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A review on antimicrobial activity of some plant

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Abstract

Many studies have recently been conducted to examine antimicrobial activities in response to rising public concern about hygiene. Antimicrobial agents have potentially harmful or hazardous effects, hence their usage needs to be monitored. In the past few years, because of older antibiotics' fewer negative reactions are being experienced, as more people are choosing to use natural substances rather than synthetic or chemical medicines, herbal plants are used as medicines. Plants can be utilized directly as their active ingredients or as plant extracts. The majority of the world's inhabitants also use herbal remedies because of their potent antibacterial effects and advantages for basic healthcare. Furthermore, oxidative stress slows down the cellular processes required for wound healing and increases the generation of reactive oxygen species (ROS). Biomaterials with strong antibacterial activity, like herbal plant medicine, can take the role of antibiotics. The antimicrobial qualities particular of plants are highlighted in this review paper. This review discusses the recent progress on antimicrobial properties of herbal materials and their efficacy in eradicating bacteria and fungus. The given antimicrobial compounds in this review include clove, ginger, cinnamon, turmeric, *Mentha* which are elaborated.

Keywords: Herbal material, antimicrobial activity, antioxidant activity, medicinal applications, reactive oxygen species (ROS)

1. Introduction

Concerns over the sustainability of human life are making it more and more important to resist the harmful effects of microbes. Numerous microbes coexist in biological harmony with the human body and its environs, but unchecked or fast microbial growth can cause some potentially harmful issues. Antimicrobial medications are used to prevent infections in human body, nevertheless they have a variety of negative side effects, particularly if they raise reactive oxygen species levels in the human body (Parham *et al.*, 2020) ^[12]. Numerous plant species are among the herbal substances utilized as therapeutic plants. Several of these herbal ingredients exhibit therapeutic properties include antimicrobial effect. Additionally, the research and manufacture of drugs can largely depend on these plants (Homaeigohar *et al.*, 2020) ^[7]. These substances have a important role in a variety of biological applications, including the treatment of cancer, cardiovascular disease, neurological disease, and skin regeneration. Herbal remedies were the principal medical roles in olden cultures in the Americas, Europe, Africa, and particularly Asia (Van Wyk and Wink, 2018) ^[18]. In certain impoverished nations, herbal remedies are the principal form of treatment for infections. Numerous investigations have demonstrated that various herbal plant remedies are resources of a variety of compounds, many of which contain antibacterial and radical scavenger capabilities that can protect the human body from pathogens as well as cellular oxidation events. Due to their antimicrobial properties, these components are important in the synthesis of several herbal medicines (Radünz *et al.*, 2019) ^[13]. List of some plant act as an antimicrobial agent and its medicinal applications are tabulated in table 1. These various molecules are taken into consideration as raw materials for novel antibacterial medication research since they can control and inhibit pathogen with minimal cell harm. Many studies have concentrated on looking for antibacterial medications with lesser side effects in order to combat the dreadful effects of the growth of bacteria and viruses (Willis *et al.*, 2019) ^[19]. This review highlights the special antibacterial properties of plants. This study covers the latest research on the antibacterial qualities of herbal materials and how well they work to eradicate fungi and bacteria. This review includes detailed information about the antimicrobial substances clove, ginger, cinnamon, turmeric, and *mentha*.

Table 1: List of some plant act as an antimicrobial agent and its medicinal applications

Plant	Scientific Name	Application area	Ref.
Clove	<i>Syzygium aromaticum</i>	Anti-inflammatory, anti-cancer, antimicrobial, antioxidant, antimutagenic, and anti-allergic	Radünz <i>et al.</i> , 2019 [13]
Cinnamon	<i>Cinnamomum verum</i>	Anti-inflammatory, antimicrobial, anticancer, antioxidant, cardiovascular, immunomodulatory and cholesterol-lowering	Willis <i>et al.</i> , 2019 [19]
Ginger	<i>Zingiber officinale</i>	Antimicrobial, anti-diabetic, antioxidant, neuroprotective, analgesic, anti-inflammatory, cardiovascular, gastrointestinal, antihypertensive and anticancer	Idris <i>et al.</i> , 2019 [9]
<i>Mentha</i>	<i>Mentha piperita</i>	Anticancer, antimicrobial, antioxidant, and anti-inflammatory	Soleimani <i>et al.</i> , 2022 [15]
Turmeric	<i>Curcuma longa</i>	Anti-inflammatory, antimicrobial, antioxidant, hypoglycemia, anticoagulant and anticancer	Abd El-Hack <i>et al.</i> , 2021; [11] Wojtyłko <i>et al.</i> , 2023 [20]

2. Important of Some selected Plant

2.1 Clove

The Myrtaceae family contains the herb clove (*Syzygium aromaticum*), which is one of the greatest potent antioxidant and antibacterial plants. The traditional herb is mostly found in Asia and Africa. Using clove's bioactive substances, such as eugenol, eugenylacetate, humulene, and 2-heptanone, and caryophyllene exhibits numerous pharmacological properties, including those of an anti-inflammatory, antioxidant, antibacterial, anticancer, anti-allergic and antimutagenic, properties (Cortés-Rojas *et al.*, 2014) [2]. The phytochemical in the clove to display one of the strongest antioxidant properties amongst natural remedies. Previous investigations have noted Clove oil and extract against several bacteria strains (Gram-negative and Gram-positive) (Radünz *et al.*, 2019) [13]. Other studies have demonstrated clove's antibacterial effectiveness against a many of bacteria, including *Klebsiella pneumoniae*, *Listeria monocytogenes*, *E. coli*, *S. aureus*, and *S. Typhimurium*. Eugenol-based clove has antibacterial properties (Idowu *et al.*, 2021) [18]. Eugenol's antibacterial method of action involves first being involved in the cytoplasmic membrane thanks to its high solubility. Then, because of its -OH group, it produces interference. It can then flow over the cell's hydrophilic section (Radünz *et al.*, 2019) [13]. Similarly, the outcome of one study demonstrated the antioxidant activity of clove extract's eugenol against superoxide radicals DPPH, and ABTS (Radünz *et al.*, 2019) [13]. When compared to vitamin C, several investigations have found that this plant has considerable antioxidant potential against DPPH. The chemical composition of this plants, such as a phenolic component, is related to the strong antioxidant action of clove's essential oil and extract (Ugbogu *et al.*, 2021) [17].

2.2 Cinnamon

The plant species known as cinnamon (*Cinnamomum zeylanicum* and *Cinnamomum verum*) is a member of the Lauraceae family. Australia and Asia are the origins of this ancient herbal medication. This plant is frequently employed in the medical sector due to its antioxidant, antibacterial, and anticarcinogenic properties. Cinnamon possesses antibacterial properties, according to earlier studies (Willis *et al.*, 2019) [19]. Due to its antibacterial, antioxidant, and antimicrobial qualities, cinnamon has long been employed. Studies conducted in the past looked into the antibacterial properties of cinnamon against different bacteria, including *E. coli* and *Bacillus*, *Yersinia enterocolitica*, *Salmonella typhimurium*, *Staphylococcus aureus* and *Pseudomonas aeruginosa* have all been demonstrated to be susceptible to the antibacterial activity of cinnamon oil (Suriyagoda *et al.*, 2021) [16]. Other researchers have shown how cinnamon essential oil inhibits the growth of *Listeria monocytogenes*, *E. coli*, and *S. aureus* by attacking their cell walls. Cinnamon has phenolic compounds that may have antioxidant, antimutagenic,

antidiabetic, anticancer, and anti-inflammatory properties. This herb's essential oil has been found to have antioxidant properties. Other investigations have noted the antioxidant properties of cinnamon extracts derived from ethanol, methanol, and water (Ezzaky *et al.*, 2023) [4].

2.3 Ginger

Ginger is an essential herb belonging to the Zingiberaceae family. It is the subterranean rhizome of the herbaceous perennial plant *Zingiber ocinale roscoe*. Polyphenolic compounds found in ginger include phenolic acids, gingerols, paradols, and shogaols. Its biological features, including its antidiabetic, antimicrobial, antioxidant, Reno protective, anti-hypertensive, anti-ulcer, cardiovascular, analgesic, anti-inflammatory, and gastrointestinal actions, are due to these main ingredients (Gulzar *et al.*, 2023) [6]. The chemical components found in ginger, like zingerone, shogaols, gingerols, and zingiberene, are what give it its antioxidant properties. Numerous *in vitro* lab tests have been used to examine the antioxidant properties of ginger and its constituent parts in several research. Researchers have found that ginger extract may have antioxidant effects. A rat study revealed the antioxidant effects of ginger extract. Ginger extract exhibits strong antibacterial action against many bacterial pathogens, including *Salmonella typhi*, *S. aureus* and *E. coli*, (Idris *et al.*, 2019) [9]. Due to the antioxidant action of plant, it may be applied to the treatment of illnesses brought on by free radicals. Furthermore, research has been done on ginger's effectiveness as an antibiotic. Generally speaking, ginger is thought to be a safe and pharmacologically effective herbal treatment (Dalsasso *et al.*, 2022) [3].

2.4 Mentha

One of the aromatic perennial herbs in the Lamiaceae family is mint, or *mentha*. It has been included into many other goods, including cosmetics and medications. The essential oil and watery extracts of mint may possess antioxidant activities as a result of their existence. Substances phenolic. *Mentha* essential oil has been proved to be an excellent substitute. Owing to its anti-inflammatory qualities, it is utilized as a temporary treatment for individuals with irritable bowel syndrome. The literature has extensively demonstrated the antibacterial and antioxidant properties of extracts or essential oils derived from several *Mentha* species (Gholamipourfard *et al.*, 2021) [5]. Additionally, it has been noted that different extracts prevent the growth of microbial biofilms made up of *Pseudomonas aeruginosa* and *Candida albicans* strains. This plant's phytochemical ability to operate as an antioxidant is entirely dependent on its chemical composition. It can aid in preventing oxidative stress in living things or at the cellular level. According to earlier research, mint extract has been employed as a bioactive natural antioxidant and antibacterial extract (Soleimani *et al.*, 2022) [15]. Several studies have demonstrated this plant's ability to inhibit several bacterial

species and its robust antibacterial qualities against Gram-positive bacteria, particularly *S. aureus*. The antibacterial properties of this plant at diverse oil concentrations have been reported in several studies. Mint oil has effective antibacterial qualities against an extensive range of bacteria, such as *S. aureus*, *S. epidermidis*, *Bacillus cereus*, *E. coli*, *Cronobacter sakazakii* and *Enterococcus faecalis*. This herbal remedy inhibits the HIV and HSV-1 viruses (Parham *et al.*, 2020) [12].

2.5 Turmeric

One of the natural medications used traditionally is turmeric (*Curcuma longa*). Turmeric contains the polyphenolic compound curcumin, which offers it antibacterial and antioxidant effects. Curcumin's shows antioxidant capabilities are owing to its phenolic component. Turmeric's phytochemical components include tumerone, cineole, vitamin C, zingiberene, borneol, d- sabinene, and d-phellandrene (Abd El-Hack *et al.*, 2021) [1]. According to previous research, turmeric possesses antimicrobial properties (both antibacterial and antifungal). Curcumin is known to suppress a variety of microorganisms, including *Salmonella typhimurium*, *S. aureus*, and *E. coli*. Turmeric's use in literature is widespread. There is evidence that extracts have potent anti-oxidant activities. It can remove reactive nitrogen species (RNS) and reactive oxygen species like hydrogen peroxide, superoxide radicals and singlet oxygen (Wojtyłko *et al.*, 2023) [20]. Through the electron transfer, three active sites can oxidize nitric oxide, peroxyxynitrite, and hydroxyl radicals and the abstraction of hydrogen. Additionally, through its indirect antioxidant effects, curcumin catalase, glutamyl cysteine, and other cytoprotective proteins are reduced. Heme oxygenase 1, glutathione reductase, glutathione S transferase, ligase, superoxide dismutase, additionally glutathione peroxidase (Panpatil *et al.*, 2013) [11] Turmeric therapy can reduce plasma malondialdehyde levels while increasing glutathione reductase, plasma albumin, catalase activity and glutathione peroxidase levels. Turmeric's aqueous and ethanol extracts exhibit strong antioxidant properties via boosting antioxidant enzymes, preventing lipid peroxidation and scavenging various free radicals. Turmeric has been shown to prevent hydrogen peroxide production in some *in vivo* experiments on rats. Via halting the oxidation of lipids in cells. The various turmeric extracts, Strong antioxidant properties can be shown in substances like n-hexane, n-butanol, ethyl acetate, and chloroform. Analysis has shown a strong relationship between scavenging capacity and phenolic content of such excerpts (Sharma, *et al.*, 2019) [14].

4. Future outlook

Due to their effectiveness as an antibacterial agent and their capacity to scavenge free radicals, replacing the chemical antimicrobial substances with natural source (Plant) antimicrobial agents is a great answer. The novel was written using herbal materials. Future research in all fields, but particularly in medicine, is very fascinating due to their special characteristics of herbal plants. New medical products have already been developed as a result of their medicinal applications. These herbs are frequently used in combination in the practice of traditional medicine. Therefore, in order to progress therapeutics and produce new pharmaceutical products, future research can concentrate on characterizing the active ingredient and the effects of herb-herb combos. Herbal materials have provided a new and fascinating subject in the sciences, particularly in the medicine and their future research owing to their exclusive qualities.

5. Conclusions

The biological applications of herbal medicines have been described by numerous researchers. Other chemical antimicrobial agents and antibiotics, such as metal oxide and metal nanoparticles, can stop the development of bacteria, but they can also produce ROS and have other unintended consequences. Contrarily, herbal remedies like clove, cinnamon, mint, ginger, turmeric work as free radical scavengers to destroy germs. Different types of extract and essential oils from these herbal medicines have different antibacterial activities against different types of bacteria. Because they are less toxic and have less adverse effects than synthetic antibacterial drugs, herbal medications are frequently chosen. These herbal remedies have strong antibacterial and antioxidant properties, making them useful for treating various kinds of wounds. Additionally, herbal medications exhibit strong antibacterial activity at a cheaper cost. The most important factor to consider when evaluating the potential health benefits of herbal medication for people is bioavailability. Herbal medicines are generally favored over synthetic antibacterial drugs since they are less toxic and have fewer adverse effects.

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