistance” in “Title/Abstract/Keywords” without date restriction in order to identify all published studies (in vitro, in vivo, clinical and case-control) that have investigated the connection between medicinal plants and their antimicrobial effects. Antimicrobial mechanisms were gathered and for review.

2. Traditional Medicinal Plants

The species of the plant kingdom are estimated to number about 500,000 and only a minor portion of them have been investigated for antimicrobial activity [9,14]. Traditional medicinal plants can be cultivated by humans over centuries without existing systematic standards and analysis due to their safety and efficacy. Hence, bioactive compounds derived from these medicinal plants apparently have more potential to succeed in toxicology screening when compared with the de novo synthesis of chemicals. The cumulative attention on traditional ethnomedicine may lead to the revealing of innovative therapeutic agents since traditional medicinal plant contains potential antimicrobial components that are beneficial for the development of pharmaceutical agents for the therapy of ailments. Nowadays, studies are progressively turning their consideration to traditional medicine and advancing better drugs to treat diabetes, cancer, and microbial infections [15,16]. A large number of studies have been piloted using medicinal plant extracts and their active principles on bacteria, fungi, algae, and viruses in different localities of the world [9,10]. Various families of traditional medicinal plants have been scientifically tested for their antimicrobial activities and are presented in Table 1. The extracts of plant organs, namely the root, stem, rhizome, bulb, leaf, bark, flower, fruit, and seed, may encompass distinctive phytochemicals with antimicrobial activities [17]. It is well-known that sole plant species of traditional medicine are habitually used to heal a great number of infections or diseases [18]. The plant extracts with an antiquity of folk use should be confirmed using contemporary methods for activities against human pathogens with the intention of identifying potential novel therapeutic drugs.
Table 1. Antimicrobial screening performed on various medicinal plants.

| Botanical Name     | Family         | Plant Used | Extracts       | MIC *          | Gram Positive                          | Gram Negative                          | Fungi                                  | References |
|-------------------|----------------|------------|----------------|----------------|----------------------------------------|----------------------------------------|---------------------------------------|------------|
|                   |                |            |                |                | B. subtilis, M. luteus, B. cereus, S. mutans, S. aureus, L. sporogenes | S. typhi, V. Cholera, M. luteus, Citrobacter | S. typhi, V. cholerae, Citrobacter, Providencia | [19]        |
| Adhatoda vasica L. | Acanthaceae    | Leaves     | Aqueous 4% v/v  | 625 μg/mL      | M. tuberculosis, E. coli, S. typhi     | E. coli, S. typhi                        | -                      |            |
|                   |                |            | Methanol 625 μg/mL |               | S. aureus                              | E. coli, S. typhi                        | -                      | [20]        |
| Pellaea calomelanos L. | Adiantaceae | Leaves, Rhizomes | Aqueous 250 μg/mL | 750–12,000 μg/mL | S. aureus, methicillin-resistant S. aureus, gentamycin-methicillin-resistant S. aureus, S. | P. aeruginosa                        | T. mentagrophytes, M. canis | [21]        |
| Plant Name                        | Family          | Plant Part(s)   | Solvent               | Concentration       | Bacterial Strains                                      | Yeast Strains       |
|----------------------------------|-----------------|-----------------|-----------------------|---------------------|--------------------------------------------------------|---------------------|
| *Sambucus australis* Cham. & Schltdl. | Adoxaceae       | Leaves and Bark | Hexane                | 50 μg/mL            | *S. aureus*, *S. typhimurium* and *K. pneumoniae*     | *C. albicans*       |
| *Carpobrotus edulis* L. N.E.Br.   | Aizoaceae       | Leaves          | Aqueous               | 100 μg/mL           | *S. mutans*, *S. sanguis*, *L. acidophilus* *L. casei* | *P. gingivalis*     |
| *Achyanthes aspera* L.            | Amaranthaceae   | Root, Leaves, Stem | Ethanol              | 1 mg/mL             | *S. aureus*, *B. subtilis*, *E. coli*, *P. vulgaris*, *K. pneumoniae* |                    |
| *Alternanthera Sessile* L.        | Amaranthaceae   | Leaves          | Ethanol               | 75 μg/mL            | *S. pyogenes*                                          | *S. typhi*          |
| *Amaranthus caudatus* L.          | Amaranthaceae   | Leaves          | Ethyl Acetate         | 162.2–665 mg/mL     | *S. aureus*, *Bacillus spp.*                           | *E. coli*, *S. typhi*, *P. mirabilis* |
| *Amaranthus hybridus* L.          | Amaranthaceae   | Leaves          | Chloroform            | 1.25 mg/mL          |                                                       |                     |
|                                  |                 |                 | Methanol              | 3–5 mg/mL           |                                                       |                     |
| *Amaranthus spinosus* L.          | Amaranthaceae   | Leaves          | Ethyl Acetate         | 200–755 mg/mL       | *E. coli*, *S. typhi*, *K. pneumoniae*, *P. aeruginosa* |                     |
|                                  |                 |                 | Chloroform            | 1.25 mg/mL          |                                                       |                     |
|                                  |                 |                 | Methanol              | 3–5 mg/mL           |                                                       |                     |
| Plant Name                                | Family          | Part(s)         | Extraction          | Minimum / Maximum Concentration | Bacteria Tested                                                                 | Reference |
|------------------------------------------|-----------------|-----------------|--------------------|---------------------------------|---------------------------------------------------------------------------------|-----------|
| Boophane disticha L.f.                   | Amaryllidaceae  | Leaves          | Aqueous, Dichloromethane/Methanol | 750–12,000 μg/mL                | *S. aureus,* *methicillin-resistant S. aureus,* *gentamicin–methicillin-resistant S. aureus,* *S. epidermidis,* *B. agri,* *P. acnes* | [21]      |
| Scadoxus puniceus (L.) Friis &Nordal.    | Amaryllidaceae  | Rhizomes, Roots | Aqueous, Dichloromethane/Methanol | 750–12,000 μg/mL                | *S. aureus,* *methicillin-resistant S. aureus,* *gentamicin–methicillin-resistant S. aureus,* *S. epidermidis,* *B. agri,* *P. acnes* | [21]      |
| Harpephyllum caffrum Bernh. exKrauss     | Anacardiaceae   | Bark, Leaves    | Aqueous, Dichloromethane/Methanol | 750–12,000 μg/mL                | *S. aureus,* *methicillin-resistant S. aureus,* *gentamicin–methicillin-resistant S. aureus,* *S. epidermidis,* *B. agri,* *P. acnes* | [21]      |
| Lannea discolor Engl.                    | Anacardiaceae   | Leaves          | Aqueous, Dichloromethane/Methanol | 50–200 μg/mL                    | *S. aureus,* *methicillin-resistant S. aureus,* *gentamicin–methicillin-resistant S. aureus,* *S. epidermidis,* *B. agri,* *P. acnes* | [21]      |
| Polyalthia cerascides L.                 | Annonaceae      | Stem Bark       | Dichloromethane     | 100 μg/mL                       | *C. Diptheriae*                                                                  | [27]      |
| Plant Name                        | Family   | Part                    | Extraction Method | MIC (μg/mL)          | Bacteria                                                      | Other Note                                           |
|----------------------------------|----------|-------------------------|-------------------|----------------------|-------------------------------------------------------------|------------------------------------------------------|
| *Berula erecta* Huds., Coville   | Apiaceae | Rhizome, Leaves, Stem   | Aqueous           | 2–16 μg/mL, 750–12000 μg/mL | *S. mutans, S. sanguis*, *L. acidophilus L. casei*          | *P. gingivalis F. nucleatum* C. albicans C. glabrata C. krusei [23] |
| *Acokanthera oppositifolia* L. Codd. | Apocynaceae | Leaves, Stem | Aqueous           | 25–200 μg/mL, 750–12000 μg/mL | *S. mutans, S. sanguis*, *L. acidophilus L. casei*          | *P. gingivalis F. nucleatum* C. albicans C. glabrata C. krusei [23] |
| *Plumeria ruba* L.               | Apocynaceae | Leaves                 | Aqueous           | 50–200 μg/mL, 100 μg/mL | *S. epidermidis*                                             | *E. coli*                                           | [16] |
| *Acokanthera oppositifolia* (Laim.) Codd., | Apocynaceae | Leaves              | Aqueous           | 10–50 μg/mL | *S. aureus*, *methicillin-resistant S. aureus*, *gentamycin–mecillin-resistant S. aureus*, *S. epidermidis*, *B. agri*, *P. acnes* | *P. aeruginosa* T. mentagrophytes, M. canis [21] |
| *Rauvolfia caffra* Sond.         | Apocynaceae | Leaves               | Aqueous           | 25, 50 μg/mL | *S. aureus*, *methicillin-resistant S. aureus*, *gentamycin–mecillin-resistant S. aureus*, *S. epidermidis*, *B. agri*, *P. acnes* | *P. aeruginosa* T. mentagrophytes, M. canis [21] |
| *Calotropis gigantea* L.         | Apocynaceae | Latex                | Ethanol           | 1–8 mg/mL |                                                                 | *C. albicans*, T. mentagrophytes, T. rubrum [16] |
| *Plumeria alba* L.               | Apocynaceae | Root               | Methanol          | 10–40 μg/mL |                                                                   | *E. coli*                                           | [16] |
| Plant Name                        | Family          | Part(s)     | Extraction Method                  | Concentration     | Inhibitory Activities                                                                 | References |
|----------------------------------|-----------------|-------------|------------------------------------|-------------------|---------------------------------------------------------------------------------------|------------|
| Ilex mitis Radlk.                | Aquifoliaceae   | Bark, Leaves| Aqueous/Dichloromethane/Methanol   | 1–8 mg/mL         | *S. aureus*, methicillin-resistant *S. aureus*, gentamicin-methicillin-resistant *S. aureus*, *S. epidermidis*, *B. agri*, *P. acnes* | [21]       |
| Anchomanes difformis Engl.       | Araceae         | Roots       | Methanol                           | 20–100 mg/mL      | methicillin-resistant *S. aureus*                                                      | [28]       |
| Zantedeschia aethiopica Spreng   | Araceae         | Leaves      | Aqueous/Dichloromethane/Methanol   | 50 µg/mL          | *S. aureus*, methicillin-resistant *S. aureus*, gentamicin-methicillin-resistant *S. aureus*, *S. epidermidis*, *B. agri*, *P. acnes* | [21]       |
| Arum dioscoridis L.              | Araceae         | Leaves      | Aqueous                            | 125–500 µg/mL     | *S. aureus*, *S. pneumoniae*, *E. coli*, *S. typhi*, *P. aeruginosa*                   | [29]       |
| Aristolochia Indica L.           | Aristolochiaceae| Leaves      | Ethanol                            | 1–8 mg/mL         | -                                                                                     | [30][3,4,31]| A. niger, A. flavus, A. fumigatus |
| Vernonia blumeoides Hook. f.     | Asteraceae      | Aerial Part | Ethanol                            | 100 µg/mL         | methicillin-resistant *S. aureus*                                                      | [28]       |
| Artemisia afra Jacq. ex Willd.   | Asteraceae      | Leaves, Stem| Aqueous/Dichloromethane/Methanol   | 2–16 µg/mL        | *S. mutans*, *S. sanguis*, *L. acidophilus L. casei*, *P. gingivalis F. nucleatum*    | [23]       |
| Tarchonanthus camphoratus L.     | Asteraceae      | Leaves      | Aqueous/Dichloromethane/Methanol   | 25–200 µg/mL      | *S. mutans*, *S. sanguis*, *L. acidophilus L. casei*, *P. gingivalis F. nucleatum*    | [23]       |
| Plant Species | Family | Plant Part(s) | Extraction Solvent | Minimum Inhibitory Concentration (μg/mL) | Bacteria Species | Yeast Species | References |
|---------------|--------|---------------|--------------------|------------------------------------------|-----------------|--------------|------------|
| *Helichrysum paronychioides* L. | Asteraceae | Whole Plant | Pet ether | 50–200 | *B. cereus*<br>*S. flexneri* | *C. glabrata*, *C. krusei*, *T. rubrum* and *T. tonsurans* | [2] |
| | | | Methanol | 50–200 |  |  | |
| | | |  | 50–200 |  |  | |
| *Senecio longiflorus* L. | Asteraceae | Stem and Leaves | Pet ether | 125–625 | *B. cereus*<br>*S. flexneri* | *C. glabrata*, *C. krusei*, *T. rubrum* and *T. tonsurans* | [2] |
| | | | Methanol | 50–200 |  |  | |
| | | |  | 50–200 |  |  | |
| *Dahlia pinnata* L. | Asteraceae | Leaves | Chloroform | 2–16 | – | *E. aerogenes*,<br>*P. aeruginosa* | – | [16] |
| | | | Aqueous | 25–200 | *S. aureus*,<br>*methicillin-resistant S. aureus*,<br>*gentamycin–methicillin-resistant S. aureus*,<br>*S. epidermidis*, *B. agri*,<br>*P. acnes* |  | |
| *Athrixia phylicoides* DC. | Asteraceae | Leaves | Dichloromethane/Methanol | 750–12,000 | *P. aeruginosa*<br>*T. mentagrophytes*,<br>*M. canis* | – | [21] |
| | | | Aqueous | 50–200 | *S. aureus*,<br>*methicillin-resistant S. aureus*,<br>*gentamycin–methicillin-resistant S. aureus*,<br>*S. epidermidis*, *B. agri*,<br>*P. acnes* |  | |
| *Dicoma anomala* Sond. | Asteraceae | Tuber | Dichloromethane/Methanol | 750–12,000 | *P. aeruginosa*<br>*T. mentagrophytes*,<br>*M. canis* | – | [21] |
| | | | Aqueous | 50–200 | *S. aureus*,<br>*methicillin-resistant S. aureus*,<br>*gentamycin–methicillin-resistant S. aureus*,<br>*S. epidermidis*, *B. agri*,<br>*P. acnes* |  | |
| *Vernonia natalensis* Sch. Bip. exWalp. | Asteraceae | Leaves, Roots | Dichloromethane/Methanol | 750–12,000 | *P. aeruginosa*<br>*T. mentagrophytes*,<br>*M. canis* | – | [21] |
| | | | Aqueous | 10–50 | *S. aureus*,<br>*methicillin-resistant S. aureus*,<br>*gentamycin–methicillin-resistant S. aureus*,<br>*S. epidermidis*, *B. agri*,<br>*P. acnes* |  | |
| Plant Species       | Family       | Part            | Extractant | MIC (μg/mL) | Organisms Tested                                      | Reference |
|--------------------|--------------|-----------------|------------|-------------|------------------------------------------------------|-----------|
| *Achillea millefolium* L. | Asteraceae   | Leaves          | Ethanol    | 50–200      | *S. aureus*, *P. aeruginosa*, *S. typhi*, *E. coli*, *C. albicans* | [29]      |
| *Blumea balsamifer* (Linn.) D.C. | Asteraceae   | Whole Plant     | Ethanol    | 250         | Methicillin-resistant *S. aureus*                   | [32]      |
| *Impatiens balsamina* L. | Balsaminaceae | Leaf            | Ethanol    | 50–200      | Methicillin-resistant *S. aureus*                   | [28]      |
| *Berberis chitria* L. | Berberidaceae | Roots           | Ethanol, Methanol | 5.5–6.5/2.5–3.5 | *S. aureus*, *E. coli*                              | [33]      |
| *Alnus nepalensis* D. Don. | Betulaceae   | TBL             | Ethanol    | 50–200      | Methicillin-resistant *S. aureus*                   | [32]      |
| *Tecoma capensis* Lindl. | Bignoniaceae | Leaves, Stem    | Aqueous, Dichloromethane/Methanol | 10–50/2.5 | *S. mutans*, *S. sanguis*, *L. acidophilus*, *L. casei*, *P. gingivalis*, *F. nucleatum*, *C. albicans*, *C. glabrata*, *C. krusei* | [23]      |
| *Spathodea campanulata* L. | Bignoniaceae | Leaves          | Ethanol    | 221–254     | *B. subtilis*, *S. aureus*                          |          |
|                     |              | Flowers         | Ethanol    | 156–173     | *E. coli*, *K. pneumonia*, *P. vulgaris*, *S. typhi*, *P. aeruginosa*, *T. mentagrophytes*, *M. canis* | [34] [35]|
| *Kigelia africana* (Lam.) Benth. | Bignoniaceae | Fruit           | Aqueous    | 2–16        | *S. aureus*, methicillin-resistant *S. aureus*, *S. epidermidis*, *B. agri*, *P. acnes* | [21]      |
| *Opuntia ficus-indica* Mill. | Cactaceae    | Leaves          | Aqueous    | 25–200      | *S. aureus*, methicillin-resistant *S. aureus*, *P. aeruginosa* | [21]      |
| Plant                          | Family           | Part(s)                          | Extraction Method | MIC (mg/mL) | Antimicrobial Activity                                                                 |
|-------------------------------|------------------|----------------------------------|-------------------|-------------|----------------------------------------------------------------------------------------|
| *Senna italic* L.             | Caesalpiniaceae  | Leaves                           | Acetone           | 2.5         | *S. aureus*, *S. epidermidis*, *B. agri*, *P. acnes*                                   |
| *Cassia fistula* L.           | Caesalpiniaceae  | Seeds                            | Aqueous Ethanol   | 780–6250 780–6250 μg/mL | *S. aureus* - - [36] *B. cereus*, *B. pumilus*, *B. subtilis*, *S. aureus*, *E. faecalis*, *S. epidermidis*, *B. agri*, *P. acnes* |
| *Warburgia salutaris* (G. Bertol.) Chiov. | Canellaceae | Bark, Twigs                       | Aqueous           | 5.0–10      | *S. mutans*, *S. sanguis*, *L. acidophilus*, *L. casei* *S. aureus*, *methicillin-resistant* *S. aureus*, *gentamycin-methicillin-resistant* *S. aureus*, *S. epidermidis*, *B. agri*, *P. acnes* |
|                                |                  |                                  | Dichloromethane, Methanol | 750–12,000 750–12,000 μg/mL | *P. gingivalis*, *F. nucleatum*, *C. albicans*, *C. glabrata*, *C. krusei*, *T. mentagrophytes*, *M. canis* |
| *Cadaba fruticosa* L.         | Capparaceae      | Leaves                           | Acetone Aqueous   | 100–200     | *S. pyogenes*, *S. aureus*, *B. subtilis*, *S. typhi*, *P. vulgaris*, *K. pneumoniae*, *P. aeruginosa*, *E. coli* |
|                                |                  |                                  | Benzene Butanol   | 4–16        |                                                         |
|                                |                  |                                  | Chloroform Ethanol| 4–16        |                                                         |
| **Boszia senegalensis** Del. | Capparidaceae | Roots | Methanol | 10–20 μg/mL | methicillin-resistant S. aureus | - | - | [28] |
| **Celastrus orbiculatus** Thunb. | Celastraceae | Vane | Ethanol | 1–2 mg/mL | methicillin-resistant S. aureus | - | - | [32] |
| **Euonymus fortunei** (Turcz.); Hand. Mazz. | Celastraceae | Leaves | Ethanol | 10–40 μg/mL | methicillin-resistant S. aureus | - | - | [32] |
| **Chenopodium ambrosioides** Bert. ex Steud. | Chenopodiaceae | Leaves | Aqueous | 2–16 μg/mL | S. aureus, methicillin-resistant S. aureus, gentamycin–methicillin-resistant S. aureus, S. epidermidis, B. agri, P. acnes | P. aeruginosa | T. mentagrophytes, M. canis | [21] |
| **Garcinia mangostana** L. | Clusiaceae | Fruit Shell | Ethanol | 25–200 μg/mL | methicillin-resistant S. aureus | - | - | [28] |
| **Garcinia morella** Desr. | Clusiaceae | Whole Plant | Ethanol | 100–400 μg/mL | methicillin-resistant S. aureus | - | - | [32] |
| **Terminalia paniculata** L. | Combretaceae | Stem Bark | Ethyl Acetate | 3.25, 3.5 mg/mL | S. aureus, B. subtilis | - | - | [38] |
| **Terminalia sericea** Burch. ex DC. | Combretaceae | Roots | Dichloromethane/Methanol | 750–12,000 μg/mL | methicillin-resistant S. aureus, gentamycin–methicillin-resistant S. aureus, S. epidermidis, B. agri, P. acnes | P. aeruginosa | T. mentagrophytes, M. canis | [21] |
| **Eupatorium odoratum** L. | Compositae | Leaves | Benzene | 300–600 μg/mL | B. cereus, S. aureus | E. coli, K. pneumoniae, V. cholerae | C. albicans | [39] |
| Plant Name                  | Family      | Part                  | Solvent            | Concentration          | Antimicrobial Activity                                      |
|-----------------------------|-------------|-----------------------|--------------------|------------------------|----------------------------------------------------------------|
| *Acmella paniculata* L.     | Compositae  | Whole Plant           | Acetone            | 300–600 μg/mL          | -                                                             |
|                             |             |                       | Chloroform         | 15 μg/mL               | -                                                             |
|                             |             |                       | Pet. ether         | 5–15 μg/mL             | -                                                             |
|                             |             |                       | Methanol           | 5–15 μg/mL             | -                                                             |
| *Cotyledon orbiculata* L.   | Crassulaceae| Leaves                | Aqueous            | 5–30 μg/mL             | *S. mutans, S. sanguis, L. acidophilus L. casei* |
|                             |             |                       | Dichloromethane    | 750–12,000 μg/mL       | *P. gingivalis F. nucleatum* |
|                             |             |                       | Methanol           | 500 μg/mL              | *C. albicans C. glabrata C. krusei* |
| *Mormodica basalmina* L.    | Cucurbitaceae| Whole Plant          | Methanol           | 500 μg/mL              | *methicillin-resistant S. aureus* |
| *Coccinia grandis* L.       | Cucurbitaceae| Leaves               | Aqueous            | 500 μg/mL              | -                                                             |
|                             |             |                       | Dichloromethane    | 2 mg/mL                | *B. cereus, S. aureus* |
| *Luffa acyntangula* L.      | Cucurbitaceae| Leaves               | Aqueous            | 5 mg/mL                | *B. cereus, S. aureus* |
|                             |             |                       | Dichloromethane    | 2 mg/mL                | -                                                             |
| *Mukia maderspatana* L.     | Cucurbitaceae| Leaves               | Aqueous            | 5 mg/mL                | *B. cereus, S. aureus* |
|                             |             |                       | Dichloromethane/Methanol | 1 mg/mL       | -                                                             |
| *Cucurbitaceae*             |             | Leaves                | Aqueous            | 5 mg/mL                | *B. cereus, S. aureus* |
| Plant Name | Family | Part | Extract | Concentration | Antimicrobial Activity |
|------------|--------|------|---------|---------------|------------------------|
| *Trichosanthes cucumerina* L. | Cucurbitaceae | Leaves, Roots | Dichloromethane/Methanol | 1 mg/mL | B. cereus, B. pumilus, B. subtilis, S. aureus, E. faecalis, E. coli, E. cloacae, K. pneumoniae, P. aeruginosa, S. marcescens |
| *Momordica balsamina* L. | Cucurbitaceae | Leaves, Roots | Acetone | 500 μg/mL | - |
| *Carex praenii* C.B. Clarke | Cyperaceae | Whole Plant | Ethanol | 15–45 μg/mL | methicillin-resistant S. aureus |
| *Dioscorea dregeana* T. Durand & Schinz. | Dioscoreaceae | Tuber | Dichloromethane/Methanol | 750–12,000 μg/mL | S. aureus, methicillin-resistant S. aureus, gentamycin–methicillin-resistant S. aureus, S. epidermidis, B. agri, P. acnes, P. aeruginosa, T. mentagrophytes, M. canis |
| *Sansevieria hyacinthoides* L. | Dracaenaceae | Leaves, rhizome | Dichloromethane/Methanol | 1–4 mg/mL, 750–12,000 μg/mL | S. mutans, S. sanguis, L. acidophilus L. casei, P. gingivalis F. nucleatum, C. albicans C. glabrata C. krusei |
| *Diospyros mespiliformis* Hochst. ex A. DC. | Ebenaceae | Leaves | Dichloromethane/Methanol | 750–12,000 μg/mL | S. aureus, methicillin-resistant S. aureus, gentamycin–methicillin-resistant S. aureus, S. epidermidis, B. agri, P. acnes, P. aeruginosa, T. mentagrophytes, M. canis |
| *Phyllanthus amarus* Schum. Thonn. | Euphorbiaceae | Whole Plant | Methanol | 650–600 μg/mL | methicillin-resistant S. aureus |
| | Euphorbiaceae | Aqueous | | 5 mg/mL | - |

References: [42], [32], [21], [23], [28]
| Plant Name                  | Family       | Parts                  | Solvent                  | MIC Range | Assayed Bacteria                                                                 | MIC Range | Other Species                                                                 |
|----------------------------|--------------|------------------------|--------------------------|-----------|----------------------------------------------------------------------------------|-----------|-------------------------------------------------------------------------------|
| Croton gratissimus Burch.  | Euphorbiaceae| Leaves, Stem           | Dichloromethane/Methanol | 750–12,000 | *S. mutans*, *S. sanguis*, *L. acidophilus*, *L. casei*, *P. gingivalis*          | C. albicans C. glabrata C. krusei |
| Spirostachys africana Sond.| Euphorbiaceae| Leaves, Bark           | Dichloromethane/Methanol | 750–12,000 | *S. mutans*, *S. sanguis*, *L. acidophilus*                                    | P. gingivalis F. nucleatum |
| Acalypha indica L.         | Euphorbiaceae| Leaves                 | Aqueous                  | 4% v/v    | *M. tuberculosis*                                                                | -         | -                                                                             | [43]        |
| Bridelia micrantha Baill.  | Euphorbiaceae| Bark, Leaves           | Dichloromethane/Methanol | 750–12,000 | *S. aureus*, *methicillin-resistant S. aureus*, *gentamycin-methicillin-resistant S. aureus*, *S. epidermidis*, *B. agri*, *P. acnes* | P. aeruginosa T. mentagrophytes, M. canis |
| Emblica officinalis L.     | Euphorbiaceae| Leaves                 | Benzene                  | 350–600   | *B. cereus*, *S. aureus*, *K. pneumonia*, *V. cholera*                          | E. coli, C. albicans |
| Hevea brasiliensis L.      | Euphorbiaceae| Leaves                 | Benzene                  | 350–600   | *B. cereus*, *S. aureus*, *K. pneumonia*, *V. cholera*                          | E. coli, C. albicans |
| Mallotus yunnanensis Pax et. Hoffm. | Euphorbiaceae| Tender Branches & Leaves | Ethanol                | 8–256     | methicillin-resistant *S. aureus*                                               | -         | -                                                                             | [32]        |
| Acacia albida Del.         | Fabaceae     | Stem, Bark             | Methanol                 | 50        | methicillin-resistant *S. aureus*                                               | -         | -                                                                             | [28]        |
| Plant Name                        | Family       | Part Used      | Extract Used     | MIC (μg/mL) | Antibacterial Activity                                                                 |
|----------------------------------|--------------|----------------|------------------|-------------|----------------------------------------------------------------------------------------|
| *Acacia catechu* (L. f.) Willd.  | Fabaceae     | Wood           | Ethanol          | 100         | methicillin-resistant *S. aureus*                                                        |
| *Peltophorum pterocarpum* (DC.)  | Fabaceae     | Bark           | Ethanol          | 4% v/v      | methicillin-resistant *S. aureus*                                                        |
| *Acacia erioloba* Edgew.         | Fabaceae     | Bark and Leaves| Aqueous         | 1.56–3.12 mg/mL | *S. aureus,* methicillin-resistant *S. aureus,* gentamicin—methicillin-resistant *S. aureus,* *S. epidermidis,* *B. agri,* *P. acnes* |
|                                  |              |                | Dichloromethane/Methanol | 750–12,000 μg/mL | *P. aeruginosa,* *T. mentagrophytes,* *M. canis* |
| *Dichrostachys cinerea* L.       | Fabaceae     | Stem           | Aqueous         | 129         | *S. mutans,* *S. sanguis,* *L. acidophilus,* *L. casei*                                |
|                                  |              |                | Dichloromethane/Methanol | 750–12,000 μg/mL | *P. gingivalis F. nucleatum* *C. albicans* *C. glabrata* *C. krusei*                   |
| *Albizia odoratissima* (L.f.) Benth | Fabaceae     | Leaves         | Hexane          | 7.5–15 mg/mL | *K. pneumoniae,* *E. coli,* *P. aeruginosa,* *P. vulgaris*                              |
|                                  |              |                | Chloroform      | 859–6875 μg/mL | *S. aureus*                                                                            |
|                                  |              |                | Ethyl Acetate   | 136–546 μg/mL |                                                                                  |
|                                  |              |                | Methanol        | 136–546 μg/mL |                                                                                  |
| *Prosopis juliflora* L.          | Fabaceae     | Pod            | Chloroform      | 250         | *M. luteus,* *S. aureus,* *S. mutans*                                                   |
|                                  |              |                |                 |             |                                                                                        |
| *Bauhinia macranthera* Benth. Ex Hemsl. | Fabaceae     | Leaves         | Aqueous         | 1.56–3.12 mg/mL | *S. aureus,* methicillin-resistant *S. aureus,* gentamicin—methicillin-resistant *S. aureus,* *S. aureus* |
|                                  |              |                | Dichloromethane/Methanol | 750–12,000 μg/mL | *P. aeruginosa,* *T. mentagrophytes,* *M. canis* |

MIC: Minimum Inhibitory Concentration; *S. aureus*: Staphylococcus aureus; *S. epidermidis*: Staphylococcus epidermidis; *B. agri*: Bacillus agri; *P. acnes*: Propionibacterium acnes.
| Plant Name                        | Family       | Part         | Extraction Method                  | Concentration | Antibiotic Activity                                                                 |
|----------------------------------|--------------|--------------|------------------------------------|---------------|-------------------------------------------------------------------------------------|
| Erythrina lysistemon Hutch.      | Fabaceae     | Leaves       | Aqueous and Methanol               | 4 mg/mL       | *S. aureus*, *methicillin-resistant S. aureus*, *P. acnes*, *S. sanguis*, *L. acidophilus*, *L. casei* |
| Elephantorrhiza elephantina      | Fabaceae     | Leaves, roots and rhizomes          | Aqueous and Methanol               | 1–4 mg/mL     | *S. aureus*, *methicillin-resistant S. aureus*, *P. aeruginosa*, *S. flexneri*   |
| Albizia lebbeck L.               | Fabaceae     | Leaves       | Benzene, Aqueous and Acetone       | 350–600 μg/mL | *B. cereus*, *S. aureus*, *E. coli*, *K. pneumoniae*, *V. cholera*, *C. albicans* |
| Adenanthera pavonina L.          | Fabaceae     | Leaves       | Aqueous and Methanol               | 5 mg/mL       | *B. cereus*, *S. aureus*                                                           |
| Alysicarpus vaginalis L.         | Fabaceae     | Leaves       | Aqueous and Methanol               | 5 mg/mL       | *B. cereus*, *S. aureus*                                                           |
| Bauhinia acuminate L.            | Fabaceae     | Leaves       | Aqueous and Methanol               | 5 mg/mL       | *B. cereus*, *S. aureus*                                                           |
| Bauhinia purpurea L.             | Fabaceae     | Leaves       | Aqueous and Methanol               | 5 mg/mL       | *B. cereus*, *S. aureus*                                                           |
| Plant Species                  | Family       | Part(s)                  | Extraction Method | Concentration (μg/mL) | Bacteria Tested | Minimum Inhibitory Concentration (MIC) | Reference |
|-------------------------------|--------------|--------------------------|-------------------|----------------------|----------------|----------------------------------------|-----------|
| Bauhinia racemose L.          | Fabaceae     | Leaves, Stem Bark        | Aqueous           | 500 μg/mL            | B. cereus, S. aureus | -                                      | [41]      |
|                               |              |                          | Dichloromethane/  | 500 μg/mL            |                |                                        |           |
|                               |              |                          | Methanol          |                     |                |                                        |           |
| Cassia alata L.               | Fabaceae     | Leaves                   | Aqueous           | 250 μg/mL            | B. cereus, S. aureus | -                                      | [41]      |
|                               |              |                          | Dichloromethane/  | 250 μg/mL            |                |                                        |           |
|                               |              |                          | Methanol          |                     |                |                                        |           |
| Cassia auriculata L.          | Fabaceae     | Leaves                   | Aqueous           | 1 mg/mL              | B. cereus, S. aureus | -                                      | [41]      |
|                               |              |                          | Dichloromethane/  | 4 mg/mL              |                |                                        |           |
|                               |              |                          | Methanol          |                     |                |                                        |           |
| Cassia fistula L.             | Fabaceae     | Root Bark, Stem Bark     | Aqueous           | 1–5 mg/mL            | B. cereus, S. aureus | -                                      | [41]      |
|                               |              |                          | Dichloromethane/  | 1–5 mg/mL            |                |                                        |           |
|                               |              |                          | Methanol          |                     |                |                                        |           |
| Cassia tora L.                | Fabaceae     | Leaves, Root Bark, Stem Bark | Aqueous           | 250–4000 μg/mL       | B. cereus, S. aureus | -                                      | [41]      |
|                               |              |                          | Dichloromethane/  | 250–4000 μg/mL       |                |                                        |           |
|                               |              |                          | Methanol          |                     |                |                                        |           |
| Crotalaria retusa L.          | Fabaceae     | Leaves                   | Aqueous           | 4 mg/mL              | B. cereus, S. aureus | -                                      | [41]      |
|                               |              |                          | Dichloromethane/  | 60 μg/mL             |                |                                        |           |
|                               |              |                          | Methanol          |                     |                |                                        |           |
| Crotalaria verrucosa L.       | Fabaceae     | Leaves                   | Aqueous           | 1 mg/mL              | B. cereus, S. aureus | -                                      | [41]      |
|                               |              |                          | Dichloromethane/  | 1 mg/mL              |                |                                        |           |
|                               |              |                          | Methanol          |                     |                |                                        |           |
| Derris Scandens L.            | Fabaceae     | Leaves                   | Aqueous           | 100 μg/mL            | B. cereus, S. aureus | -                                      | [41]      |
|                               |              |                          | Dichloromethane/  | 100 μg/mL            |                |                                        |           |
|                               |              |                          | Methanol          |                     |                |                                        |           |
| Desmodium triflorum (L.) DC.  | Fabaceae     | Stem Bark                | Aqueous           | 1 mg/mL              | B. cereus, S. aureus | -                                      | [41]      |
| var. majus Wight & Arn.       |              |                          | Dichloromethane/  | 1 mg/mL              |                |                                        |           |
|                               |              |                          | Methanol          |                     |                |                                        |           |
|                               |              |                          | Dichloromethane/  | 25 μg/mL             |                |                                        |           |
|                               |              |                          | Methanol          |                     |                |                                        |           |
| Plant Name                  | Family         | Organs                  | Extraction | MIC | Antimicrobial Activity          | Reference |
|-----------------------------|---------------|-------------------------|------------|-----|-------------------------------|-----------|
| Erythria variegata L.       | Fabaceae      | Leaves, Stem Bark       | Aqueous    | 1–5 mg/mL, 250–1000 µg/mL     | B. cereus, S. aureus | [41] |
| Indigofera tinctoria L.     | Fabaceae      | Leaves                  | Aqueous    | 500 µg/mL                      | B. cereus, S. aureus | [41] |
| Mimosa pudica L.            | Fabaceae      | Stem Bark               | Aqueous    | 1–2 mg/mL, 250–5000 µg/mL      | B. cereus, S. aureus | [41] |
| Myroxylon balsamum L.       | Fabaceae      | Leaves                  | Aqueous    | 1 mg/mL, 500 µg/mL             | B. cereus, S. aureus | [41] |
| Pterocarpus marsupium Roxb. | Fabaceae      | Leaves                  | Aqueous    | 4 mg/mL, 250 µg/mL             | B. cereus, S. aureus | [41] |
| Pterocarpus santalinus L.   | Fabaceae      | Leaves                  | Aqueous    | 2 mg/mL, 4 mg/mL               | B. cereus, S. aureus | [41] |
| Saraca asoca (Roxb.) Willd  | Fabaceae      | Leaves                  | Aqueous    | 120 µg/mL, 5 mg/mL             | B. cereus, S. aureus | [41] |
| Sesbania grandiflora (L.) Poiret | Fabaceae | Stem Bark, Root Bark, Leaves | Aqueous, Dichloromethane/ Methanol | 2 mg/mL, 100 µg/mL | B. cereus, S. aureus | [41] |
| Tamarindus indica L.        | Fabaceae      | Leaves                  | Aqueous    | 250–500 µg/mL                  | B. cereus, S. aureus | [41] |
| Tephrosia purpurea L. Pers. | Fabaceae      | Leaves                  | Aqueous    | 5 mg/mL, 5 mg/mL               | B. cereus, S. aureus | [41] |
| Species                        | Family       | Part         | Extractants                          | MIC (μg/mL)                      | Bacteria                                      | R-SSL | References |
|-------------------------------|--------------|--------------|--------------------------------------|----------------------------------|-----------------------------------------------|-------|------------|
| *Butea monosperma* L.         | Fabaceae     | Leaves       | Aqueous, Dichloromethane/Methanol/Ethanol | 4 mg/mL, 2 mg/mL, 100–200 μg/mL | *B. cereus, S. aureus, methicillin-resistant S. aureus* | -     | [41,45]   |
| *Senna alata*                 | Fabaceae     | Leaf         | Ethanol                              | 100 μg/mL                         | *methylillin-resistant S. aureus*             | -     | [46]       |
| *Quercus infectoria* Olivier | Fagaceae     | Nutgalls     | Ethanol                              | 100–200 μg/mL                     | *methylillin-resistant S. aureus*             | -     | [16]       |
| *Cyclobalanopsis austroglauca* Y.T. Chang | Fagaceae | TBL          | Ethanol                              | 8–256 μg/mL                       | *methylillin-resistant S. aureus*             | -     | [32]       |
| *Scaevola spinescens* L.      | Goodeniaceae | Aerial parts | Ethyl Acetate, Methanol              | 500 μg/mL                         | *S. pyogenes, S. aureus*                      | -     | [38]       |
| *Gunnera perpensa* L.         | Gunneraceae  | Leaves, Rhizome | Dichloromethane/Methanol            | 750–12,000 μg/mL                  | *S. aureus, methicillin-resistant S. aureus, gentamycin-methicillin-resistant S. aureus, S. epidermidis, B. agri, P. acnes* | P. aeruginosa | [21]       |
| *Eucomis punctate* L’Her.     | Hyacinthaceae | Leaves      | Aqueous, Dichloromethane/Methanol   | 500 μg/mL, 750–12,000 μg/mL       | *S. mutans, S. sanguis, L. acidophilus L. casei, P. gingivalis F. nucleatum* | C. albicans C. glabrata C. krusei | [23]       |
| *Drimia sanguinea* L.         | Hyacinthaceae | Bulb        | Pet ether                            | 18.75, 37.5, 300, 600, 1200 μg/mL | *B. cereus, S. flexneri*                     | C. glabrata, C. krusei, T. rubrum, T. tonsurans | [2]        |
| *Hypoxis hemerocallidea* L.   | Hypoxidaceae | Leaves      | Pet ether                            | 195–12,500 μg/mL                  | *B. cereus, S. flexneri*                     | T. rubrum, T. tonsurans, C. glabrata C. krusei | [47]       |
| Plant                  | Family               | Part                          | Extraction/Preservation | MIC (µg/mL)          | Antibacterial Activity                                                                 |
|-----------------------|----------------------|-------------------------------|--------------------------|----------------------|----------------------------------------------------------------------------------------|
| Curculigo orchioides  | Hypoxidaceae         | Whole Plant                   | Methanol                 | 390–3125             | methicillin-resistant S. aureus                                                         |
| Gaertn.               |                      |                               | Ethanol                  | 8–256                |                                                                                        |
| Illicium simonsii     | Illiciaceae          | TBL                           | Ethanol                  | 8–256                | methicillin-resistant S. aureus                                                         |
| Maxim.                |                      |                               |                          |                      |                                                                                        |
| Aristeia ecklonii     | Iridaceae            | Leaves and Roots              | Aqueous                  | 129                  | S. aureus, methicillin-resistant S. aureus, gentamycin–methylcillin-resistant S. aureus, S. epidermidis, B. agri, P. acnes |
| Baker.                |                      |                               | Dichloromethane/         | 750–12,000           |                                                                                        |
|                       |                      |                               | Methanol                 | µg/mL                |                                                                                        |
| Tetradenia riparia    | Lamiaceae            | Leaves, Stem                  | Aqueous                  | 200–755              | S. mutans, S. sanguis, L. acidophilus L. casei                                         |
| Hochst.               |                      |                               | Dichloromethane/         | 750–12,000           |                                                                                        |
|                       |                      |                               | Methanol                 | µg/mL                |                                                                                        |
| Thymus vulgaris L.    | Lamiaceae            | Leaves                        | Essential Oil           | 50                   | methicillin-resistant S. aureus                                                         |
|                       |                      |                               | Methanol                 | µg/mL                |                                                                                        |
| Mentha aquatica L.    | Lamiaceae            | Aerial Parts                  | Chloroform              | 1.56–3.12            |                                                                                       |
|                       |                      |                               |                          | 128                  |                                                                                       |
|                       |                      |                               |                           | 32–128               |                                                                                       |
|                       |                      |                               | Acetone                  | µg/mL                |                                                                                       |
| Stachys guyoniana     | Lamiaceae            | Leaves                        | n-Butanol               | 4                    |                                                                                       |
| Noë ex. Batt.         |                      |                               |                          |                      |                                                                                       |
|                       |                      |                               | Ethyl Acetate            | 128                  |                                                                                       |
|                       |                      |                               |                           | 32–128               |                                                                                       |
|                       |                      |                               | Chloroform               | µg/mL                |                                                                                       |
| Ocimum basilicum L.   | Lamiaceae            | Stem, leaves                  | Ethanol                  | 1–4                  |                                                                                       |
|                       |                      |                               |                          |                      |                                                                                        |
| Plant Name                        | Family          | Part                  | Extraction solvent | MIC (μg/mL) | Bacteria Species                                      | References |
|----------------------------------|-----------------|-----------------------|--------------------|-------------|------------------------------------------------------|------------|
| *Ocimum gratissimum* L.          | Lamiaceae       | Leaves                | Methanol           | 780–6250    | *S. aureus*, *S. typhi, E. coli*, *S. paratyphi*     | [38]       |
| *Ocimum sanctum* L.              | Lamiaceae       | Whole Plant           | Methanol           | 360         | *S. aureus*, *S. saprophyticus*                      | [6]        |
| *Mentha longifolia* Huds.        | Lamiaceae       | Leaves                | Aqueous/Dichloromethane/Methanol | 150, 300, 600, 750–12,000 | *S. aureus*, *S. saprophyticus*, *S. typhi*, *E. coli*, *S. paratyphi* | [21]       |
| *Melissa officinalis* L.         | Lamiaceae       | Leaves                | Ethanol            | 49          | -                                                   | [42]       |
| *Ocimum americanum* L.           | Lamiaceae       | Leaves                | Acetone            | 2.5         | *B. cereus*, *B. pumilus*, *B. subtilis*, *S. aureus*, *E. faecalis* | [16]       |
| *Machilus salicina* Hance.       | Lauraceae       | Tender Branches & Leaves | Ethanol           | 500         | methicillin-resistant *S. aureus*                    | [32]       |
| *Meliosma squamulata* Hance.     | Lauraceae       | TBL                   | Ethanol            | 1–4         | methicillin-resistant *S. aureus*                    | [32]       |
| *Sophora alopecuroides*          | Leguminosae     | Aerial Parts, Seeds   | Ethanol            | 129         | *B. subtilis*, *S. aureus*, *B. subtilis*            | [50]       |
| *Acacia karroo* Hayne.           | Leguminosae     | Leaves, Stem          | Aqueous/Dichloromethane/Methanol | 200–755, 750–12,000 | *S. mutans*, *S. sanguis*, *L. acidophilus*, *L. casei*, *P. gingivalis*, *F. nucleatum*, *C. albicans*, *C. glabrata*, *C. krusei* | [23]       |
| *Acacia polyacantha* Willd.      | Leguminosae     | Leaves, Stem          | Aqueous            | 50          | *S. mutans*, *S. sanguis*, *L. acidophilus*, *L. casei*, *P. gingivalis*, *F. nucleatum*, *C. albicans*, *C. glabrata*, *C. krusei* | [23]       |
| Plant Species                     | Family            | Tissue                  | Extractant       | MIC Range       | Bacteria Tested                      | Authors Note |
|----------------------------------|-------------------|-------------------------|------------------|----------------|--------------------------------------|--------------|
| Dalbergia obovate E. Mey.        | Leguminosae       | Leaves, stem            | Aqueous          | 1.56–3.12 mg/mL | S. mutans, S. sanguis, L. acidophilus L. casei, P. gingivalis F. nucleatum, C. albicans C. glabrata C. krusei | [23]         |
| Sophora jaubertii                | Leguminosae       | Aerial Parts, Seeds     | Alcohol          | 4 mg/mL         | B. subtilis, P. aeruginosa, S. aureus | [38]         |
| Glycyrrhiza glabra L.            | Leguminosae       | Leaves                  | Methanol         | 1–4 mg/mL       | K. kristinae, M. luteus, S. auricularis, B. megaterium, A. bohemicus, E. coli | [51]         |
| Allium cepa L.                   | Liliaceae         | Bulb                    | Aqueous          | 780–6250 μg/mL  | M. tuberculosis                      | [43]         |
| Allium sativum L.                | Liliaceae         | Bulb                    | Aqueous          | 4% v/v          | M. tuberculosis                      | [43]         |
| Allium vera L.                   | Liliaceae         | Gel                     | Aqueous          | 4% v/v          | M. tuberculosis                      | [43]         |
| Lobelia nicotianaeefolia L.      | Lobeliaceae       | Root                    | Chloroform       | 129 mg/mL       | S. aureus                           | [39]         |
|                                 |                   |                         | Acetone          | 6 mg/mL         |                                      |              |
|                                 |                   |                         | Ethanol          | 6 mg/mL         |                                      |              |
|                                 |                   |                         | Methanol         | 6 mg/mL         | S. aureus                           | [39]         |
| Woodfordia fruticose L.          | Lythraceae        | Flower                  | Aqueous          | 200–755 mg/mL   | S. aureus, B. cereus, S. typhi, E. coli, S. dysenteriae, V. cholerae | [37]         |
| Manglietia hongheensis Y.m Shui et. W.H. Chen. | Magnoliaceae | TBL                     | Ethanol          | 50 μg/mL        | methicillin-resistant S. aureus     | [32]         |
| Malva parviflora L.              | Malvaceae         | Leaves                  | Aqueous          | 500 μg/mL       | S. aureus, methicillin-resistant S. aureus, P. aeruginosa | [21]         |
| Plant Species                  | Family        | Part Used            | Extraction Method | MIC (μg/mL) | Antimicrobial Activity                                                                 |
|-------------------------------|---------------|----------------------|-------------------|-------------|-----------------------------------------------------------------------------------------|
| Sida rhombifolia L.           | Malvaceae     | Stem                 | Chloroform        | 162.2–665 mg/mL | *S. lutea*, *B. subtilis*, *E. coli*, *Shigella* shiga, *P. vulgaris*, *E. coli*, *P. aeruginosa* |
| Walsura robusta L.            | Meliaceae     | Wood                 | Ethanol           | 250 μg/mL   | methicillin-resistant *S. aureus*, *T. mentagrophytes*, *M. canis*                      |
| Swietenia mahagoni            | Meliaceae     | Seed                 | Ethanol           | 500 μg/mL   | methicillin-resistant *S. aureus*, *T. mentagrophytes*, *M. canis*                      |
| Azadirachta indica            | Meliaceae     | Leaves, Stem         | Methanol          | 1.56–3.12 mg/mL | *M. luteus*, *S. aureus*, *S. pyogenes*, *P. vulgaris*, *E. coli*, *P. aeruginosa*       |
| Ekebergia capensis Sparrm.    | Meliaceae     | Bark, Leaves         | Dichloromethane/Methanol | 750–12,000 μg/mL | *P. aeruginosa*, *T. mentagrophytes*, *M. canis*                                        |
| Trichilia emetica Vahl        | Meliaceae     | Leaves               | Dichloromethane/Methanol | 750–12,000 μg/mL | *P. aeruginosa*, *T. mentagrophytes*, *M. canis*                                        |
| Melia azedarach L.            | Meliaceae     | Leaves               | Methanol          | 3.33–3.3 mg/mL | *B. cereus*, *S. aureus*, *E. coli*, *P. aeruginosa*, *A. niger*, *A. flavus*, *F. oxysporum*, *R. stolonifer* |

**Notes:**
- MIC: Minimal Inhibitory Concentration
- *S.*: Staphylococcus
- *E.*: Escherichia
- *P.*: Pseudomonas
- *A.*: Aspergillus
- *F.*: Fusarium
- *R.*: Rhizopus
- *T.*: Trichophyton
- *M.*: Microsporum
| Plant Name | Family | Part | Extraction | Concentration | Antibiotic Activity |
|------------|--------|------|------------|---------------|---------------------|
| *Melianthus comosus* Vahl. | Melianthaceae | Leaves | Aqueous | 50 mg/mL | *S. aureus*, methicillin-resistant *S. aureus*, gentamicin–methicillin-resistant *S. aureus*, *S. epidermidis*, *B. agri*, *P. acnes*, methicillin-resistant *S. aureus* |
| *Melianthus major* L. | Melianthaceae | Leaves | Ethanol | 10–100 mg/mL | methicillin-resistant *S. aureus* |
| *Melianthus major* L. | Melianthaceae | Leaves | Aqueous | 5–50 mg/mL | *S. aureus*, methicillin-resistant *S. aureus*, gentamicin–methicillin-resistant *S. aureus*, *S. epidermidis*, *B. agri*, *P. acnes* |
| *Cissampelos torulosa* E. Mey. Ex Harv. | Menispermaceae | Leaves, Stem | Aqueous | 25, 50, 100 mg/mL | *S. mutans*, *S. sanguis*, *L. acidophilus*, *L. casei* |
| *Tinospora crispa* L. | Menispermaceae | Stem | Ethanol | 10 mg/mL | methicillin-resistant *S. aureus* |
| *Cissampelos capensis* Thunb. | Menispermaceae | Leaves | Aqueous | 3.33–33.3 mg/mL | *S. aureus*, methicillin-resistant *S. aureus*, *P. aeruginosa* |
| Plant Species               | Family           | Part(s)       | Extraction Method                  | MIC Range (μg/mL) | Antimicrobial Activity                                                                 | References |
|----------------------------|------------------|---------------|------------------------------------|-------------------|----------------------------------------------------------------------------------------|------------|
| Ficus natalensis Hochst.   | Moraceae         | Leaves        | Aqueous, Dichloromethane/Methanol  | 250–12,000 μg/mL  | S. aureus, methicillin-resistant S. aureus, gentamycin–methicillin-resistant S. aureus, S. epidermidis, B. agri, P. acnes | [21]       |
| Ficus sur Forssk.          | Moraceae         | Bark, Leaves  | Aqueous, Dichloromethane/Methanol  | 750–12,000 μg/mL  | P. aeruginosa, T. mentagrophytes, M. canis                                            | [21]       |
| Moringa oleifera Lam.      | Moringaceae      | Leaf          | Ethanol                            | 5–50 mg/mL        | methicillin-resistant S. aureus                                                        |           |
| Myrothamnus flabellifolia Welw., | Myrothamnaceae | Leaves        | Aqueous, Dichloromethane/Methanol  | 156–625 μg/mL, 750–12,000 μg/mL | S. mutans, S. sanguis, L. acidophilus L. casei, P. gingivalis F. nucleatum, C. albicans C. glabrata C. krusei | [23]       |
| Embelia ruminata (E. Mey.exA.Dc.)Mez | Myrsinaceae | leaves        | Aqueous, Dichloromethane/Methanol  | 350–600 μg/mL, 750–12,000 μg/mL | S. aureus, methicillin-resistant S. aureus, gentamycin–methicillin-resistant S. aureus, S. P. aeruginosa, T. mentagrophytes, M. canis | [21]       |
| Common Name                      | Family         | Part(s)          | Extraction solvent | Concentration(s)          | Inhibition of strains                                      | References |
|----------------------------------|----------------|------------------|--------------------|---------------------------|------------------------------------------------------------|------------|
| Embelia burm f.                  | Myrsinaceae    | Leaves           | Ethanol            | 500 μg/mL                 | methicillin-resistant S. aureus                            | [32]       |
| Callistemon rigidus R.Br.        | Myrtaceae      | Leaf             | Methanol           | 800 mg/disc               | methicillin-resistant S. aureus                            | [28]       |
| Psidium guajava L.               | Myrtaceae      | Leaf             | Ethanol            | 600, 1200 μg/mL           | methicillin-resistant S. aureus                            | [28]       |
| Heteropyxis natalensis Harv.     | Myrtaceae      | Leaves, Stem     | Aqueous,           | 5 mg/mL                   | S. mutans, S. sanguis, L. acidophilus L. casei              | [23]       |
| Eucalyptus camaldulensis Dehnh.  | Myrtaceae      | Bark             | Aqueous            | 9.375, 18.75, 37.5, 75, 150, 300, 600 μg/mL | S. aureus, methicillin-resistant S. aureus, gentamycin-methicillin-resistant S. aureus, S. epidermidis, B. agri, P. acnes | [21]       |
| Eucalyptus deglupta              | Myrtaceae      | Leaves           | Benzene            | 37.5, 75, 150, 300, 600 μg/mL | B. cereus, S. aureus                                       | [39]       |
| Myrtus communis L.               | Myrtaceae      | Leaves           | Ethanol            | 12.5–50 mg/mL             | B. cereus, L. monocytogenes, E. coli                       | [42]       |
| Nelumbo nucifera L.              | Nelumbonaceae   | Flower           | Ethanol            | 8–32 mg/mL                | B. subtilis, S. aureus, E. coli, K. pneumonia, P. aeruginosa | [54]       |
| Nymphaea lotus L.                | Nymphaeaceae   | Leaf             | Ethanol            | 500 μg/mL                 | methicillin-resistant S. aureus                            | [21]       |
| **Plant** | **Family** | **Part** | **Extraction** | **MIC** | **Antibiotic Sensitivity** | **References** |
|-----------|------------|----------|----------------|---------|---------------------------|---------------|
| Oxalis corniculata L. | Oxalidaceae | Leaves | Aqueous | 5 mg/mL | 37.5, 75, 150, 300, 600 μg/mL | *B. cereus, S. aureus*<br> *E. coli, K. pneumoniae, V. cholera*<br> *C. albicans* [39] |
| Oxalis corniculata L. | Oxalidaceae | Leaves | Benzene | - | *K. kristinae, M. luteus, S. auricularis, B. megaterium*<br> *A. bohemicus, E. coli* | - [51] |
| Oxalis corniculata L. | Oxalidaceae | Leaves | Acetone | 6 mg/mL | - | - |
| Oxalis corniculata L. | Oxalidaceae | Leaves | Acetone | 4–8 mg/mL | *S. aureus*<br>*P. aeruginosa*<br>*K. pneumoniae*<br>*E. coli* | - [55] |
| Argemone mexicana | Papaveraceae | Stem | Chloroform | 32.4–55.8 μg/mL | *S. aureus*<br>*E. coli, P. aeruginosa, K. pneumoniae* | - |
| Passiflora Mexicana L. | Passifloraceae | Aerial Parts | Ethanol | 33.7–58.3 μg/mL | *S. aureus*<br>*E. coli* | - [21] |
| Cleistanthus collinus | Phyllanthaceae | Leaves | Benzene | 100 mg/mL | *B. cereus, S. aureus*<br>*E. coli, K. pneumoniae, V. cholerae* | *C. albicans* [39] |
| Cleistanthus collinus | Phyllanthaceae | Leaves | Aqueous | 4–8 mg/mL | - | - |
| Cleistanthus collinus | Phyllanthaceae | Leaves | Acetone | 5 mg/mL | - | - |
| Piper nigrum L. | Piperaceae | Bark, Seeds | Ethanol | 500 μg/mL | *S. aureus, B. cereus, S. fecalis*<br>*P. aeruginosa, E. coli, S. typhi* | - [38] |
| Piper nigrum L. | Piperaceae | Bark, Seeds | Acetone | 6 mg/mL | - | - |
| Piper nigrum L. | Piperaceae | Bark, Seeds | Dichloromethane/Methanol | 12.5–50 μg/mL | - | - |
| Pittosporum viridiflorum Sims. | Pittosporaceae | Leaves | Dichloromethane/Methanol | 750–12,000 μg/mL | *S. aureus, methicillin-resistant S. aureus, gentamycin–methicillin-resistant S. aureus, S. epidermidis, B. agri, P. acne*<br> *P. aeruginosa*<br>*T. mentagrophytes, M. canis* | - [21] |
| Spinifex littoreus | Poaceae | Grass | Acetone | 2.5 mg/mL | - | Dermatophytes [27] |
| Plant Name                  | Family          | Part Description | Extraction Method     | MIC (μg/mL) | Antimicrobial Activity                                                                 |
|---------------------------|-----------------|------------------|-----------------------|------------|----------------------------------------------------------------------------------------|
| *Polygonum molle* D. Don. | Polygonaceae    | Whole Plant      | Ethanol               | 25–50      | Methicillin-resistant *S. aureus*                                                      |
|                           |                 |                  |                      |            |                                                                                        |
| *Eichhornia crassipes* L. | Pontederiaceae  | Leaves, Shoot    | Ethanol               | 500–4000   | Methicillin-resistant *S. aureus*                                                      |
|                           |                 |                  | Chloroform            | 32.4–55.8  | *M. luteus*                                                                             |
|                           |                 |                  | Aqueous               | 2.5–15     | *R. rubrum*                                                                             |
|                           |                 |                  |                      |            | *M. ruber, A. fumigates*                                                                |
| *Punica granatum* L.      | Punicaceae      | Fruit Shell      | Ethanol               | 70         | Methicillin-resistant *S. aureus*                                                      |
| *Clematis brachiate* Thunb.| Ranunculaceae  | Flower, Leaves, Stem, Root | Aqueous, Dichloromethane/ Methanol | 1         | *S. mutans, S. sanguis, L. acidophilus* |
|                           |                 |                  |                      | 750–12,000 | *L. casei*                                                                             |
|                           |                 |                  |                      |            | *P. gingivalis*                                                                        |
|                           |                 |                  |                      |            | *C. albicans, C. glabrata, C. krusei*                                                   |
| *Ziziphus mucronata* Willd.| Rhamnaceae     | Bark, Leabes     | Dichloromethane/ Methanol | 750–12,000 | *S. aureus, gentamicin–methicillin-resistant* |
|                           |                 |                  |                      |            | *S. aureus, S. epidermidis, B. agri, P. acnes, S. mutans, S. sanguis, L. acidophilus* |
|                           |                 |                  |                      |            | *T. mentagrophytes, M. canis, C. albicans, C. glabrata, C. krusei*                   |
| *Eriobotrya japonica* (Thunb.) Lindl.| Rosaceae | Leaves | Ethanol               | 2–16       | *K. kristinae, M. luteus, S. auricularis, B. megaterium*    |
| *Pavetta crassipes* K. Schum. | Rubiaceae     | Leaf             | Methanol              | 12.5–50    | Methicillin-resistant *S. aureus*                                                      |
| *Uncaria gambir* (Hunter) Roxb. | Rubiaceae     | Leaf, Stem       | Ethanol               | 8–32       | Methicillin-resistant *S. aureus*                                                      |
| *Vangueria spinose* L.   | Rubiaceae      | Leaves           | Ethyl Acetate         | 500        | *E. coli, K. pneumoniae, P. aeruginosa*                                                 |
| Plant Name                          | Family        | Plant Part                          | Extraction Method            | MIC (μg/mL) | Bacteria                                      | References                     |
|-----------------------------------|---------------|-------------------------------------|------------------------------|-------------|-----------------------------------------------|-------------------------------|
| Pentanisia prunelloides Walp.     | Rubiaceae     | Root Bark                           | Aqueous, Dichloromethane/Methanol | 5 mg/mL     | S. aureus, methicillin-resistant S. aureus, gentamycin- methicillin-resistant S. aureus, S. epidermidis, B. agri, P. acnes | [21]                          |
| Rothmannia capensis Thunb.        | Rubiaceae     | Leaves                             | Aqueous, Dichloromethane/Methanol | 22.4–52.3 μg/mL | S. aureus, methicillin-resistant S. aureus, gentamycin- methicillin-resistant S. aureus, S. epidermidis, B. agri, P. acnes | [21]                          |
| Geophila repens L.                | Rubiaceae     | Leaves, Stem Bark                   | Aqueous, Dichloromethane/methanol | 1 mg/mL     | B. cereus, S. aureus                         | [41]                          |
| Guettarda speciose L.             | Rubiaceae     | Leaves                             | Aqueous, Dichloromethane/Methanol | 2 mg/mL     | B. cereus, S. aureus                         | [41]                          |
| Haldina cordifolia L.             | Rubiaceae     | Leaves                             | Aqueous, Dichloromethane/Methanol | 1 mg/mL     | B. cereus, S. aureus                         | [41]                          |
| Hedgotis auricularia L.           | Rubiaceae     | Leaves                             | Aqueous, Dichloromethane/Methanol | 300 μg/mL   | B. cereus, S. aureus                         | [41]                          |
| Knoxia zeylanica L.               | Rubiaceae     | Leaves, Stem                        | Aqueous, Dichloromethane/Methanol | 250 μg/mL   | B. cereus, S. aureus                         | [41]                          |
| Mitragyna parvifolia L.           | Rubiaceae     | Leaves                             | Aqueous, Dichloromethane/Methanol | 300 μg/mL   | B. cereus, S. aureus                         | [41]                          |
| Plant Name                        | Family      | Part          | Extraction Method | Concentration | Bacterial Strains          | Source |
|----------------------------------|-------------|---------------|-------------------|---------------|---------------------------|--------|
| *Morinda umbellate* L.           | Rubiaceae   | Leaves, Stem, Bark | Aqueous/MeOH      | 100 μg/mL, 250 μg/mL | *B. cereus, S. aureus* | [41]   |
| *Nauclea orientalis* L.          | Rubiaceae   | Leaves        | Aqueous/MeOH      | 500 μg/mL     | *B. cereus, S. aureus* | [41]   |
| *Oldenlandia biflora* L.         | Rubiaceae   | Leaves        | Aqueous/MeOH      | 2 mg/mL, 5 mg/mL | *B. cereus, S. aureus* | [41]   |
| *Oldenlandia herbacea* L.        | Rubiaceae   | Stem, Root    | Aqueous/MeOH      | 5 mg/mL       | *B. cereus, S. aureus* | [41]   |
| *Ophiarrhiza mungos* L.          | Rubiaceae   | Leaves        | Aqueous/MeOH      | 2 mg/mL, 5 mg/mL | *B. cereus, S. aureus* | [41]   |
| *Paederia foetida* L.            | Rubiaceae   | Leaves, Stem  | Aqueous/MeOH      | 3 mg/mL       | *B. cereus, S. aureus* | [41]   |
| *Pavetta lanceolate* Ecl.        | Rubiaceae   | Leaves        | Aqueous/MeOH      | 1 mg/mL, 250 μg/mL | *B. cereus, S. aureus* | [41]   |
| *Spermacoce hispida* L.          | Rubiaceae   | Leaves, Stem  | Aqueous/MeOH      | 3 mg/mL       | *B. cereus, S. aureus* | [41]   |
| *Wendlandia bicuspidata* Wight & Arn. | Rubiaceae | Leaves | Aqueous/MeOH | 60 μg/mL, 5 mg/mL | *B. cereus, S. aureus* | [41]   |
| **Species**                  | **Family** | **Plant Part** | **Extraction** | **Concentration** | **Activity**                                                                 | **Reference** |
|-----------------------------|------------|----------------|---------------|-------------------|-----------------------------------------------------------------------------|---------------|
| Chassalia kolly             | Rubiaceae  | Whole Plant    | Methanol      | 5 mg/mL           | S. aureus, S. typhi, P. aeruginosa                                           | [16]          |
| Randia dumetorum L.         | Rubiaceae  | Fruits         | Methanol      | 9.375, 18.75, 37.5, 75, 150, 300, 600 μg/mL | S. aureus, S. epidermidis, B. subtilis E. coli, S. typhi                  | [23]          |
| Mitragyna speciosa L.       | Rubiaceae  | Leaves         | Methanol      | 37.5, 75, 150, 300, 600 μg/mL | S. typhi                                                                   | [42]          |
| Clausena anisate (Willd) Hook. f. ex. | Rutaceae  | Leaves, Stem, Twigs | Aqueous, Dichloromethane/ Methanol | 12.5–50 mg/mL, 750–12,000 μg/mL | S. mutans, S. sanguis, L. acidophilus L. casei P. gingivalis F. nucleatum C. albicans C. glabrata C. krusei | [23]          |
| Zanthoxylum capense Harv.    | Rutaceae   | Stem           | Aqueous, Dichloromethane/ Methanol | 8–32 mg/mL, 750–12,000 μg/mL | S. mutans, S. sanguis, L. acidophilus L. casei P. gingivalis F. nucleatum | [23]          |
| Aegle marmelos L.           | Rutaceae   | Leaves and Fruits | Methanol      | 500 μg/ml      | S. aureus, B. cereus E. coli, S. typhi, P. aeruginosa, S. boydii, K. aerogenes, P. vulgaris | [20]          |
| Evodia daneillii (Benn) Hemsl. | Rutaceae  | Tender Branches & Leaves | Ethanol      | 3.33–33.3 mg/mL | Methicillin-resistant S. aureus                                                | [32]          |
| Skimmia arborescens Anders. | Rutaceae   | TBL            | Ethanol       | 250 mg/mL       | Methicillin-resistant S. aureus                                                | [32]          |
| Plant Name                             | Family           | Part of Plant | Extraction Method         | Concentration (mg/mL or μg/mL) | B. cereus, B. subtilis, S. aureus, E. faecalis | S. aureus, S. epidermidis, B. agri, P. acnes | Gentamicin-methicillin-resistant S. aureus | S. epidermidis, S. aureus | T. mentagrophytes, M. canis |
|---------------------------------------|------------------|---------------|---------------------------|--------------------------------|-----------------------------------------------|---------------------------------------------|------------------------------------------|-------------------------------------|----------------------------------|
| *Salvadora australis*                 | Salvadoraceae    | Leaves        | Acetone                   | 10–100 mg/mL                   | -                                             | -                                           |                          | -                                   | [18]                             |
| *Viscum capense* L.f.                 | Santalaceae      | Leaves        | Aqueous                   | 5–50 mg/mL                     | S. aureus, S. epidermidis, B. agri, P. acnes   | T. mentagrophytes, M. canis                 | -                                       | -                                   | [21]                             |
| *Dodonaea angustifolia* (L.f.) Benth  | Sapindaceae      | Leaves        | Ethanol                   | 156–625 μg/mL                  | methicillin-resistant S. aureus               | -                                           | -                                       | -                                   | [28]                             |
| *Dodonaea viscosa* Jacq.              | Sapindaceae      | Leaves, Stem  | Aqueous/Dichloromethane/Methanol | 350–600 μg/mL 750–12,000 μg/mL | S. mutans, S. sanguis, L. acidophilus L. casei | P. gingivalis F. nucleatum C. albicans C. glabrata C. krusei | -                                       | -                                   | [23]                             |
| *Cardiospermum halicacabum* L.        | Sapindaceae      | Leaves        | n-Butanol/Ethyl acetate/Chloroform | 500 μg/mL 60 μg/mL 40 μg/mL  | S. aureus, S. agalactiae E. coli, S. typhimurium and K. pneumoniae | T. rubrum, C. albicans                     | -                                       | -                                   | [58]                             |
| *Dodonaea angustifolia* L. f.         | Sapindaceae      | Leaves        | Dichloromethane/Methanol  | 750–12,000 μg/mL               | S. aureus, S. epidermidis, B. agri, P. acnes  | P. aeruginosa T. mentagrophytes, M. canis   | -                                       | -                                   | [21]                             |
| Plant Name                      | Family               | Part(s)       | Extraction Method | Concentration Range (μg/mL) | Bacterial Species                                      | Candida Species                  | Reference |
|--------------------------------|----------------------|---------------|-------------------|-----------------------------|--------------------------------------------------------|----------------------------------|-----------|
| Englerophytum magalismontanum  | Sapotaceae           | Leaves, Stem  | Aqueous           | 600, 1200                   | *S. mutans*, *S. sanguis*, *L. acidophilus*, *L. casei* | *P. gingivalis*, *F. nucleatum*  | [23]     |
|                                |                      |               | Dichloromethane/ Methanol | 750–12,000                  |                                                        | *C. albicans*, *C. glabrata*, *C. krusei* |          |
| Schisandra viridis             | Schisandraceae       | Vane          | Ethanol           | 5 mg/mL                     | Methicillin-resistant *S. aureus*                      | -                                | [32]     |
| A.c. Smith.                    |                      |               |                   |                             |                                                       |                                  |          |
| Halleria lucida L.             | Scrophulariaceae     | Leaves, Stem  | Aqueous           | 1–8 mg/mL                   | *S. aureus*, methicillin-resistant *S. aureus*, gentamycin–methylillin-resistant *S. aureus*, *S. epidermidis*, *B. agri*, *P. acnes* | *P. aeruginosa*, *T. mentagrophytes*, *M. canis* | [21]     |
|                                |                      |               | Dichloromethane/ Methanol | 750–12,000                  |                                                        |                                  |          |
| Brandisia hancei Hook.f.       | Scrophulariaceae     | Whole Plant   | Ethanol           | 3.33–33.3 mg/mL             | Methicillin-resistant *S. aureus*                      | -                                | [32]     |
|                                |                      |               |                   |                             |                                                       |                                  |          |
| Selaginella tamariscina        | Selaginellaceae      | Whole Plant   | Ethanol           | 250 mg/mL                   | Methicillin-resistant *S. aureus*                      | -                                | [32]     |
| (Seauv.) Spring.              |                      |               |                   |                             |                                                       |                                  |          |
| Datura stramonium L.           | Solanaceae           | Leaves, Stem, Fruit | Aqueous           | 10–100 mg/mL                | *S. mutans*, *S. sanguis*, *L. acidophilus*, *L. casei* | *P. gingivalis*, *F. nucleatum*  | [23]     |
|                                |                      |               | Dichloromethane/ Methanol | 750–12,000                  |                                                        | *C. albicans*, *C. glabrata*, *C. krusei* |          |
| Solanum incanum L.            | Solanaceae           | Leaves        | Aqueous           | 5–50 mg/mL                  | *S. aureus*, methicillin-resistant *S. aureus*, gentamycin–methylillin-resistant *S. aureus*, *S. epidermidis*, *B. agri*, *P. acnes* | *P. aeruginosa*, *T. mentagrophytes*, *M. canis* | [21]     |
|                                |                      |               | Dichloromethane/ Methanol | 750–12,000                  |                                                        |                                  |          |
| Solanum trilobatum L.          | Solanaceae           | Leaves        | Acetone           | 156–625 μg/mL               |                                                        | *S. typhi*, *P. vulgaris*, *K. pneumonia*             | [37]     |
| Plant Species                     | Family            | Parts                  | Extraction Method   | Concentration (mg/mL or μg/mL) | Inhibitory Activities                                      |
|----------------------------------|-------------------|------------------------|---------------------|-------------------------------|------------------------------------------------------------|
| **Antibiotics**                  |                   |                        |                     |                               |                                                            |
| *Datura metel* L.                | Solanaceae        | Leaves                 | Aqueous             | 350–600 μg/mL                 | *B. cereus, S. aureus*                                      |
|                                  |                   |                        | Dichloromethane/Methanol | 1 mg/mL                       |                                                            |
| **Solanum macrocarpon** L.       | Solanaceae        | Leaves, Stem           | Aqueous             | 500 μg/mL                     | *B. cereus, S. aureus*                                      |
|                                  |                   |                        | Dichloromethane/Methanol | 60 μg/mL                      |                                                            |
| **Solanum melongena** L.         | Solanaceae        | Leaves, Root Stem      | Aqueous             | 800 mg/disc                    | *B. cereus, S. aureus*                                      |
|                                  |                   |                        | Dichloromethane/Methanol | 100 μg/mL                     |                                                            |
| **Solanum nigrum** L.            | Solanaceae        | Leaves, Stem           | Aqueous             | 600, 1200 μg/mL               | *B. cereus, S. aureus*                                      |
|                                  |                   |                        | Dichloromethane/Methanol | 1 mg/mL                       |                                                            |
| **Solanum torvum** Sw.           | Solanaceae        | Leaves                 | Aqueous             | 3.33–33.3 mg/mL               | *B. cereus, S. aureus*                                      |
|                                  |                   |                        | Dichloromethane/Methanol | 60 μg/mL                      |                                                            |
| **Solanum virginianum** L.       | Solanaceae        | Leaves, Stem, Root     | Aqueous             | 250 mg/mL                     | *B. cereus, S. aureus*                                      |
|                                  |                   |                        | Dichloromethane/Methanol | 4 mg/mL                       |                                                            |
| **Withania somnifera** (L.) Dunal| Solanaceae        | Roots & Leaves         | Aqueous             | 10–100 mg/mL                  |                                                            |

**Notes:**
- Concentrations indicate the range or specific values for each plant species and its extraction method.
- Inhibitory activities denote the bacterial species inhibited by the plant extracts.
- Some concentrations are noted with specific units (mg/mL or μg/mL) to reflect the concentration levels used for testing.
- Plant parts and extraction methods vary, with aqueous extractions being the most common, and sometimes dichloromethane/methanol is used.
- Bacterial strains include *B. cereus*, *S. aureus*, and *P. aeruginosa*.

**References:**
- [41, 59]
| Plant                     | Family          | Part       | Extraction   | Concentration          | Activity                                    | Reference |
|--------------------------|-----------------|------------|--------------|------------------------|---------------------------------------------|-----------|
| Cola acuminate L.        | Sterculiaceae   | Stem       | Acetone      | 5–50 mg/mL, 100 μg/mL  | *B. cereus*, *S. aureus*, methicillin-resistant *S. aureus* | [16]      |
| Schima sinensis (Hemsl. et. Wils) Airy-shaw. | Theaceae       | Tbl        | Ethanol      | 156–625 μg/mL          | methicillin-resistant *S. aureus* - -        | [32]      |
| Coriandrum sativum       | Umbelliferae    | Seeds      | Aqueous      | 350–600 μg/mL          | *S. aureus*, *K. pneumoniae*, *P. aeruginosa*, *A. niger*, *P. lilacinum* | [27]      |
| Clerodendrum inerme L.   | Verbenaceae     | Leaves     | Methanol     | 500 μg/mL              | *S. aureus* - -                            | [60]      |
| Schima sinensis (Hemsl. et. Wils) Airy-shaw. | Theaceae       | Tbl        | Ethanol      | 156–625 μg/mL          | methicillin-resistant *S. aureus* - -        | [32]      |
| Lantana rugosa Thunb.    | Verbenaceae     | Leaves     | Aqueous      | 800 mg/disc            | *S. aureus*, methicillin-resistant *S. aureus*, gentamycin-methicillin-resistant *S. aureus*, *S. aureus*, *S. epidermidis*, *B. agri*, *P. acnes* | [21]      |
| Lantana camara L.        | Verbenaceae     | Leaves, Flower | Chloroform  | 600, 1200 μg/mL         | *E. coli*, *S. typhi*, *P. aeruginosa*, *K. aerogenes*, *P. vulgaris*, *S. Boydii*, *K. pneumoniae*, *V. cholerae* | [39]      |
| Lantana indica L.        | Verbenaceae     | Leaves     | Methanol     | 1–8 mg/mL, 1–2 mg/mL   | *S. aureus*, *B. cereus*                    |           |
| Cyphostemma lanigerum Harv. | Vitaceae      | Leaves, Stem | Aqueous     | 250 mg/mL              | *P. gingivalis F. nucleatum*, *C. albicans*, *C. glabrata* | [23]      |
| Plant                  | Family            | Part(s)                  | Extraction | MIC Range | Organisms                                                                 | References |
|-----------------------|-------------------|--------------------------|------------|-----------|---------------------------------------------------------------------------|------------|
| Cyphostemma setosum   | Vitaceae          | Leaves, Stem, Fruit      | Aqueous    | 10–100 mg/mL, 750–12,000 μg/mL | *S. mutans*, *S. sanguis*, *L. acidophilus* L. casei, *P. gingivalis* F. nucleatum, *C. albicans* C. glabrata C. krusei | [23]       |
| Aloe arborescens Mill. | Xanthorrhoeaceae  | Leaves                   | Aqueous    | 5–50 mg/mL                           | *S. aureus*, *methicillin-resistant S. aureus*, *gentamicin-methicillin-resistant S. aureus*, *S. epidermidis*, *B. agri*, *P. acnes*, *P. aeruginosa*, *T. mentagrophytes*, *M. canis* | [21]       |
| Siphonochilus aethiopicus | Zingiberaceae  | Leaves, Stem, Root       | Aqueous    | 156–625 μg/mL, 750–12,000 μg/mL | *S. mutans*, *S. sanguis*, *L. acidophilus* L. casei, *P. gingivalis* F. nucleatum, *C. albicans* C. glabrata C. krusei | [23]       |
| Curcuma xanthorrhiza   | Zingiberaceae     | Rhizome                  | Ethanol    | 350–600 μg/mL                         | *methicillin-resistant S. aureus*                                                                  | [46]       |
| Kaempferia pandurata   | Zingiberaceae     | Rhizome                  | Ethanol    | 500 μg/mL                             | *methicillin-resistant S. aureus*                                                                  | [46]       |
| Peganum harmala L.     | Zygophyllaceae    | Seeds                    | Ethanol    | 800 mg/disc                           | *S. aureus*, *E. coli*                                                                              | [21]       |

* MIC (minimum inhibitory concentration) is the lowest drug concentration at which a given antimicrobial extract inhibits the visible growth of a tested organism. 

**MIC absolute value:** the given absolute value of drug concentration inhibits the growth of all tested organisms/ **MIC ranges:** the given range of drug concentrations (minimum to maximum) inhibit the growth of the individual to all tested organisms.
2.1. Phytocomponent Fractions and Antimicrobial Methods

Fresh or dried plant extracts were prepared using aqueous and different organic solvents in traditional extraction techniques (maceration, percolation, Soxhlet extraction). During the extraction method, the solvents penetrate into the plant material and dissolve active compounds with a related polarity [62]. At the completion of the technique, solvents have been vaporized, resulting in the formation of a concentrated mixture that yields the active compounds [63]. A successful extraction is mainly reliant on the nature of the solvent utilized during the extraction. The most regularly established extracts are aqueous extract followed by organic solvents, which include using methanol, ethanol, hexane, isopropanol, ethyl acetate, benzene, acetone, chloroform, and dichloromethane [64].

Two popular types of antibacterial susceptibility test, namely diffusion and dilution methods, are generally performed to determine the antibacterial efficacy of the plant materials. The method of diffusion is a screening test to classify bacteria that aid susceptibility or resistance to the tested plant material based on the size or diameter of the inhibition zone [62]. On the other hand, the activity of plant materials is determined as minimum inhibitory concentration (MIC) in the dilution method. In the MIC method, the lowest concentration is capable of inhibiting bacterial growth. Redox indicators and turbidity are most often measured for the analysis of results in broth dilution methods. The turbidity can be calculated colorimetrically while changing the indicator color represents the inhibition of bacterial growth [62]. The screening of traditional plant extracts has been of great attention to researchers investigating novel bioactive compounds effective in the treatment of microbial infections. Plant extracts exhibit: (a) direct antimicrobial activity presenting effects on metabolism and development of microbes and (b) indirect activity as antibiotic resistance adapting substances which, joint with antibiotics, upsurge their efficiency. Numerous studies have considered the antimicrobial screening of traditional plant extracts. The studies of medicinal plants from diverse topographical areas include: Armenia [65], Iran [66], Mexico [67], Saudi Arabia [68], Libya [26], Ethiopia [64], India [63], Poland [69], Cameroon [70], Nigeria [71], and other Middle Eastern countries [72]. Based on the available information, the traditional plant extracts showed antimicrobial activity against a huge number of pathogenic bacteria, fungi, viruses, algae, protozoan, and Trypanosoma [26,63,64,66].

3. Bioactive Compounds (Bioactive Phytocomponents)

Traditional medicinal plants possess various chemical substances that support certain physiological and biochemical activities in the human body and they are known as phytochemicals or phytocomponents. These chemicals are non-nutritive substances used to heal various infectious diseases, as well as provide disease preventive properties [9,10]. With advances in phytochemical practices, numerous active principles have been isolated from medicinal plants and presented as a valuable drug in contemporary systems of medicine. Mostly, the pharmacological activity of medicinal plants resides in their secondary metabolites, which are relatively smaller in quantity in contrast to the primary molecules such as carbohydrates, proteins, and lipids. Plant secondary metabolites are commonly accountable for their antimicrobial properties [62]. These metabolites offer clues to manufacture new structural types of antimicrobial and antifungal chemicals that are comparatively safe to humans [62]. The classes of secondary metabolites that have greater antimicrobial properties are flavonoids (flavones, flavonols, flavanols, isoflavones, anthocyanidins), phenolic acids (hydroxybenzoic, hydroxycinnamic acids), stilbenes, lignans, quinones, tannins, coumarins (simple coumarins, furanocoumarins, pyranocoumarins), terpenoids (sesquiterpene lactones, diterpenes, triterpenes, polypetepenes), alkaloids, glycosides, saponins, lectins, steroids, and polypeptides [6,16,56,62,73–83]. These compounds have copious mechanisms that underlie antimicrobial activity, e.g., disturbing microbial membranes, weakening cellular metabolism, control biofilm formation, inhibiting bacterial capsule production, attenuating bacterial virulence by controlling quorum-sensing, and reducing microbial toxin production [3–6,73–85]. Various bioactive compounds have been scientifically tested for their antimicrobial activities and are presented in Table 2.
| Botanical Name          | Family           | Extracts | Bioactive Compounds                                                                 | MIC *                | Organism Inhibited                                      | References |
|------------------------|------------------|----------|------------------------------------------------------------------------------------|----------------------|----------------------------------------------------------|------------|
| *Allium sativum* L.    | Alliaceae        | Methanol | Cyanidin-3-(6'-malonyl)-glucoside, vanillic acid caffeic acid, p-coumaric acid, ferulic acid, sinapic acid, L-alliin, alliin isomer and methiin | -                    | *B. cereus, L. monocytogenes* *S. aureus, P. aeruginosa, E. coli* | [11]       |
| *Searsia chirindensis* (Baker f.) Moffett | Anacardiaceae   | Ethanol  | Methyl gallate, myricetin-3-O-arabinopyranoside, myricetin-3-O-rhamnoside, kaempferol-3-O-rhamnoside, quercetin-3-O-arabinofuranoside | 30–130 µg/mL         | *C. jejuni, E. coli, S. flexneri, S. aureus* | [86]       |
|                        |                  | Ethanol  |                                                                                     | 60–250 µg/mL         |                                                          |            |
|                        |                  | Ethanol  |                                                                                     | 130–250 µg/mL        |                                                          |            |
|                        |                  | Ethanol  |                                                                                     | 250 µg/mL            |                                                          |            |
|                        |                  | Ethanol  |                                                                                     | 250–6250 µg/mL       |                                                          |            |
|                        |                  | Ethanol  |                                                                                     | 130–3125 µg/mL       |                                                          |            |
|                        |                  | Ethanol  |                                                                                     | 60–780 µg/mL         |                                                          |            |
|                        |                  | Ethanol  |                                                                                     | 60–780 µg/mL         |                                                          |            |
| *Xylopia aethiopica* (Dunal) A. Rich. | Annonaceae | Aqueous | 1R-a-Pinene, β-Pinene, 2-Carene, Cyclohexene, 5-methyl-3-(1-methylethenyl)-trans-(+)-Bicyclo [3.1.0] hexane, 6-isopropylidene-1-methyl-, Eucalyptol, Ethyl 2-(5-methyl-5-vinyltetrahydrofuran-2-yl) propan-2-yl carbonate, Isogeraniol, a-Campholenal, L-trans-Pinocarveol, Pinocarvone, Myrtenal, (-)-Spathulenol | 1–256 µg/mL | *S. aureus, B. licheniformis, E. coli, K. pneumoniae* | [87]       |
| *Polyalthia cerasoides* | Annonaceae       | Hexane   | N-(4-hydroxy-β-phenethyl-4-hydroxy cinnamide)                                        | 64–128 µg/mL         | *C. diphtheria, B. subtilis, B. cereus, M. luteus*       | [88]       |
| *Unonopsis lindmanii* R. E. Fries | Annonaceae       | Hexane   | Gallic acid, kaempferol, ellagic acid, epicatechin, vitexin, corilagin                | 25–250 µg/mL         | *C. albicans*                                           | [89]       |
| *Allagoptera leucocalyxa* (Drude) Kuntze, | Arecales    | Hexane   | Gallic acid, kaempferol, ellagic acid, epicatechin, vitexin, corilagin                | 162.2–665 mg/mL      | *C. albicans*                                           | [89]       |
| *Bactris glaucescens* Drude   | Arecales        | Hexane   | Gallic acid, kaempferol, ellagic acid, epicatechin, vitexin, corilagin                | 200–755 mg/mL        | *C. albicans*                                           | [89]       |
| *Scheelea phalerata* Mart    | Arecales        | Hexane   | Gallic acid, kaempferol, ellagic acid, epicatechin, vitexin, corilagin                | 129 mg/mL            | *C. albicans*                                           | [89]       |
| Plant Name                      | Family          | Extraction Method | Active Constituents                                                      | Antimicrobial Activity                                      | Ref. |
|--------------------------------|-----------------|-------------------|------------------------------------------------------------------------|-------------------------------------------------------------|------|
| Artemisia herba-alba Asso       | Asteraceae      | Aqueous           | 1,8-cineole, β-thujone, α-thujone, camphor                              | 640–2500 μg/mL T. rubrum and E. floccosum                   | [90] |
| Vernonia adoensis Sch. Bip. ex Walp. | Asteraceae       | Acetone           | Chondrillasterol                                                       | 50 μg/mL S. aureus, K. pneumonia, P. aeruginosa             | [1]  |
| Matricaria chamomilla           | Asteraceae      | Ethanol           | Phenolic acid                                                          | 1.56–3.12 mg/mL S. typhimurium                              | [19] |
| Solidago graminifolia L. Salisb. | Asteraceae      | Ethanol Methanol  | di-C-glycosylflavones (schaftoside, isoschaftoside), caftaric acid, gentisic acid, chlorogenic acid, p-coumaric acid, ferulic acid, hyperoside, rutin, quercitrin, quercetin, Luteolin, kaempferol, gallic acid, protocatechuic acid, vanillic acid, syringic acid, rosmarinic acid | 40–3120 μg/mL E. coli, S. aureus, S. pyogenes, E. faecalis, K. pneumonia, P. aeruginosa, P. mirabilis, S. typhi, and C. albicans | [12] |
| Baccharis trimera               | Asteraceae      | Crude             | Polyphenols, flavonoids, alkaloids, and terpenes                       | 7.8–500 μg/mL                                              | [88] |
| Tecoma stans                    | Bignoniaceae    | Aqueous           | Phenolic compounds                                                     | 50–600 μg/mL S. aureus                                      | [91] |
| Bixa orellana L                 | Bixaceae        | Aqueous           | Bixin, catechin, chlorogenic acid, chrysine, butein, hypolaetin, licochalcone A, and xanthohumol. | 16–32 μg/mL B. cereus, S. aureus                           | [9]  |
| Trichodesma indicum             | Boraginaceae    | Ethanol           | Lanast-5-en-3β-D-glucopyranosyl-21(24)-oilde                           | 2.4–19.2 μg/mL S. aureus                                   | [92] |
| Boswellia dalzielii Hutch.      | Burseraceae     | Crude             | Oleic acid, squalene and n-hexadecanoic acid                           | -                                                          | [93] |
| Caesalpinia coriaria (Jacq) Willd | Caesalpinioideae | Aqueous Ethanol   | Methyl gallate and gallic acid                                         | 1.56–25 mg/mL S. typhi, E. coli, P. aeruginosa, L. monocytogenes, S. aureus | [94] |
| Senecio aculeate (Bth.) Irw et Barn | Caesalpinioideae | Hexane            | Gallic acid, kaempferol, ellagic acid, epicatechin, vitexin, corilagin | 25, 50, 100 mg/mL C. albicans                               | [89] |
| Plant/Species          | Family          | Extraction | Constituents                                         | Activity            | Ref. |
|-----------------------|-----------------|------------|------------------------------------------------------|---------------------|------|
| *Kochia scoparia*     | Chenopodiaceae  | Crude      | Polyphenols, flavonoids, alkaloids, and terpenes     | 3.125 mg/mL         | [8]  |
| *Buchenavia tomentosa*| Combretaceae    | Hexane     | Gallic acid, Kaempferol, Ellagic acid, epicatechin,  | 10 mg/mL            |      |
| (Mart) Eichler        |                 |            | Vitexin, Corilagin                                   |                     | [89] |
| *Terminalia phanerophlebia*| Combretaceae | Crude      | Methyl gallate (methyl-3,4,5-trihydroxybenzoate) and a | 125 μg/mL           | [95] |
| Engl. & Diels         |                 | Dichloromethane | phenylpropanoid glucoside, 1,6-di-O-coumaroyl | 16–250 μg/mL        |      |
|                       |                 | Hexane     | glucopyranoside                                      | 31–250 μg/mL        |      |
|                       |                 | Ethyl Acetate |                                                   | 8–125 μg/mL         |      |
|                       |                 | n-butanol  |                                                   | 31–250 μg/mL        |      |
| *Buchenavia tomentosa*| Combretaceae    | Crude      | Gallic acid, quinic acid, kaempferol, (-) epicatechin,| 200–12500 μg/mL     | [96] |
| L.                     |                 |            | ellagic acid, buchenavianine, eschweilenol b,      |                     |      |
|                       |                 |            | eschweilenol c, vitexin, corilagin, 1α,23β-dihydroxy- |                     |      |
|                       |                 |            | 12-oleanen-29-oicacid-23β-O-α-L-4-acetylramnopiranose |                     |      |
|                       |                 |            | and punicalin                                        |                     |      |
| *Diadema setosum f.*  | Diademataceae   | Acetone    | Polyunsaturated fatty acids (PUFAs) and β-carotene   | 500–4000 μg/mL      | [1]  |
| depressa Dollfus & Roman. |             |            |                                                     |                     |      |
| *Monotes kerstingii*  | Diptercarpaceae | Crude      | Stilbene-coumarin derivative, coumarin-carbinol and fatty | 1–8 mg/mL           | [7]  |
| Gilg                  |                 |            | glycoside                                            |                     |      |
| Plant Name       | Family       | Extraction Method | Constituents                                                                 | MIC Range (μg/mL) | Organisms                                                                 |
|-----------------|--------------|-------------------|-------------------------------------------------------------------------------|-------------------|--------------------------------------------------------------------------|
| Croton doctoris S. Moore | Euphorbiaceae | Hexane         | Gallic acid, kaempferol, ellagic acid, epicatechin, vitexin, corilagin         | 500               | C. albicans                                                              |
| Jatropha weddelliana Baillon   | Euphorbiaceae | Hexane         | Gallic acid, kaempferol, ellagic acid, epicatechin, vitexin, corilagin         | 4-32              | C. albicans                                                              |
| Cassia alata   | Fabaceae     | Ethanol         | 4-butylamine, cannabinoid, dronabinol, methyl-6-hydroxy                        | 1.25, 1.5         | S. aureus, E. coli, P. aeruginosa, C. albicans                           |
| Dalbergia scandens Roxb., Corom. | Fabaceae     | Ethanol         | Dalpanitin, vicenin-2 and 3, rutin                                            | 780-6250          | C. albicans                                                              |
| Acacia nilotica | Fabaceae     | Crude           | Alkaloids                                                                     | 600-1200          | S. aureus                                                                |
| Cassia alata   | Fabaceae     | Hexane         | Alkaloids                                                                     | 12.5-100          | S. haemolyticus, S. hominis, E. faecalis, S. epidermis, S. pyogenes, S. aureus |
| Salvia sessei Benth | Lamiaceae   | Ethanol         | Sessein, isosessein                                                           | 100               | S. aureus, E. coli, C. albicans                                         |
| Mentha piperita | Lamiaceae    | Methanol        | 1,1-diphenyl-2-picrylhydrazyl-hydrate                                        | 12.5-100          | S. epidermidis, S. aureus, B. subtilis, E. coli, P. aeruginosa, K. pneumoniae, C. glabrata, C. albicans |
| Ocimum basilicum L. | Lamiaceae   | Ethanol         | Gallic acid, 3,4-dihydroxy benzoic acid, 4-hydroxy benzoic acid, 2,5 dihydroxybenzoic acid, chlorogenic acid, vanillic acid, Epicatechin, caffeic acid, p-coumaric acid, ferulic acid, rutin, ellagic acid, naringin, quercetin, cinnamic acid, α-pinene, camphene, sabinene, β-pinene, myrcene, 3-octanol, α-terpinene, p-cymene, limonene, 1,8-cineole, (Z)-β-oicinene, (E)-β-oicinene, γ-terpinene, cis-sabine hydrate, terpinolene, linalool, nonanal, pentylosvalerate, 1-octen-3-yl acetate, cis-p-menth-2-en-1-ol, 3-octyl acetate, α-campholenal, camphor, trans-verbenol, δ-terpineol, 4-terpineol, α-terpineol, cis-dihydrocarvone, trans-carveol, (Z)-3-hexenyl isovalerate, pulegone, neral, carvone, linalyl acetate, bornyl acetate, dihydroedulan IA, isodihydrocarvyl acetate, α-terpinyl acetate, cis-carvyl acetate, neryl acetate, geranyl acetate, β-elemene,(Z)-jasmone, β-caryophyllene, β-copaene, aromadendrene, α-humulene, (E)-β-farnesene, cis-muurola-4(14), 5-diene germacrene D, bicyclogermacrene, germacrene A, δ-cadinene, (E)-α-bisabolene, (E)-nerolidol, Spathulenol, caryophyllene oxide, viridiflorol, 1, 10-di-epi-cubenol, T-cadinol, T-murololol, monoterpenic hydrocarbons, oxygenated monoterpenes, sesquiterpene hydrocarbons, oxygenated sesquiterpenes, apocarotenes | 16-256          | S. epidermidis, S. aureus, B. subtilis, E. coli, P. aeruginosa, K. pneumoniae, C. glabrata, C. albicans |
### Thymus algeriensis

**Boiss. & Reut**

**Lamiaceae**

**Ethanol**

- non-terpene derivatives
  - Gallic acid, 3,4-dihydroxy benzoic acid, 4-hydroxy benzoic acid, 2,5 dihydroxybenzoic acid, chlorogenic acid, vanillic acid, epicatechin, caffeic acid, p-coumaric acid, ferulic acid, rutin, ellagic acid, naringin, quercetin, cinnamic acid, α-pinene, camphene, sabinene, β-pinene, myrcene, 3-octanol, α-terpinene, 3-cymene, limonene, 1,8-cineole, (Z)-β-ocimene, (E)-β-ocimene, γ-terpinene, cis-sabinene hydrate, terpinolene, linalool, nonanal, pentylisovalerate, 1-octen-3-yl acetate, cis-p-menth-2-en-1-ol, 3-octyl acetate, α-campholenal, camphor, trans-verbenol, δ-terpineol, 4-terpineol, α-terpineol, cis-dihydrocarvone, trans-carveol, (Z)-3-hexenyl isovalerate, pulegone, nerol, carvone, linalyl acetate, bornyl acetate, dihydroedulan IA, isodihydrocarvyl acetate, α-terpinyl acetate, cis-caryl acetate, neryl acetate, geranyl acetate, β-elemene, (Z)-jasmine, β-caryophyllene, β-copaene, aromadendrene, α-humulene, (E)-β-farnesene, cis-muurola-4(14), 5-diene germacrene D, bicyclogermacrene, germacrene A, δ-cadinene, (E)-α-bisabolene, (E)-nerolidol, spathulenol, caryophyllene oxide, viridiflorol, 1, 10-diepi-cubenol, T-cadinol, T-muurolol, monoterpane hydrocarbons, oxygenated monoterpenes, sesquiterpene hydrocarbons, oxygenated sesquiterpenes, apocarotenes

- 32–512 μg/mL

S. epidermidis, S. aureus, B. subtilis, E. coli, P. aeruginosa, K. pneumoniae, C. glabrata, C. albicans

### Cinnamomum inerme

**Lauraceae**

- Ethyl Acetate
- Hexane
- Acetone
- n-butanol

- 5-(1,5-dimethyl-2-4-hexenyl)-methyl phenol

- 100–800 μg/mL
- 8000 μg/mL
- 8000 μg/mL
- 100–800 μg/mL

S. aureus, E. coli

### Allium sativum

**Liliaceae**

- Crude

- Allicin

- 49 μg/mL

C. albicans

### Strychnos nigratana

**Baker**

**Loganiaceae**

- Crude

- Nigritanine, Speciociliatine, Mytragine Paynantheine Rhyncophylline

- 128–256 μg/mL

S. aureus

### Mascagnia benthamiana

**Gries**

**Anderson**

**WR**

**Malpighiaceae**

- Hexane

- Gallic acid, kaempferol, ellagic acid, epicatechin, vitexin, corilagin

- 17.84 mg/mL

C. albicans
| Plant Name                        | Family         | Extraction Type | Active Compounds                                             | MIC Value (μg/mL) | Pathogen                         | Reference |
|----------------------------------|----------------|-----------------|--------------------------------------------------------------|-------------------|----------------------------------|-----------|
| *Mouriri elliptica* Mart         | Memecylaceae   | Hexane          | Gallic acid, kaempferol, ellagic acid, epicatechin, vitexin, corilagin | 100                | *C. albicans*                    | [89]      |
| *Artocarpus communis*            | Moraceae       | Crude           | Atonin E, 2-(3,5-dihydroxy)-(Z)-4-(3 methyl but-1-etyl)      | 4–512              | *P. aeruginosa*, *S. typhi*, *S. aureus*, *K. pneumoniae* | [101]     |
| *Myrtus nivellei Batt. & Trab.*  | Myrtaceae      | Crude           | 1,8-cineole, limonene, isoamylicyclopentane, di-nor-sesquiterpenoids | 5                  | *C. neoformans*                  | [102]     |
| *Myrtus communis* L.             | Myrtaceae      | Crude           | α-pinene, 1,8-cineole, linalool, and linalyl acetate         | 156–625            | *E. floccosum*, *M. canis*, *T. rubrum* | [102]     |
| *Piper nigrum*                   | Piperaceae     | Aqueous         | Piperine                                                     | 500–1000           | *E. coli*, *M. luteus*           | [91]      |
| *Citrus aurantium* L.            | Rutaceae       | Ethanol         | Polyphenols, flavonoids, alkaloids, and terpenes             | 1562–6250          | *Amoxycillin resistant*, *B. cereus* | [103]     |
| *Salix babylonica* L.            | Salicaceae     | Hydroalcoholic  | Luteolin, luteolin 7-O-glucoside                             | 1.56–100           | *E. coli*, *S. aureus* and *L. monocytogenes* | [103]     |
| *Verbascum glabratum* subsp. bosnense (K. Malý) Murb* | Scrophulariaceae | Ethanol       | Quercitrin and rosmarinic acid, 4-hydroxybenzoic acid, salicylic acid, morin, and apigenin | 600, 1200         | *E. coli*, *S. aureus*, *Candida albicans* | [17]      |
| *Simaba ferruginea* A. St.-Hil   | Simaroubaceae  | Methanol        | Canthin-6-one, indole β-carboxylic                            | 12.5–200           | *S. flexneri*, *S. aureus* and *S. aureus* | [91]      |
| *Camellia sinensis*              | Theaceae       | Aqueous         | Catechin                                                     | 7.81–31.25         | *S. mutans*                      | [104]     |
| Talaromyces sp.                  | Trichocomaceae | Aqueous         | Talaropeptide A and B                                        | 5                  | *B. subtilis*                    | [18]      |
| *Hybanthus enneaspermus*         | Violaceae      | Crude           | Flavonoids, Tannins                                         | 37.5, 75, 150, 300, 600 | *P. vulgaris*, *V. cholera*      | [100]     |

* MIC (minimum inhibitory concentration) is the lowest drug concentration at which a given antimicrobial extract inhibits the visible growth of a tested organism.

**MIC absolute value**: the given absolute value of drug concentration inhibits the growth of all tested organisms. **MIC ranges**: the given range of drug concentrations (minimum to maximum) inhibit the growth of the individual to all tested organisms.
4. Mechanism of Actions of Antibacterial Bioactive Compounds

As proven by in vitro experiments, medicinal plants produce a boundless quantity of secondary metabolites that have great antimicrobial activity [9,10,18]. These plant-produced low molecular weight antibiotics are classified according to two types, namely phytoanticipins, which are involved in microbial inhibitory actions, and phytoalexins, which are generally anti-oxidative and synthesized de novo by plants in response to microbial infection [16,74]. Plant antimicrobial secondary metabolites are generally categorized into three broad classes, namely phenolic compounds, terpenes, and alkaloids. Numerous studies have shown that the antimicrobial activity of the plant extracts and their active compounds have the following potential: to promote cell wall disruption and lysis, induce reactive oxygen species production, inhibit biofilm formation, inhibit cell wall construction, inhibit microbial DNA replication, inhibit energy synthesis, and inhibit bacterial toxins to the host [75,85,105–109]. In addition, these compounds may prevent antibacterial resistance as well as synergetics to antibiotics, which can ultimately kill pathogenic organisms (Figure 1).

**Figure 1.** Mechanisms of antimicrobial activity of bioactive compounds.

4.1. Promote Cell Wall Disruption and Lysis

Phenolic compounds are a family of aromatic rings consisting of a hydroxyl functional group (-OH) which is alleged to absolute toxicity to microorganisms, although increased reactions of hydroxylation result in microbial cell lysis [110]. Quinones also have aromatic rings with two ketone molecules, which enables the production of an irreversible complex with nucleophilic amino acids, resulting in greater antimicrobial properties. These potential aromatic compounds are usually targeted to microbial cell surface adhesins, membrane-bound polypeptides, enzymes, and eventually lysis of the microbes [111]. Flavonoids are hydroxylated phenolic substances which are also able to complex with bacterial cell walls and disrupt microbial membranes [75,105]. Highly active flavonoids, quercetin (1), rutin (2), naringenin (3), sophoraflavanone (4), tiliroside (5) and 2, 4, 6-trihydroxy-3-methyl chalcone (6) (Figure 2) decreased lipid bilayer thickness and fluidity levels and increased membrane permeability, supporting the leaking of intracellular protein and ions in *S. aureus* and *S. mutans* [112,113]. These compounds contribute to the synergistic effect with ampicillin and tetracycline [114]. The other active flavonoids, acacetin (7), apigenin (8), morin (9), and rhamnetin
(10) (Figure 2) cause weakening of the bacterial cell wall by disarrangement and disorientation of the lipid bilayer and ultimately persuade vesicle leakage [115–117]. The synthetic flavonoid lipophilic 3-arylidene (11) was found to be very active against *S. aureus*, *S. epidermidis*, and *E. faecalis* due to a bacterial cell clump that influences the integrity of the cell wall as a result of biofilm disruption [118]. Tannins are classes of another polymeric phenolic substance, characterized as astringency, which is capable to deactivate microbial adhesins, enzymes, and membrane transporter systems [105,119]. Coumarins (12) are benzo-α-pyrones known to stimulate macrophages, which could have an adverse effect on infections [7,120]. Terpenes are organic compounds containing isoprene subunits, which involve microbial membrane disruption [121,122]. Thymol (13), eugenol (14), Cinnamaldehyde (15), carvone (16), and carvacrol (17) (Figure 2) disintegrate the external membrane of various Gram-negative bacteria, releasing LPS and increasing the permeability [123–125].
Isovitexin (19)  
EGCG (20)  
3-O-octanoyl-epicatechin  
(21)  
5, 7, 40-trihydroxyflavanol (22)  
Kaempferol (23)  
Chrysins (24)  
Phloretin (25)  
Epicatechin gallate (26)  
Proanthocyanidins (27)  
6-aminoflavone (28)  
6-hydroxyflavone (29)  
Daidzein (30)  
Genistein (31)  
Auronol (32)  
Pinostrobin (33)  
Catechins (34)  
Epicatechin (35)  
Sakuranetin (36)
Eriodictyol (37)  
Taxifolin (38)  
5, 6, 7, 40, 50-pentahydroxyflavone (39) 

5-hydroxy-40, 7-dimethoxyflavone (40)  
4, 20, 40-trihydroxychalcone (41)  
Fisetin (42) 

Myricetin (43)  
Baicalein (44)  
Luteolin (45) 

Butein (46)  
Isoliquirtigenin (47)  
Kaempferide (48) 

DL-cycloserine (49)  
kaempferide-3-O-glucoside (50)  
Nobiletin (51) 

Tangeritin (52)  
Robinetin (53)  
 Iso bavachalcone (54) 

6-prenylapigenin (55)  
Licochalones (56)  
Silibinin (57)
Isoquercetin (58) quercitrin (59) Silymarin (60)

40, 50, 5-trihydroxy-6, 7-dimethoxy-flavone (61) kaempferol-3-O-rutinoside (62) quercetin glycoside (63)

Figure 2. Chemical structures of antibacterial bioactive compounds.

4.2. Inhibition of Biofilm Formation

The key features of bacteria developing biofilms are generally 100–1000 times more resistant to antimicrobial drugs while related to their usual planktonic forms [64]. Interestingly, numerous researchers have described how flavonoids cause the aggregation of multicellular composites of bacteria and inhibit bacterial growth after aggregation, which indicates that flavonoids are potent antibiofilm compounds. The bioactive flavonoids such as galangin (18), isovitexin (19), EGCG (20) and 3-O-octanoyl-epicatechin (21), as well as 5, 7, and 40-trihydroxyflavanol (22) induce pseudo multicellular aggregation of *S. aureus* and *S. mutans* [106–109]. Quorum sensing involves cell signaling molecules called autoinducers present in *E. coli*, *Vibrio cholerae*, and *S. typhi*, which is a notable regulatory factor for biofilm formation [126]. Interestingly, apigenin (8), kaempferol (23), quercetin (1), and naringenin (3) are effective antagonists of cell–cell signaling [126,127] that have been revealed to inhibit enteroaggregative biofilm formation in *E. coli* and *P. aeruginosa* in a concentration-dependent manner [128,129]. Moreover, chrys in (24), phloretin (25), naringenin (3), kaempferol (23), epicatechin gallate (26), proanthocyanidins (27), and EGCG (20) (Figure 2) inhibited N-acyl homoserine lactones-mediated QS [130–132]. Hydrophilic flavonoids such as 6-aminoflavone (28), 6-hydroxyflavone (29), apigenin (8), chrys in (24), daidzein (30), genistein (31), auronol (32), and phloretin (25) (Figure 2) have inhibitory effects on *E. coli* biofilm formation [133,134]. In addition, Phloretin (25) inhibited fimbiae formation in *E. coli* by reducing the expression of the curli genes (csgA, csgB) and toxin genes (hemolysin E, Shiga toxin 2) [6], eventually inhibiting the formation of biofilm. Hence, phloretin (25) is well known as an antibiotic resistant compound. Pinostrobin (33), EGCG (20) and prenylated flavonoids enhanced membrane permeability in *E. faecalis*, *S. aureus*, *E. coli*, and *P. aeruginosa*, *Porphyromonas gingivalis*, which is consistent with its effect on efflux-pump inhibitors and anti-biofilm formation [34,135,136].
4.3. Inhibition of Cell Wall Construction

The bacterial cell wall is accountable for osmoregulation, respiration, the transport mechanism, and biosynthesis of lipids. For the execution of these functions, membrane integrity is very important, and its disruption can directly or indirectly cause metabolic dysfunction eventually leads to bacterial death. Catechins (34) attract lipid bilayers of the membrane which involves the following mechanisms [137]. Catechins form hydrogen bonds, which attract polar head groups of lipids at the membrane edge. Epicatechin (35) and epigallocatechin gallate (26) alter phospholipids, which can alter structural changes in the cell membrane. Moreover, these catechins promote the inactivation or inhibition of intracellular and extracellular enzyme synthesis [137]. Generally, the inhibition of enzymes in fatty acid biosynthesis is an excellent target for antimicrobial agents for blocking bacterial growth, especially the key enzyme fatty acid synthase II (FAS-II) inhibitor is significant as an antimicrobial drug. Quercetin (1), apigenin (8), and sakuranetin (36) have been demonstrated to inhibit 3-hydroxyacyl-ACP dehydrase from *Helicobacter pylori* [138] and eriodictyol (37). Further, naringenin (3) and taxifolin (38) (Figure 2) inhibit 3-ketoacyl-ACP synthase from *E. faecalis* [139]. Flavonoids such as Epigallocatechin gallate (EGCG) (20), 5, 6, 7, 40, 50- pentahydroxyflavone (39), and 5-hydroxy-40, 7-dimethoxyflavone (40) inhibit the malonyl CoA-acyl carrier protein transacylase that regulates bacterial FAS-II [140,141]. EGCG (20) inhibits 3-ketoacyl-ACP reductase and enoyl-ACP reductase and prevents fatty acid biosynthesis [142]. Quercetin (1), kaempferol (23), 4, 20, 40-trihydroxychalcone (41), fisetin (42), morin (9), myricetin (43), baicalein (44), luteolin (45), EGCG (20), butein (46), and isoliquiritigenin (47) (Figure 2) inhibit various enzymes involved in fatty acid synthesis, including, FAS-II, enoyl-ACP-reductase, β-ketoacyl-ACP reductase, and β-hydroxy acyl-ACP dehydratases in *Mycobacterium sp.* [143]. Baicalein (44), EGCG (20), galangin (18), kaempferide (48), DL-cycloserine (49), quercetin (1), apigenin (8), and kaempferide-3-O-glucoside (50) (Figure 2) inhibit the synthesis of peptidoglycan, which is an essential component of the bacterial cell wall, resulting in cell wall damage [144–146].

4.4. Inhibition of Prokaryotic DNA Replication

Alkaloids are nitrogenous compounds characterized by their alkaline nature, which aids the inhibition of cell respiration, intercalates with DNA, and inhibits various enzymes involved in replication, transcription, and translation [147]. Plant-based bioactive compounds such as quercetin (1), nobiletin (51), myricetin (43), tangeritin (52), genistein (31), apigenin (8), chrysin (24), kaempferol (23), and 3, 6, 7, 30, 40-pentahydroxyflavone (39) have been recognized as noteworthy DNA gyrase inhibitors, which are essential for DNA replication in prokaryotes including *V. harveyi, B. subtilis, M. smegmatis, M. tuberculosis*, and *E. coli* [146,148–151]. These bioactive compounds binding to the β subunit of gyrase and the corresponding blockage of the ATP binding pocket eventually contribute to the antimicrobial activity. Bioactive compounds have mediated the dysfunction of DNA gyrase functions in a dose-dependent manner that leads to the impairment of cell division and/or completion of chromosome replication, resulting in the inhibition of bacterial growth [149]. Luteolin (45), morin (9), and myricetin (43) have been demonstrated to inhibit the helicases of *E. coli* [152]. Helicases constitute another significant replicative enzyme responsible for separating and/or rearranging DNA double-strands [153]. Furthermore, myricetin (43) and baicalein (44) have been proposed as potent inhibitors of numerous DNA and RNA polymerases, as well as viral reverse transcriptase, resulting in the inhibition of bacterial growth [154]. EGCG (20), myricetin (43), and robinetin (53) have been demonstrated as inhibitors of dihydrofolate reductase in *Streptomonas maltophilia, P.vulgaris, S. aureus, M. tuberculosis*, and *E. coli* [43,155,156]. Dihydrofolate reductase is key enzyme for the synthesis of the purine and pyrimidine rings of nucleic acid, resulting in reduced DNA, RNA, and protein synthesis [156].

4.5. Inhibition of Energy Production

Energy production or ATP synthesis is the supreme vital requirement for the existence and development of bacteria as these chemicals are the main source of living systems. The treatment of
flavonoids such as isobavachalcone (54) and 6-prenylapigenin (55) with \textit{S. aureus} cause membrane depolarization, resulting in bacterial cell wall lysis [101]. Similarly, licochalcones (56) inhibited oxygen consumption in \textit{M. luteus}, interrupting the electron transport system eventually killing the bacteria [6]. It has been described that flavonoids such as baicalein (44), morin (9), silybinin (57), quercetin (1), isoquercetin (58), quercitrin (59), and silymarin (60) can constrain the F1FO ATPase system of \textit{E. coli} and result in the obstruction of ATP synthesis [157–159]. Additionally, EGCG (20), 40, 50, 5-trihydroxy-6, 7-dimethoxy-flavone (61), and proanthocyanidins (27) have also inhibited \textit{S. mutans}, \textit{P. aeruginosa} and \textit{S. aureus} through the enzymatic activity of FIFO ATPase respectively [100,104,141].

4.6. Inhibition of Bacterial Toxins

It is noteworthy that catechins and other flavonoids can cause bacterial cell wall destruction, resulting in an inability to discharge toxins [160,161]. Catechins (34), pinocembrin, kaempferol, EGCG (20), gallocatechin gallate (26), kaempferol-3-O-rutinoside (62), genistein (31), quercetin glycoside (63), and proanthocyanidins (27) (Figure 2) are suggested to neutralize bacterial toxic factors initiating from \textit{V. cholerae}, \textit{E. coli}, \textit{S. aureus}, \textit{V. vulnificus}, \textit{B. anthracis}, \textit{N. gonorrhoeae}, and \textit{C. botulinum} [162–165]. Bacterial hyaluronidases are enzymes formed by both Gram-positive and Gram-negative bacteria and directly interact with host tissues, causing the permeability of connective tissues and reducing the viscosity of body fluids due to hyaluronidase-mediated degradation [166]. Flavonoids such as myricetin (43) and quercetin (1) have been identified as hyaluronic acid lyase inhibitors in \textit{Streptococcus equisimilis} and \textit{Streptococcus agalactiae} [167].

4.7. Mechanism of Resistance to Antibacterial Agents

Pathogenic bacteria generally receive the resistance to various antibiotics through diverse mechanisms. Such mechanisms include: (a) bacteria can share the resistance genes through transformation, transduction, and conjugation; (b) bacteria produce various enzymes to deactivate the antibiotics through the process of phosphorylation, adenylation, or acetylation; (c) damage or alteration of the drug compound; (c) prevent the interaction of the drug with the target; (d) efflux of the antibiotic from the cell [168–170]. Emodin (1, 2, 8-trihydroxy-6-methylanthraquinone) (64) is an anthraquinone derivative which prevents the transformation of resistance genes in \textit{S. aureus} [171]. Baicalein is a potent inhibitor of the expression of the SOS genes, \textit{RecA}, \textit{LexA}, and \textit{SACOL1400} that prevent rifampin-resistant mutation in \textit{S. aureus} [172]. Phenolic compounds such as Carnosic (65) and rosmarinic acids (66) inactivate cmeB, cmeF, and cmeR genes in \textit{Campylobacter jejuni} [173].

4.8. Antimicrobial Action with Generation of Reactive Oxygen Species

Reactive oxygen species (ROS) can be formed by the partial reduction of molecular oxygen that targets the exertion of antimicrobial activity, which aids host defense against various disease-causing pathogens. The suggested method of antimicrobial activity of catechins (34) involves augmentation of the production of oxidative stress (ROS and RNS), which can alter membrane permeability and cause as cell wall damage [174]. In addition, catechins damage liposomes as they contain a high amount of negatively charged lipids and are susceptible to damage [175]. An earlier study indicated that catechins support the leaking of potassium and disturbs the membrane transport system in a methicillin-resistant \textit{S. aureus} strain [85]. This team has further demonstrated that acylated 3-O-octanoyl-epicatechin (21) is a lipophilic compound that produces more outcomes in antibacterial activity.

5. Conclusions

Since time immemorial, traditional medicinal plants have been cultivated by diverse populations to treat a great number of infectious diseases. Various investigations on the pharmacognostics and kinetics of medicinal plants have shown that crude extracts and plant-derived bioactive compounds may enhance the effects of traditional antimicrobials, which may be cost-
effective, have fewer side effects, and improve the quality of treatment. Numerous studies have shown that the antimicrobial activity of plant extracts and their active compounds have the following potential: promote cell wall disruption and lysis, induce reactive oxygen species production, inhibit biofilm formation, inhibit cell wall construction, inhibit microbial DNA replication, inhibit energy synthesis, and inhibit bacterial toxins to the host. In addition, these compounds may prevent antibacterial resistance as well as synergetics to antibiotics, which can ultimately kill pathogenic organisms. Based on these comprehensive antimicrobial mechanisms, the cultivation of traditional plant extracts and bioactive compounds offers a promising treatment for disease-causing infectious microbial pathogens. Hence, this mechanism constitutes an encouraging ally in the development of pharmacological agents required to combat the growing number of microbial strains that have become resistant to extant antibiotics in clinical practice.

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Abbreviation:

| Abbreviation       | Full Name                                      |
|--------------------|------------------------------------------------|
| A. bohemicus       | Acinetobacter bohemicus                        |
| A. flavus          | Aspergillus flavus                             |
| A. fumigatus       | Aspergillus fumigatus                          |
| A. niger           | Aspergillus niger                              |
| A. solani          | Alternaria solani                              |
| B. agri            | Brevibacillus agri                             |
| B. brevis          | Brevibacillus brevis                           |
| B. cereus          | Bacillus cereus                                |
| B. megaterium      | Bacillus megaterium                            |
| B. pumilus         | Bacillus pumilus                               |
| B. subtilis        | Bacillus subtilis                              |
| C. albicans        | Candida albicans                               |
| C. Diptheriae      | Corynebacterium Diptheriae                     |
| C. dubliniensis    | Candida dubliniensis                           |
| C. glabrata        | Candida glabrata                               |
| C. graminicola     | Colletotrichum graminicola                     |
| C. jejuni          | Campylobacter jejuni                           |
| C. krusei          | Candida krusei                                 |
| C. lunat           | Candida lunat                                  |
| C. lunatus         | Cochliobolus lunatus                           |
| C. macrocarpum     | Cladosporium macrocarpum                       |
| C. neoformans      | Cryptococcus neoformans                        |
| C. parapsilosis    | Candida parapsilosis                           |
| C. sphaerospermum  | Cladosporium sphaerospermum                    |
| C. tropicalis      | Candida tropicalis                             |
| C. maydis          | Cercospora zeae-maydis                         |
| D. turcica         | Drechslera turcica                             |
| E. aerogenes       | Enterobacter aerogenes                         |
| E. cloacae         | Enterobacter cloacae                           |
| E. coli            | Escherichia coli                               |
| E. facalis         | Enterococcus facalis                           |
| E. ficariae        | Entyloma ficariae                              |
| E. floccosum       | Epidermophyton floccosum                       |
| F. nucleatum       | Fusobacterium nucleatum                        |
| F. oxysporum       | Fusarium oxysporum                             |
| F. verticillioides | Fusarium verticillioides                       |
| H. carbonum        | Helminthosporium carbonum                      |
| H. pylori          | Helicobacter pylori                            |
| Bacterial Name                  | Scientific Name                      |
|--------------------------------|--------------------------------------|
| K. aerogenes                   | Klebsiella aerogenes                 |
| K. kristinae                   | Kocuria kristinae                    |
| K. pneumonia                   | Klebsiella pneumonia                 |
| L. acidophilus                 | Lactobacillus acidophilus            |
| L. casei                       | Lactobacillus casei                  |
| L. innocua                     | Listeria innocua                     |
| L. monocytogenes               | Listeria monocytogenes               |
| L. sporogenes                  | Lactobacillus sporogenes             |
| M. canis                       | Microsporum canis                    |
| M. luteus                      | Micrococcus luteus                   |
| M. morganii                    | Morganella morganii                  |
| M. ruber                       | Monascus ruber                       |
| M. smegmatis                   | Mycobacterium smegmatis              |
| M. tuberculosis                | Mycobacterium tuberculosis           |
| M. verticillata                | Mortierella verticillata             |
| P. acnes                       | Propionibacterium acnes              |
| P. aeruginosa                  | Pseudomonas aeruginosa               |
| P. brasiliensis                | Paracoccioides brasiliensis         |
| P. fluorescens                 | Pseudomonas fluorescens              |
| P. gingivalis                  | Porphyromonas gingivalis            |
| P. herbarum                    | Pleospora herbarum                   |
| P. innundatus                  | Protomyces innundatus                |
| P. intermedia                  | Prevotella intermedia                |
| P. lilacinum                   | Purpureocillium lilacinum            |
| P. mirabilis                   | Proteus mirabilis                    |
| P. sojae                       | Phytophthora sojae                   |
| P. vulgaris                    | Proteus vulgaris                     |
| R. rubrum                      | Rhodospirillum rubrum                |
| R. solanacearum                | Ralstonia solanacearum               |
| R. solani                      | Rhizoctonia solani                   |
| R. stolonifera                 | Rhizopus stolonifera                 |
| S. agalactiae                  | Streptococcus agalactiae             |
| S. anginosus                   | Streptococcus anginosus              |
| S. aureus                      | Staphylococcus aureus                |
| S. auricularis                 | Staphylococcus auricularis           |
| S. boydii                      | Shigella boydii                      |
| S. dysenteriae                 | shigella dysenteriae                 |
| S. epidermidis                 | Staphylococcus epidermidis           |
| S. fecalis                     | Streptococcus fecalis                |
| S. flexneri                    | Shigella flexneri                    |
| S. gordonii                    | Streptococcus gordonii               |
| S. haemolyticus                | Staphylococcus haemolyticus          |
| S. heidelberg                  | Salmonella heidelberg                |
| S. hominis                     | Staphylococcus hominis               |
| S. japonicas                   | Schizosaccharomyces japonicas        |
| S. kneipii                     | Spizellomyces kneipii                |
| S. lutea                       | Sarcina lutea                        |
| S. marcescens                  | Serratia marcescens                  |
| S. mutans                      | Streptococcus mutans                 |
| S. para typhi                  | Salmonella para typhi                |
| S. pneumoniae                  | Streptococcus pneumoniae             |
| S. pseudodichotomus            | Spizellomyces pseudodichotomus       |
| S. pyogenes                    | Streptococcus pyogenes               |
| S. sanguis                     | Streptococcus sanguis                |
| S. saprophyticus               | Staphylococcus saprophyticus         |
| S. shiga                       | Shigella shiga                       |
| S. typhi                       | Salmonella typhi                     |
| T. deformans                   | Taphrina deformans                   |
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