Indian Journal of Novel Drug Delivery

IJNDD

An Official Publication of Karnataka Education and Scientific Society

Review Article

An Overview: Promising Approach of Medicinal Plant as Antimicrobial Activity

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ARTICLE DETAILS

Article history:
Received on 26 May 2023
Modified on 21 June 2023
Accepted on 26 June 2023

Keywords:
Antimicrobial,
WHO,
Medicinal Plants,
Bioactive Compounds,
Mechanism.

ABSTRACT

Prior to the invention of conventional antibiotics, medicinal plants were used to treat human illnesses. However, because they are affordable, accessible, and free of the side effects sometimes associated with conventional antibiotics, medicinal herbs continue to be used by people. From the perspectives of pharmacognosy and microbiology, reproducibility has become a problem when screening plants for antibacterial activity. Although it's normally not one component but a mixture of metabolites, the beneficial medical effects of plant materials are typically caused by the secondary products present in the plant. Some therapeutic plants have multiple functions, such as targeting microbial proteins and peptides, which are crucial for the creation of natural remedies.

INTRODUCTION

The notion that some plants had healing properties or even included what we would now refer to as antimicrobial principles was widely believed long before humans learned about the presence of bacteria. Since ancient times, people have utilised plants to treat common infectious diseases, and some of these folk remedies are now used routinely to treat a variety of ailments. For instance, various manuals of phytotherapy report the use of cranberry juice (*Vaccinium macrocarpon*) and bearberry (*Arctostaphylos uva-ursi*) to treat urinary tract infections, while species like tee tree (*Melaleuca alternifolia*), lemon balm (*Melissa officinalis*), and garlic (*Allium sativum*) are described as broad-spectrum antimicrobial agents [1]. Medicinal plants have been an excellent source of plant-based flavonoids, antioxidants, and anticancer chemicals that have been utilised to combat diseases brought on by bacteria and viruses. They have a number of supporters over some native plants, including those who claim that they improve concentration and mental clarity, combat air pollution by making habitations cozy and moist, and so forth [2].

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A plentiful supply of components for pharmacological or synthetic medication creation is thought to be medicinal plants. As long-term therapy for diabetes and other anti-cancer medications, they are also used. Due to the existence of numerous anti-cancerous and antibacterial chemicals, even a single medicinal plant exhibits pharmacological and biological effects. They have multiple targets for microbes and influence a variety of reactions. However, the manner in which individual chemicals are isolated and purified before being used in various marketing-related applications determines how they will behave. Due to their biological functions, they are highly valuable [3–4]. The World Health Organisation (WHO) asserts that the greatest place to get a range of medications is from medicinal plants [5]. Many ethnic groups use different plant species to treat a variety of illnesses, from mild infections to dysentery, skin conditions, asthma, malaria, and a plethora of other indications [6]. Further research on plant-based antimicrobials is urgently needed because they represent a big untapped source of medicines. Plant-based antimicrobials have a huge medicinal promise. There is a lengthy history of plant-derived antimicrobials offering the much-needed new therapeutics [7]. The swiftly transforming and potentially harmful external environmental

variables are constantly interacting with plants. Plants, which lack the ability to move, have developed sophisticated alternative defense mechanisms that use a wide range of chemicals.

Bioactive Compounds

Phytochemicals, often known as plant chemicals, are what give plants their medical value since they have a specific physiological effect on people. In herbal and homoeopathic remedies, these phytochemicals were employed to treat the illness [8]. These compounds, which are not nutrients, have a protective or disease-prevention function [9]. Screening medicinal plants for bioactive chemicals becomes necessary and serves as a foundation for additional pharmacological research. Many of the medicinal plants' active ingredients have been identified and presented as useful drugs in contemporary medical systems thanks to advancements in phytochemical techniques. Alkaloids, flavonoids, tannins, and phenolic compounds are the most significant of these bioactive substances [10]. These are the essential raw materials used in the manufacture of drugs [11]. Most plants contain several compounds with antimicrobial properties for protection against aggressor agents, especially microorganisms [12].

Reason for Reconsidering Plant as Antimicrobial Agent [13]

The development of antimicrobial resistance by the targeted bacteria, which used a number of established ways to resist the effects of chemotherapeutic drugs like antibiotics, prompts a quick response with the release of new antimicrobials. The methicillin-resistant Staphylococcus aureus, which has developed resistance to practically all kinds of medications, is a notable example. Antimicrobial agent abuse and overuse frequently lead to antibiotic resistance. The demand for alternatives such as probiotics and phytomedicine has arisen due to the development of antibiotic resistance among bacteria necessitating continuous medication research and the mild to severe unfavourable side effects of synthetic drug use on patients.

Numerous causes, including the idea that all herbal products are safe and effective, have contributed to the tremendous growth in the consumption of herbal therapies around the world. Worldwide, the usage of phytomedicine is rising steadily throughout industrialised, emerging, and underdeveloped countries. Products like Ginkgo (*Ginkgo biloba*), Echinacea species (often known as cone flower), Garlic, and many more are frequently touted as safer, more natural, and healthier alternatives to conventional treatments in the United States of America, for instance. More than 15 million Americans use herbal remedies or high-dose vitamins, and more than 34 billion dollars in out-of-pocket expenses are incurred for complementary and alternative medicine (CAM) each year, significantly outpacing visits to general practitioners. For a variety of illnesses, around 70% of German doctors recommended plant-based medications to their patients.

Importance of Plants as Antimicrobial Agents

Using the disc-diffusion and broth dilution assays, 38 plant-derived flavonoids from seven different structural groups were tested for antibacterial activity. The methicillin-resistant *Staphylococcus aureus* (MRSA) was inhibited by five flavonoids (flavanonol, myricetin, datiscetin, kaempferol, and quercetin) and two flavones (apigenin and luteolin) out of the flavonoids that were studied. Additionally, it was discovered that flavanonol prevented the development of VRE, multidrug-resistant *Burkholderia cepacia*, and other critical pathogens like *Klebsiella pneumoniae* and *Staphylococcus* epidermidis. Myricetin has a similar bactericidal effect on *B. cepacia*. The results of the radiolabel incorporation assay demonstrated that myricetin prevented *B. cepacia* from producing proteins. Traditional uses of medicinal plants include the treatment of illnesses and disease prevention. These plants are a source of bioactive chemicals that have additive characteristics for food. Terpenes and phenolic chemicals, which have antibacterial and antioxidant characteristics, are abundant in medicinal plants. The biological properties of essential oils obtained from plants included antioxidant, anticancer, antivenom, anti-inflammatory, and antibacterial actions. 94% less germs were present after treatment with medical smoke produced by burning wood and a combination of odoriferous and medicinal herbs. The bactericidal potential of the medicinal smoke treatment is demonstrated by the absence of pathogenic bacteria (*Corynebacterium urealyticum, Enterobacter aerogenes, Klebsiella mobilis, Kocuria rosea, Pseudomonas syringae pv. persicae,* and *Staphylococcus lentus*) in the open room even after 30 days. There is potential for using medicinal smoke made from natural herbal items as a smoking or inhaling method of medicine administration.

Antimicrobials derived from plants have great medicinal promise. They effectively treat infectious infections while also minimizing a number of the adverse effects frequently connected to synthetic antimicrobial medicines. They are powerful but delicate. Numerous plants exhibit tropisms towards particular bodily organs or systems. Phytomedicines typically have a variety of physiological effects. They frequently take activities that go beyond simply treating a disease's symptoms. *Hydrastis canadensis* is an illustration of this. In addition to having antibacterial properties, *hydrastis* also improves blood flow to the spleen, which encourages the spleen's ideal ability to release mediating compounds [14–17].

Table 1: Some medicinal plants used for the treatment of antimicrobial disease

Botanical Name	Family	Local Name	Parts	Mode of Action/Aliments
Acacia nilotica	Mimosaceae	Karuvelam	St	Young stem is used as toothbrush. Toothache
Achyranthes aspera	Amaranthaceae	Nayuruvi	L	Decoction of leaf is used for skin eruption.
Acorus calamus	Araceae	Vasambu	Rh	Dried rhizome is given orally for throat infection.
Aegele marmelos	Rutaceae	Vilvam	L	Juice of leaf extract applied for eye disease.
Aerva lanata	Amaranthaceae	Sirupeelai	WP	Juice of whole plant is taken orally for cough, sore throat
Ageratum conyzoides	Asteraceae	Sethupunthalai	L	Leaves paste mixed with common salt is applied on affected part in skin diseases

Mechanisms of Action of Antimicrobial Agents

Three requirements must be satisfied for an antibacterial agent to work against bacteria: There must be sensitive antibacterial targets in the cell (i), and (ii). In addition, the antibacterial agent must sufficiently reach the target and (iii) cannot be altered or rendered inactive. The cell wall, ribosome, nucleic acid, and bacteria metabolic enzymes are some of the known target areas with which antibacterial drugs interact to exert their effects.

Several identified antibacterial activity pathways include:

(i) Peptidoglycan synthesis inhibition (e.g., -lactams, glycopeptides);
(ii) Protein synthesis inhibition (e.g., tetracyclines, chloramphenicol, mupirocin, macrolides, aminoglycosides-aminocyclitols);
(iii) Inhibition of nucleic acid synthesis by interfering with nucleotide metabolism; (e.g., additionally, some antimicrobials (such as polymyxins) interfere with the integrity of membranes).

It is important to remember that most antimicrobial substances that prevent the synthesis of proteins are typically bacteriostatic, whereas those that prevent the synthesis of nucleic acids are frequently bactericidal. In essence, plant extracts' antibacterial effects can be utilised to forecast which bacterial cell targets are most likely to be affected [18–20].

Antimicrobial Activity Mechanisms of Medicinal Plant-Derived Chemical Compounds

Despite the fact that many nations have previously approved synthetic antibacterial medicines; the use of natural compounds derived from medicinal plants continues to catch the interest of several experts. The potential for discovering novel bioactive chemicals from medicinal plants that can combat hardy bacteria is immense. A large collection of chemical compounds that have been discovered naturally in plants are referred to as medicinal plant-derived substances. By making older antibiotics more potent, they can restore their clinical use and prevent the development of resistance.

The majority of therapeutically useful plant-derived bioactive substances (phytochemicals) are secondary metabolites. The end products or intermediates of secondary plant metabolism are known as secondary metabolites. According to the structure, number, and location of substituent groups, the presence of glycosidic linkages, the alkylation of OH groups, the topography, and climate of the region of origin, they have a wide range of antibacterial action. In fact, the number and quality of bioactive secondary metabolites affect how effective they are as antimicrobials against certain bacteria strains.

Bioactive plant extracts typically include intricate combinations of components, and their synergistic action might result in an amplified effect. These substances have a variety of effects on the microbial cell. The cytoplasmic membrane is typically the major target region for bioactive substances, which alters its structure and integrity, permeability, or functionality in various ways. Plant extracts may contain EP inhibitors in their makeup, according to some speculation. In addition, one of the most promising mechanisms of action of bioactive chemicals against MDR pathogens has been identified as the disruption of regular cell communication (quorum sensing, or QS). QS inhibitors must have the capacity to reduce the expression of QS-controlled genes and must be chemically stable to withstand the host organism's metabolic and disposal processes. Certain substances have the ability to alter or suppress protein-protein interactions, making them potent regulators of apoptosis, mitosis, and immunological response. Additionally, they have the capacity to disrupt or impede the development of biofilms, which give pathogens a protective advantage during infection, cause the coagulation of cytoplasmic components, and interfere with intermediate metabolism. Multiple antiviral elements found in medicinal plant extracts interact with diverse viral proteins at distinct viral replication stages.

Despite the fact that there are many of these compounds, they can be divided into several major groups based on their chemical structures, chemical composition, biosynthetic pathway, or level of solubility. These groups include alkaloids, phenolic compounds, sulfur-containing compounds, coumarins, terpenes/essential oils, lectins, and polypeptides [21].

CONCLUSION

Antimicrobials derived from plants have great medicinal promise. They effectively treat infectious infections while also minimising a number of the adverse effects frequently connected to synthetic antimicrobial medicines. Due to the growing acceptance of natural plant-based products as nontoxic, having no side effects, easily accessible at reasonable prices, and occasionally the only source of healthcare available to the poor, the demand for herbal medications is rising globally. Herbal therapy can effectively utilise plant extracts and biologically active chemicals that have been extracted from plant species. The use of medicinal plants as antimicrobial agents in new medications for the treatment of infectious disorders in humans can be inferred from their activity against various pathogens.

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