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Antimicrobial activity of Plant Extract: A review of recent literature

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Abstract

Recently, organic plant-based anti-microbial agents are being developed more tremendous focus as a second choice to some chemical-based food inhibitor or biocides due to the health concerns, external influences governing food safety, and business obstacles. Foodborne outbreaks connected to frequently consumed foods can also be caused by erroneous executing & directing, variations in the environment while transport and remain consistent, poor physical cleanliness measures. Numerous pathogenic microorganisms which could be present in the nearby air, water, and soil sources and may be present in the field settings are brought into contact with food crops. In fact, businesses that process agricultural plants produce large amounts of products and by-products that are rich in phenols, which may be potential untapped sources of inorganic antimicrobial substances. Plant extracts are abundant in flavonoids along with polyphenolic molecules, that have potent antimicrobial capabilities and help with handling the avoidance of several illnesses. In this review, we present a summary on some of the particular plants along with most current antimicrobial applications of Plant Extracts. This review also discusses the mechanisms of antimicrobial activity of plant extract and also briefly summarized the key challenges and opportunities regarding plant extracts and their antimicrobial efficiency.

Keywords: Plant Extract, Phytochemicals, Foodborne pathogen, Antibacterial efficacy.

1. Introduction

Botanical aromatic compounds and plant-based substance are widely recognized for their health benefits, but now they have been examined for their potential as antimicrobials. Plant components like fruits, seeds, buds, bark, roots, flowers and wood, are used for the manufacture of plant extracts and essential oils (Eos). These oils and extract can be produced using a variety of techniques, including expression, and fermentation,

effleurages (Burt, 2004). For business purposes, their active ingredients can also be synthesized (Nazzaro et al., 2013). Terpenoids, flavonoids, Phenols, flavanols, polyphenols, coumarins, quinines, flavones, tannins, lectins alkaloids, and polypeptides are among the substances included in Eos and extracts (Prakash et al.,2020). The methods like mass spectrometry and chromatography may be used to evaluate these substances. Numerous extracts of plant are also now used for their preservation abilities. When EOs, extracts, and their constituent parts are combined with conventional preservatives like nisin to, nitrite of sodium, and the salt, synergistic action has also been seen against particular microbes (Burt, 2004). The anti-allergic and protective agent properties of substances & organic compounds are also supported by a large body of research (Nazzaro et al., 2013). The antiviral, antimycotic, antiparasitic, Insecticidal, antioxygenic, and antibacterial effects of EOs, or plant-based products, or the substances that are active in them, have been recognized (Yasmin et al., 2023). It additionally has potential ability with resistance to some refractory to antibiotics bacteria.

A compound's antibacterial action may be affected by its ingredients and extraction methodology, the concentration and pH of media utilized, the kind of medium employed, the stage of life of the organism, the use of a chemical solution or buffer to help with floating, incubating procedure, and the degree of heat, can all have an impact on a compound's substance and extraction technique (Nazzaro et al., 2013). Several studies have found that as Gram-negative bacteria have a protective outer barrier, they're less vulnerable to the antibacterial effect of EOs and extracts than Gram-positive species, in several studies, it has been shown that organic molecules are effective against Gram-negative bacteria. (Bajpai et al., 2012). In this review, we present a summary on some of the particular plants along with most current antimicrobial applications of Plant Extracts. This review also discusses the mechanisms of antimicrobial activity of plant extract and also briefly summarized the key challenges and opportunities regarding plant extracts and their antimicrobial efficiency.

2. Plant Extract

Biologically active substances from a variety of plant sources, such as crops & blossoms, fruits, seeds, origins, & branches, are extracted to create plant extracts (Chamorro et al., 2022). These are abundant sources of biologically active substances such terpenoids (carotenoids, phytosterols, iridoids, triterpenes, terpenes) alkaloids, organo-sulfurs, cinnamic acid, benzoic acid, anthocyanins, flavanols, flavanols, stilbenes, lignin tannin and polyphenols. Plant extracts provide potential sources of antibacterial substance (Rahul et al., 2022). These compounds have antioxidant and antibacterial properties, making them popular candidates for use as natural preservatives that might partially or completely replace synthetic preservatives. Plants were extracted by applying a variety of techniques, including infusion, decoction, maceration, digesting, percolation, and Soxhlet extraction, as well as microwave and ultrasonic assistance (Kamil et al., 2019). Additionally, the secondary metabolites were properly sterilized and detached from each other employing high-performance liquid chromatography, thin-layer chromatography, gas chromatography and paper chromatography (Ebere et al., 2019). The variety from plant substance, the type of chemical being applied, its temperature, pH, and the solvent to sample ratio all play a role in selecting the best extraction technique. It also relies on how the finished items are going to be used. The outcome of substances is subsequently described and tested for antimicrobial activity.

3. Antimicrobial agents

The potential of plants to produce aromatic compounds, the bulk of which are compounds of chemical compounds or they have oxygen substitutions, is practically endless. Numerous essential oils and extracts are extracted from plants which contain a variety of antibacterial agents. These compounds frequently act as defensive mechanisms for plants against herbivores, insects, and microbial predators. Some, like terpenoids, are in charge of the smell of plants, while others, like quinones and tannins, are in charge of the color of plants. The flavor of plants is caused by a variety of substances, including the terpenoid capsaicin found in chili peppers.

4. Mechanisms of Antimicrobial-resistant Sensitivity of Plant Extract

Numerous Research has indicated the organic compounds and extracts contain significant in vitro antimicrobial efficacy upon a variety Many pathogens associated with including both Gram-positive and Gram-negative bacteria as well as bacteria that cause spoilage (Gutierrez et al., 2008). Applying the micro plate assay to test the antibiotic efficacy 23 chemically active substances and 96 organic compounds against *Escherichia coli O157:H7*, *Campylobacter Jejuni*, *S. enterica* and *Listeria monocytogenes (*Lai et al., 2016). All four bacterial

types were resistant to 27 oils and 12 active substances. It may be possible to assess the potential using antibiotics derived from plants in complex agricultural systems by understanding the mechanism of action (MOA) for such compounds (Picone et al., 2013). Yet, it can be little trickier to ascertain the MOA when examining a possible beneficial substance than it's deciding the range in operations as well composition. It's more probable both organic compounds & components have several objectives leading to main mechanisms of action and subsidiary mechanisms of action rather than a single main MOA linked to a single ingredient. (Nazzaro et al., 2013; Picone et al., 2013). It's because EOs and extracts are made up of a variety of compounds. It's true of the active elements or a variety fell short of the organic compound effectiveness or substance as an entire unit, indicating the possibility of other trace compounds within the MOA, is evidence for this.

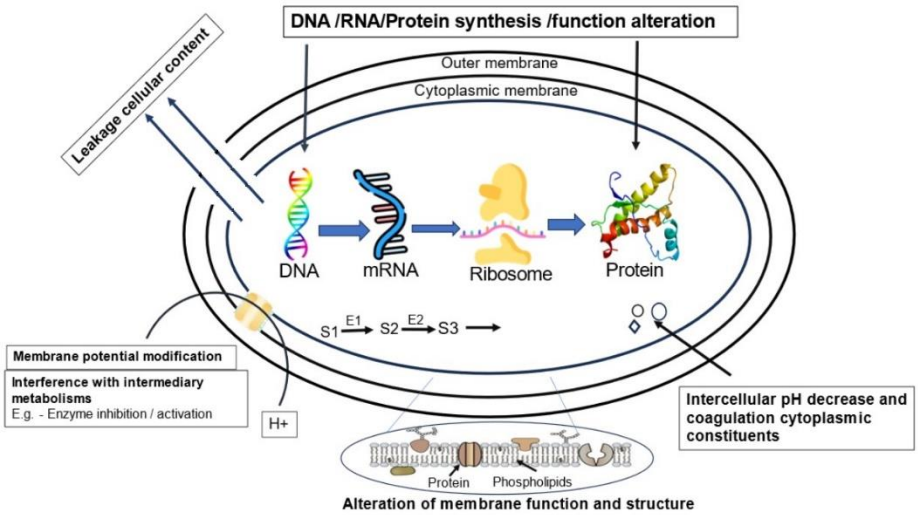

Figure 1: Mechanisms of Antimicrobial-resistant Sensitivity of Plant Extract

According the research, main mechanism of action (MOAs) of organic substances and their derived products is connected to the various components' physicochemical qualities, this permits them to separate in the triglycerides of the outer layers of cells, increasing their permeability. But their life span will additionally be lacking if essential quantities are missing (Nazzaro et al., 2013). Cells can normally with stand a maximum quantity of loss before potential is lost. Additionally, imply the polyphenol rings, as are present in a large number of organic substance & extracts from plants parts, appears in charge of the antibiotic effect (Ultee et al., 2002). This was determined after looking at other substances that don't include the phenolic ring, such menthol, which showed considerably lower antibacterial activity than those found in EOs and extracts that do. The association between phenolic content and antibacterial action has been shown in other investigations as well (Shan et al., 2007).

Table 1: The following organic substance and extracts of plant have been researched & examined for their antibacterial properties:

No.	Plant extract or plant phenolic	Microbe	Mechanisms of activity	Refs.
1	Olive leaf extract	*L. monocytogenes*	Lose their flagella and become less mobile after being given sub-inhibitory concentrations.	Liu et al., 2017
2	Berry phenolics	*Salmonella enterica, S. enterica serovar*	Producing lipopolysaccharide (LPS), or it can intercalate into the outermost layer of the membrane and replace stabilizer cations.	Suriyaprom et al., 2022
3	Rice plant extracts (Ferulic acid)	*E. coli, L. monocytogenes, P. aeruginosa*	Cytoplasmic K+ efflux: perfusion of the plasma membrane	Borges et al., 2013
4	Salvia officinalis (Coumarins)	*Bacillus subtilis*	Coumarins inhibit the initial phase of cell division in bacteria.	Duggirala et al., 2014
5	Purple cauliflower (anthocyanins)	*L. monocytogenes, S. Enteritidis*	Glycoprotein or DNA are leaking due to barrier breakdown	Zhou et al., 2020

5. Challenges and opportunities

The key challenges and opportunities of plant extract regarding their antimicrobial efficiency are summarized as follows:

- A Potential 'ESCAPE' from antimicrobial Resistance of 'ESKAPE' pathogens by exploiting plants
- Determination of antimicrobial Efficacy of plant extracts is too difficult.
- It's to challenges of development new antimicrobials from plant Extracts.
- Toxicity of plant extract.
- Standardization method of extraction and *In vivo* testing.
- The integration of revolutionary technology
- The goods redesign structurally
- Global partnerships and guidelines for standard technologies

6. Conclusion

Larger amounts are required for analyzing the antimicrobial activity of organic compound or extracts in products in contrast to studies conducted in vitro, it has been discovered. The pH, where more activity is seen at reduced pH as a result of the EO's increased hydrophobia, The level of humidity at where food is kept depends, the percentage from oxygen in the atmosphere, and especially the Protein, fat, and liquid percentage, are all aspects of the composition The various consumption which could influence the activity of plant components and organic solvents. Due to possibility that it offers bacterial protection, foods with a high fat content appear to have less antimicrobial action. In order to avoid or limit contamination by foodborne pathogens, several have suggested using plant extracts and EOs as Natural substitutes for the prevalent substances utilized in the food manufacturing industry. In addition to satisfying the demands of the "green" movement that has grown over the last decades, the use of plant-based solvents and molecules as organic antimicrobial agent or preservation agents protects the broader public from food-borne illnesses. In general, several plant substances have shown their effectiveness in opposition to several food-related illnesses *in-vitro* as well as in model food structures, and as a result, they may be included food contains ingredients to improve the protection of microbes. The real-world integration of these compounds in the food industry will benefit from more investigation.

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