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Plants used for antimicrobial activity: a review

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Abstract

The rising prevalence of antibiotic-resistant bacteria has long been a source of concern in the scientific community. Many experts across the world are doing plant study in order to uncover potential antibacterial chemicals. Many plants secondary compounds have been shown to exhibit a wide range of biological functions. Antibacterial, antifungal, and anticancer properties may be present. The present review shows the plants recently used for antimicrobial activity.

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Introduction

Antimicrobial compounds are abundant in medicinal plants. Many potent and strong medications are derived from plants, which are utilised medicinally in various nations. It is thought that medicinal plants are a significant source of novel chemicals with potential therapeutic benefits. The primary healthcare system of the developed nations should be able to incorporate traditional medicine even more. Compared to current synthetic pharmaceuticals, natural remedies are thought to be more palatable to the human body. Therefore, the most crucial element required is to maximize the benefits of traditional medicine in order to provide comprehensive healthcare services to rural populations (Ghani 1990).Natural resources have always been a significant source of pharmaceuticals. Based on their use in conventional medicine, an amazing number of contemporary medications have been identified from or derived from natural sources. The hunt for pharmacologically active components from plants has been strengthened by recent scientific research showing a strong association between certain of the plants' traditional or folkloric uses. The plants have been utilised traditionally for ages (Egharevba and Kunle, 2010).

Rasayana, a plant-based medicine, has long been used to treat a variety of human illnesses. More than 80% of the world's population relies on traditional medicine for their primary health care requirements, according to the World Health Organization (WHO) [1]. Inscriptions from the early civilizations in China, India, and the

north east date back more than five millennia, but the usage of medicinal plants as a source of cures for illnesses is as ancient as mankind. Higher plants' potential as a source of novel pharmaceuticals is yet mostly untapped. Only a small portion of the estimated 250 000– 500,000 plant species have undergone phytochemical investigation, and even fewer have been subjected to biological or pharmacological screening. Numerous medicinal agents have been created from compounds, whether they are natural or synthetic, antimicrobial agents are abundant in medicinal plants. Different nations employ plants as medicine, and they are the source of potential and potent medications [2, 3, 4. 5]. A vast variety of medicinal components are employed to create several rasayanas, each of which has unique therapeutic capabilities against various microorganisms. The antibacterial capabilities of hundreds of plant species have been studied, although most of these have not been sufficiently assessed [6]. The present study is based on an examination of these plants because of the enormous potential of plants as sources for antibacterial medicines.

1. Stephania glabra [7].

Part used – Rhizome.

Extracted with- Three solvents -Ethanol, N-Hexane and Acetone.

Antimicrobial activities tested- Antibacterial and Antifungal.

Test organisms:

1. **Bacterial strains-** Staphylococcus mutans, Staphylococcus epidermidis, Escherichia coli, Klebsiella pneumonia.
2. **Fungal strains-** Aspergillus niger, Aspergillus fumigatus, Penicillum citranum, Microsporum gypseum, Microsporum canis, Trichophyton rubrum.

Method of assay - Agar disc diffusion method. The zone of inhibition and minimum inhibitory concentration was determined against standard drug novobiocin (15 μg/mL) for antibacterial activity and erythromycin (15 μg/mL) for antifungal activity.

Results reported- Out of three extract the ethanolic extract was reported to be most active against all bacterial as well as fungal strains. The extract was found to be most effective against two bacterial strains viz. S. mutans and S. epidermidis with minimum inhibitory concentration of 50μg/ml.

2. **Woodfordia fruticosa** [8]

Part used- Stem and flowers.

Extracted with- Petroleum ether, Chloroform, Diethyl ether and Acetone.

Antimicrobial activity tested- Antibacterial

Test organisms- Escherichia coli, Bacillus subtili, Staphylococcus aureus and Pseudomonas aeruginosa.

Method of assay –Disc diffusion method by comparing with the control which is pure solvents free from extracts.

Results reported-The 80 μg and 120 μg of acetone extract was reported to show proportional antimicrobial activity against all bacterial strains undertaken for study. It was further tested with comparison of known antibiotic erythromycin.

3. Betula utilis [9]

Part used- Bark

Extracted with- Petroleum Ether, Chloroform, Methanol, Ethanol and Water.

Antimicrobial activity – Antibacterial.

Method used- Agar well diffusion method. Gentamicin 10mcg/disc (5 mm in diameter) was used as standard drug.

Test organisms- Escherichia coli, Klebsiella pneumonia, Proteus mirabilis,Pseudomonas aeruginosa, Salmonella para typhi, Salmonella typhi, Salmonella typhimurium, Shigella flexneri, Shigella sonnei, Staphylococcus aureus, Streptococcus faecalis, Shigella boydii, Citrobacter sp.,Salmonella paratyphi B and Shigella boydii.

Result reported-Methanol extract was found to show significant activity against all the tested bacteria followed by ethanol and aqueous extract. No activity was reported for chloroform and petroleum ether extract.

4. Calotropis gigantean [10]

Parts used- Latex Extracted with-Ethanol

Antimicrobial activity tested- Antifungal. Method used- Disc diffusion method, Zone of inhibition was observed for minimum inhibitory concentration and minimum fungicidal concentration by comparing with Amphotericin B.

Test organisms-Candida albicans,Saccharomyc escerevisiae,Trichophyton mentagrophytes, Trichophyton rubrum,Aspergillus fumigates,Aspergillus lavus, Aspergillus niger, Penicillium chrysogenum.

Result reported-

The latex extract was reported to show significant zone of inhibition in dose dependent manner. The MIC and

MFC values of latex extract against fungal strains was found to be varied from 1 mg to 8 mg with the comparison of Amphotericin B.

5. Nelumbo nucifera [11]

Extracted with- Hydroethanolic extract.

Part used- Flowers. (Both white and pink)

Activity tested- Antibacterial and Antifungal.

Method used- Agar diffusion method.

Test organism:

1. **Bacterial-**Escherichia coli, Klebsiella pneumonia, Pseudomonas aeruginosa, Bacillus subtilis, Staphylococcus aureus.
2. **Fungal-** Monascus purpureus, Aspergillus niger.

Result reported

It was discovered that both Nelumbo nucifera flower extracts improved their antibacterial activity in a dose-dependent way. White and pink Nelumbo nucifera flowers showed the greatest zone of inhibition against Escherichia coli (16mm & 14mm), Bacillus Subtilis (15mm & 13mm), and Staphylococcus aureus (13mm & 11mm). Both white and pink flower extracts were observed to have a moderate zone of inhibition against Klebsiella pneumonia (12mm & 10mm) and Pseudomonas aeruginosa (9mm & 8mm). In contrast to earlier claims that plant extracts are more effective against gramme positive bacteria than gramme negative bacteria, gram-negative bacteria were found to be more responsive to Nelumbo nucifera flower extracts. The hydroethanolic extract of the white Nelumbo nucifera flower demonstrated effective antibacterial activity when compared to the pink Nelumbo nucifera flower. This difference in antibacterial activity may be attributable to the phytochemical constituents of the white flower, which differ in flavonoids, alkaloids, and tannins. The results were contrasted with those obtained using the common antibiotic chloramphenicol (30 g/ml). When compared to pink Nelumbo nucifera flower, white Nelumbo nucifera flower extract was found to have the lowest MIC against both bacteria. The lowest inhibitory concentrations for the white and pink Nelumbo nucifera flower extracts were determined to be 430 and 450 g and 490 and 480 g, respectively, against Escherichia coli and Staphylococcus aureus. From which the author deduced that the pink flower extract demonstrated greater MIC against both bacterial strains than the white flower extract. The antifungal activity was also measured in a dose-dependent manner, with white floral hydroethanolic extract showing the maximum activity against Aspergillus niger (15mm) and pink flower exhibiting a moderate level of activity (11mm). Both floral extracts were observed to have roughly the same effect on Monascus purpureus (13mm & 12mm). After that, these findings were contrasted with the established Clotrimazole (30 g/ml).

6. Comparative antimicrobial activity on

Hemidesmus indicus (roots), Eclipta alba (fruits), Coscinium fenestratum (stems), Curcubito pepo (seeds), Tephrosia purpurea (roots), Mentha piperita (leaves), Pongamia pinnata (seeds), Symplocos racemosa (barks), Euphorbia hirta (roots), Tinospora cordyfolia (roots), Thespesia populnea (roots), and Jasminum officinale (flowers) [12].

Extracted with-Ethanol

Activity reported- Antimicrobial effect against acne inducing bacteria.

Method used- Disc diffusion and broth dilution methods.

Test Organism- Propionibacterium acnes and Staphylococcus epidermidis.

Result reported

It was claimed that the extract stopped Propionibacterium acnes from growing. The extract from Hemidesmus indicus is one of th em. the fenestrated Coscinium, the purple Tephrosia,Curcubito, Symplocos racemosa, and Euphorbia hirtaPepo and Eclipta alba were discovered to show powerful inhibiting results. based on a dilution in broth the Coscinium fenestratum extract demonstrated highest level of antibacterial protection. The MIC numbers were same (0.049 mg/ml) for each bacterial species. The MBC values and species were discovered to be When used against Propionibacterium, 0.049 and 0.165 mg/ml Staphylococcus epidermidis and acne respectively. The Coscinium fenestratum extract demonstrated potent inhibitory zones against Propionibacterium acnes in the bioautography experiment.

A phytochemical analysis of Coscinium fenestratum identified an alkaloid that may be in charge of these actions. According to the research, Coscinium fenestratum significantly inhibited Propionibacterium acnes and Staphylococcus epidermidis growth.

7. Antimicrobial activity on

Albizia lebbeck (L.), Cleistanthus collinus (Roxb.)., Emblica officinalis (Phyllanthus emblica L.), Eucalyptus deglupta (Eucalyptus tereticornis), Eupatorium odoratum (Chromolaena odorata), Oxalis corniculata L., Hevea brasiliensis and Lantana camara L. [13]

Activity reported- Antimicrobial.

Part used- leaf Extracted with- Benzene, water and acetone.

Method used- Agar well diffusion method.

Test organisms- Escherichia coli (MDR), Staphylococcus aureus (MDR), Klebsiella pneumoniae, Bacillus cereus, Vibrio cholerae and Candida albicans

Result reported

The highest zone of inhibition (>11mm) against Escherichia coli, Klebsiella pneumoniae, Staphylococcus aureus, Bacillus cereus, Vibrio cholerae, and Candida albicans was reported for the extracts of Albizia lebbeck, Cleistanthus collinus, Emblica officinalis, Eucalyptus deglupta, Eupatorium odoratum, Oxalis corn Lantana camara demonstrated an 11–13 mm zone of inhibition against Candida albicans, Staphylococcus aureus, Bacillus cereus, Klebsiella pneumoniae, and Staphylococcus aureus. Lantana camara demonstrated an 11–13 mm zone of inhibition against Candida albicans, Staphylococcus aureus, Bacillus cereus, Klebsiella pneumoniae, and Staphylococcus aureus. There have been reports of modest activity (8 to 11 mm) from the extracts of Butea frondosais, Melastoma malabathricum, Terminalia Arjuna, and Lycopodium japonicum against all of the tested bacteria. Against all harmful microbes, plants like Adina cordifolia, Asparagus racemosus, Aegle marmelos, Cassia tora, Dillenia pentagyna, and Valeriana wallichii shown only minimal activity (5 to 8 mm). Ocimum basilicum was said to have better antifungal activity than moderate antibacterial activity (05mm-08mm) (12 mm). Additionally, it was found that organic solvents like acetone and benzene remove antimicrobial compounds from plant cells more effectively than water does.

Additionally, all aqueous, benzene, and acetonic extracts of ethnomedicinal plants (leaves) were reported to be effective against locally isolated human pathogens like Candida albicans, Escherichia coli (MDR), Klebsiella pneumoniae, Staphylococcus aureus (MDR), Bacillus cereus, and Vibrio cholerae. In comparison to the other twelve plants, the extracts of eight plants, including Albizia lebbeck, Cleistanthus collinus, Emblica officinalis, Eucalyptus deglupta, Eupatorium odoratum, Oxalis corniculata, Hevea brasiliensis, and Lantana camara, significantly inhibited the growth of multi-drug resistant clinically isolated organisms.

Plant extract MIC values were discovered to be significant between 0.35 and 0.80 mg/ml. Albizia lebbeck, Cleistanthus collinus, Emblica officinalis, Eucalyptus deglupta, Eupatorium odoratum, Oxalis corniculata, and Hevea brasiliensis were found to exhibit low MIC values of 0.35 mg/ml to 0.60 mg/ml among the examined plants. The best action was noted for the acetonic extracts of Emblica officinalis, Eucalyptus deglupta, Oxalis corniculata, and Hevea brasiliensis.

8. Comparative antimicrobial activity on

Acacia nilotica, Sida cordifolia, Tinospora cordifolia, Withania somnifer and Ziziphus Mauritian [14].

Part used- leaf, roots, bark

Extracted with- Methanol.

Activity reported- Antibacterial, Antifungal

Method used- Disc diffusion method.

Test organism

Bacterial- Bacillus subtilis, Escherichia coli, Pseudomonas fluorescens, Staphylococcus aureus and Xanthomonas axonopodis pv. Malvacearum.

Fungal- Aspergillus flavus, Dreschlera turcica and Fusarium verticillioides.

Result reported

When compared to root/bark extracts, the methanolic leaf extracts of Acacia nilotica, Sida cordifolia, Tinospora cordifolia, Withania somnifer, and Ziziphus mauritiana still exhibit significant antibacterial activity against Bacillus subtilis, Escherichia coli, Pseudomonas fluorescens, Staphylococcus aureus, and Xanthomonas.A. nilotica, S. cordifolia, and Z. mauritiana leaf extracts showed the highest antibacterial activity against B. subtilis and X. a. pv. malvacearum, respectively. Significant activity was shown against all test microorganisms for S. cordifolia root and leaf extract. Bark and leaf extract from A. nilotica were reported to have considerable antifungal action against A. flavus, Ziziphus mauritiana, and Tinospora cordifolia, as well as against D. turcica. According to reports, F. verticillioides was significantly resistant to the antifungal effects of the Sida cordifolia methanol extract.

9. Comparative antimicrobial activity on

Acalypha indica, Adhatoda vasica, Allium cepa, Allium sativum and Aloe vera [15].

Part used-Leaves, bulb, clove and gel respectively.

Extracted with- Aqueous extract.

Activity reported- Antituberoculosis.

Method used- Lowenstein Jensen (L-J) medium and colorimetric BacT/ALERT 3D system.

Test organism- M. tuberculosis, M. fortuitum.

Result reported:

The five plants A. indica, A. vasica, A. cepa, A. sativum, and A. vera all have extracts that have been shown to have anti-tuberculosis action in L-J medium. As

mentioned above, the percentage of inhibition of these plant extracts was found to be 95, 32, 37, 72, 32 percent for MDR isolate DKU-156 and 68, 86, 79, 72, 85 percent for another MDR isolate JAL-1236, while the percentage of inhibition for sensitive M. tuberculosis H37Rv was found to be 68, 70, 35, 63, and 41 percent at a 4 percent v/v concentration in L-J medium. The quick growth M. fortuitum was not affected by inhibition, according to reports. These plants' extracts significantly inhibited M. tuberculosis in BacT/ALERT as well.

10. Antimicrobial Activity on

Mikania glomerata, (Psidium guajava), Syzygium aromaticum, Allium sativum, Cymbopogon citratus, Zingiber officinale, Baccharis trimera, and Mentha piperita [16].

Extracted with- 70% methanol.

Antimicrobial activity- Antibacterial (Synergistic activity on 8 plant extracts)

Test organism- Staphylococcus aureus strains.

Method used- Disc Diffusion method.

Result reported

In the synergism experiments for the plants and their corresponding extracts, characteristics, MIC 90 percent (mg/ml) values against 32 S. aureus strains, and one-fourth the MIC 90 percent values were reported. All the plants showed anti-S. aureus action, which was confirmed. The most active species was S. aromatic, followed by P. guajava, while Cymbopogon citratus displayed the least amount of activity. The MIC 90 percent range was 0.36 mg/ml for Syzygium aromaticum and 17.84 mg/ml for C. citratus, and the researchers found that the antibacterial activity of the examined plants varied depending on the species and phytochemical characteristics.C. citratus, B. trimera, and Z. afficinale have not demonstrated very significant antibacterial activity. These plants were the subject of synergism experiments, and it was discovered that the synergism rate of C. citratus was comparable to that of S. aromaticum. The medicines utilised here had a variety of antibacterial actions, but the ones that worked best in combination with folic acid and inhibitors of bacterial cell wall construction were the ones that block protein synthesis. Tetracycline was noted to exhibit synergism with all of the extracts among the protein synthesis inhibitors, followed by chloramphenicol and netilmicin.

10. Antimicrobial Activity on

Arnebia nobilis, Garcinia indica, Boehavia diffusa, Solanum albicaule, Vitex negundu, Bunium persicum, Acacia concinna and Albizia lebbeck [17, 18, 19, 20].

Extracted with-Ethanol

Activity tested-Antibacterial

Method used- Well diffusion method.

Test organism-Pure culture of all test organisms, namely Pseudomonas aeruginosa, Staphylococcus aureus positive, Escherichia coli, Staphylococcus aureus negative and fungi Candida albicans.

Result reported:

A. nobilils, G. indica, B. diffusa, S. albicaule, V. nigundu, B. persicum, A. concinna, and A. lebbeck were among the plants whose crude extracts were tested for their antibacterial efficacy against a variety of test bacterial strains.

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