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Review Article

ANTIMICROBIAL PROPERTIES OF SOME IMPORTANT MEDICINAL PLANTS

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ABSTRACT

Plants have been used for thousands of years to enrich and preserve food, cure ailments, and prevent infections, including epidemics. Medicinal plants have played an important role in the regeneration of deteriorating diseases caused by microbial infections., also to prevent from spreading of infectious disease. Furthermore, medicinal plants provide a valuable resource for potentially beneficial compounds for the development of novel chemotherapeutic drugs, which have significantly contributed to human health and well-being. Plant-derived products have the potential to regulate microbial growth in many different kinds of conditions. In the particular context of infection control, several studies have attempted to characterize the chemical constitute of these plant antimicrobial compounds and the processes behind microbial growth suppression, either in isolation or in combination with traditional antimicrobials. Such works should be brought to the attention of every concerned person. The current paper is an attempt to provide a review of some these kinds of plants.

INTRODUCTION

Nowadays, research on medicinal plants has been attracting a lot of interest, both domestically and internationally. A significant amount of investigation has been done to demonstrate the potential advantages of employing medicinal plants in traditional, complementary, and alternative approaches of treating human ailments. Numerous secondary metabolites, including tannins, terpenoids, alkaloids, flavonoids, etc., are abundant in plants and have been shown to have antibacterial qualities in vitro[1]. Antimicrobial plant extracts are of interest to clinical microbiologists for two reasons. First, since several of these phytochemicals are currently undergoing human testing, it is highly possible that they will end up in the arsenal of antimicrobial medications that physicians prescribe. Since scientists are aware that antibiotics have a finite effective life span, they are also looking into other sources, particularly plant sources. Second, the public's awareness of the issues surrounding the over prescription and improper usage of conventional antibiotics is growing. Furthermore, a lot of people would like greater control over their medical care[2].

Antimicrobial agents exist in medicinal plants. Several countries use plants as medicine, and they represent a source of effective and promising medications[3]. Several *Rasayanas* are created by combining a variety of medicinal components, each with its own set of therapeutic properties against specific microbes. Many plant species have been studied for their antibacterial properties, but most have received little attention[4]. This work is based on a survey of such plants, which have significant potential as sources of antibacterial characteristics.

MATERIALS AND METHODS

Using the primary database from the field of microbiology, this review is carried out in 2024. A total of 17 publications are reviewed, including ancient literatures, books and journals that are available in college library and a variety of electronic databases (including ScienceDirect, Research Gate, Medline, PubMed, and Google Scholar). Only publications related to antimicrobial activity are preferred from

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both national and international organizations, examined, and reviewed. The various plant parts extract utilized as antimicrobial agent are discussed in this article. Using the search phrases like "anti-microbial", "medicinal plants", "anti-fungal", and "anti-bacterial", were looked up for results. Relevant information discovered from the numerous publications linked to the antimicrobial activities of medicinal plant studies carried out globally.

RESULTS

Antimicrobial activity of 6 medicinally important plants viz. *Acorus calamus* L., *Aquilaria agallocha* Roxb., *Azadirachta indica* A. Juss., *Brassica alba* Boiss., *Commiphora wightii* (Arn.) Bhandari and *Vateria indica* L. are reviewed. These plants shall be used for future research on antimicrobial properties. Reviews on these plants are as follows:

1. *Acorus calamus* L. (*Vacha*)

Plant part used: Rhizome.

Extracted with: Crude methanol, petroleum ether (50 to 2000mg).

Active constituent: Acorenone, isocalamendiol.

Antimicrobial activity: Anti-bacterial, anti-fungal.

Method used: The crude methanol extract was prepared using column chromatography.

Test organisms: *Trichophyton rubrum, Microsporum gypseum, and Penicillium marneffei* (Filamentous fungi), *Candida albicans, Cryptococcus neoformans* and *Saccharomyces cerevisiae* (yeasts), *B. subtilis, E. coli, P. aeruginosa*, and *S. aureus* (Bacteria).

Result reported: With IC50 values of 0.2, 0.2, and 0.4 mg/ml, respectively, the results showed significant activity against filamentous fungus *Trichophyton rubrum*, *Microsporum gypseum*, and *Penicillium marneffei*. It did, however, demonstrate poor action against bacteria (MIC 5 - >10mg/ml) and significant potency against yeasts (MIC 0.1 to 1mg/ml), *Saccharomyces cerevisiae*, and *Cryptococcus neoformans*. Hyphae and conidia treated with this fraction shrunk and collapsed, probably as a result of cell fluid leakage, as seen by scanning electron microscopy[5].

Properties according to Ayurveda

- ***Rasa:*** *Katu, Tikta*
- ***Guna:*** *Laghu, Tikshna*
- ***Virya:*** *Ushna*
- ***Vipaka:*** *Katu*
- ***Karma:*** *Deepani, Krimihar, Kanthya, Kaphahara, Medhya, Vaatahara, Mala-mutra vishodhani, Vaamak*[6].
- **Mode of action:** The mode of action is noted for its *Krimighna* properties, functioning as an anti-bacterial agent effective against bacterial strains like *Salmonella typhi, Pseudomonas aeruginosa, Klebsiella pneumoniae,* and *Staphylococcus aureus*, thereby inhibiting bacterial growth[7].

2. *Aquilaria agallocha* Roxb. (*Agaru*)

Plant part used: Bark, stem

Extracted with: Methanol and aqueous extracts

Active constituent: Concentrations of fat, saponin, tannin, glycoside, anthraquinone, and alkaloids were low, whereas those of amino acids, alkaloids, and terpenoid compounds were high.

Antimicrobial activity: Anti-bacterial

Method used: The Agar well diffusion technique was employed.

Test organisms: *B. brevis, B. subtilis, P. aeruginosa* and *S. flexneri.*

Result reported: *S. flexneri* and *P. aeruginosa* showed distinct inhibitory zones in response to an aqueous extract of the leaf and bark. While the methanol extract of the bark did not exhibit any inhibition effect against *B. subtilis*, the methanol extract of the leaf did[8].

Properties according to Ayurveda

- ***Rasa:*** *Katu, Tikta*
- ***Guna:*** *Laghu, Snigdha, Tikshna*
- ***Virya:*** *Ushna*
- ***Vipaka:*** *Katu*
- ***Karma:*** *Shirovirechana, Kaphahara, Pittalam, Tvachya, Vaatahara*[9]
- **Mode of action:** *Krimighn* (anti-bacterial and anti-inflammatory) and special use in *Sutikagara*[10].

3. *Azadirachta indica* A.Juss (*Nimba*)

Plant part used: Leaf

Extracted with: Drying and pulverizer

Active constituent: Azadirachtin, quercetin, ß-sitosterol, nimbin, nimbanene, 6-desacetylnimbinene, nimbandiol, nimbolide, ascorbic acid, n-hexacosanol, amino acid, 7-desacetyl-7-benzoylazadiradione, 7-desacetyl-7-benzoylgedunin, 17-hydroxyazadiradione, and nimbiol.

Antimicrobial activity: Anti-bacterial, anti-fungal, anti-viral.

Method used: The agar well diffusion method was employed.

Test organisms: *Staphylococcus aureus* (Gram positive bacteria) and *Escherichia coli, Salmonella typhi, Klebsiella pneumoniae, Pseudomonas aeruginosa* and *Proteus vulgaris* (Gram negative bacteria).

Result reported: Most efficient against *S. aureus* and *S. typhi*, but less effective against *K. pneumoniae*, *E. coli*, and *Proteus vulgaris*, as well as moderately effective against *Pseudomonas aeruginosa*. *A. indica* exhibited

the largest zone of inhibition against Gram positive *S. aureus* and the least zone of inhibition against Gram negative *E. coli*, according to measurements of the zone of inhibition (ZOI). Additionally, when 700 µg of extract were employed, the maximal inhibition on *S. aureus* was seen to be 22±3 mm, with the zone of inhibition rising with increasing dose[11].

Properties according to Ayurveda

- ***Rasa:*** *Tikta*
- ***Guna:*** *Ruksha*
- ***Virya:*** *Sheeta*
- ***Vipaka:*** *Katu*
- ***Karma:*** *Grahi, Vaatala, Pittanasak*[12]
- **Mode of action:** *Krimighna* and *Vishaghna* are anti-microbial, anti-bacterial properties of *nimba* that assist to dry up the intracellular fluid inside the bacterial wall and inhibit the growth of the bacteria. They are particularly effective against pyogenic bacteria like *Staphylococcus aureus* and *Staphylococcus pyogenes*[13].

4. *Brassica alba* L. (*Gaur Sarshap*)

Plant part used: Seed

Extracted with: Soxhlet apparatus

Active constituents: Fatty acid (41.3% erucic acid), glucosinolates, and phenolic acid (trans-Sinapic, trans-caffeic, trans-ferulic, and P-Hydroxy benzoic acid) are the active ingredients.

Antimicrobial activity: Anti-bacterial

Method used: Agar well diffusion method

Test organisms: *Staphylococcus aureus* (Gram positive) and *Escherichia coli, Pseudomonas aeruginosa* (Gram negative).

Result reported: *Pseudomonas aeruginosa* and *Escherichia coli* are not being targeted in any way. Activity against *Staphylococcus aureus* is moderate.

Properties according to Ayurveda

- ***Rasa:*** *Katu, Tikta*
- ***Guna:*** *Ushna, Tiksna*
- ***Virya:*** *Ushna*
- ***Vipaka:*** *Katu*
- ***Karma:*** *Kaphahara, Vaatahara, Deepani, Jantughna*[15]
- **Mode of action:** *Krimighna* (anti-microbial)[16]

5. *Commiphora wightii* (Arn.) *Bhandari (Guggulu)*

Plant part used: Resin

Extracted with: Orbital shaker, centrifuge

Active constituent: Alkaloids, flavonoids, glycosides, steroids, and terpenoids.

Antimicrobial activity: Anti-bacterial

Method used: Agar well diffusion method

Test organisms: *Bacillus subtilis, Bacillus cereus, Bacillus pyogenes, Escherichia coli, Salmonella typhi, and Staphylococcus aureus.*

Result reported: Data indicated that methanol extract was found to have maximum inhibitory power against almost all the bacteria tested except *Salmonella typhi* and *Streptococcus pyogenes*.

Only *Staphylococcus aureus* was shown to be susceptible to the effects of hexane and aqueous extracts. The maximum susceptibility was shown by *Staphylococcus aureus* which was inhibited almost all the gum resin extracts followed by *Bacillus subtilis, Bacillus cereus* and *Escherichia coli*[17].

Properties according to Ayurveda

- ***Rasa:*** *Katu, Tikta, Kashaaya*
- ***Guna:*** *Laghu, Sara, Vishada*
- ***Virya:*** *Ushna*
- ***Vipaka:*** *Katu*
- ***Karma:*** *Balya, Rasaayan, Varnya, Vatabalasajit, Medohara*[18]
- **Mode of action:** *Krimighna* is an antibacterial agent that works against both gram-positive and gram-negative bacteria. It works by dissolving the internal fluids of infections, hence stopping their growth[19].

6. *Vateria indica* L. (*Sarjras*)

Plant part used: Bark exudate

Extracted with: 100% ethanol with a Soxhlet apparatus

Active constituent: Alkaloids, carbohydrates, flavonoids, glycosides, monoterpenes, oligostabinoides, phenols, saponins, steroids, and tannins.

Antimicrobial activity: Anti-bacterial

Method used: Disc diffusion method was used.

Test organisms: *Escherichia coli* and *Staphylococcus aureus.*

Result reported: Exudate showed effective inhibition of growth against both *Escherichia coli* and *Staphylococcus aureus* against showed significant effects when compared to that of standard drugs[20].

Properties according to Ayurveda

- ***Rasa:*** *Katu, Tikta, Kashaaya*
- ***Guna:*** *Snigdha, Ushna*
- ***Virya:*** *Ushna*
- ***Vipaka:*** *Katu*
- ***Karma:*** *Kaphaghna, Vaatahara, Svedahara, Varnya, Vishaghna, Krimighna*[21].
- **Mode of action:** *Krimighna* (anti-bacterial and anti-inflammatory) and also useful in wound healing[22].

Figure 1: (a) *Vacha*; *Acorus calamus* (b) *Agaru*; *Aquilaria agallocha* (c) *Nimba*; *Azadirachta indica* (d) Gaur *Sarshap*; *Brassica alba* (e) *Guggulu*; *Commiphora wightii* (f) *Srajras*; *Vateria indica*

DISCUSSION

The reviewed medicinal plants viz. *Acorus calamus* L., *Aquilaria agallocha* Roxb., *Azadirachta indica* A. Juss., *Brassica alba* Boiss., *Commiphora wightii* (Arn.) Bhandari and *Vateria indica* L. exhibit a wide range of antimicrobial properties, highlighting their potential as alternative therapeutic agents. Numerous researches have led to results indicating that these plants have noteworthy efficacy against a diverse

range of diseases, such as viruses, fungus, and bacteria. The antibacterial activity of Acorus calamus L. rhizomes and leaves is thought to be attributed to the presence of an active component of derived compound. *Aquilaria agallocha* Roxb. also exhibit antimicrobial property against various bacteria and fungi and special use in *sutikagara* for fumigation process. The active compounds of *Azadirachta indica* A. Juss., including azadirachtin, nimbin, and quercetin, disrupt microbial growth and replication. Neem's low toxicity and high efficacy make it a promising agent for developing antimicrobial treatments. The application of *Brassica alba* L. extracts in food preservation and as a natural antimicrobial agent is particularly promising. Significant antibacterial activity against gram-positive bacteria and moderate activity against gram-negative bacteria were demonstrated by an active component of the methanolic extract of gum from *Commiphora wightii* (Arn.). *Vateria indica* L. shows potential in treating infections and promoting wound healing.

As per Ayurveda concepts, *Krimighna/ Jantughna dravya* should possess properties like *Katu-Tikta-Kashaya rasa, Ushna guna, Ushna veerya, Katu vipaka.* All the drugs which were reviewed earlier exhibit such properties, which are considered to be bactericidal, hence shows antimicrobial activity. Additionally, exploring synergistic effects between them, pharmaceutical formulations of these plants could lead to more effective combination for the anti-microbial therapies.

CONCLUSION

The antimicrobial properties of these medicinal plants underscore their potential as natural alternatives to synthetic antimicrobial agents. Each plant exhibits unique bioactive compounds that target a wide range of pathogens, providing a valuable resource for developing new treatments in the face of rising antimicrobial resistance. Future research should focus on isolating and characterizing these bioactive compounds, understanding their mechanisms of action, and evaluating their efficacy and safety in clinical settings. Integrating these medicinal plants into modern medicine could enhance our ability to combat infections while mitigating the adverse effects associated with synthetic antimicrobial agents.

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