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Thyme Essential Oil as a Natural Antibacterial Agent against Re-emerging Foodborne Pathogens

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Introduction

Foodborne illnesses remain a significant public health challenge worldwide. Despite advances in food safety protocols, the emergence and re-emergence of pathogenic microorganisms in the food supply continue to pose risks to human health. Re-emerging foodborne pathogens, such as Salmonella, Escherichia coli, Listeria monocytogenes, and Campylobacter jejuni, have led to a resurgence in foodborne infections, highlighting the need for effective antimicrobial solutions. The overuse of synthetic antibiotics and chemical preservatives in food processing has raised concerns regarding the development of Antimicrobial Resistance (AMR), prompting interest in alternative, natural solutions. Among the various natural antimicrobial agents, essential oils (EOs) derived from plants have gained significant attention due to their broad-spectrum antibacterial properties, sustainability, and minimal toxicity to humans and animals. Thyme Essential Oil (TEO), in particular, has been extensively studied for its potent antimicrobial activity, making it a promising candidate for controlling foodborne pathogens. This article explores the antimicrobial properties of thyme essential oil and its potential as a natural tool against re-emerging foodborne pathogens.

Description

Thyme essential oil is derived from the leaves and flowers of the Thymus vulgaris plant, a member of the mint family. This aromatic herb is native to the Mediterranean region but is now cultivated worldwide. Thyme has long been used in traditional medicine for its antiseptic, antifungal, and antibacterial properties. The primary bioactive compounds in thyme essential oil are phenolic compounds, including thymol and carvacrol, which are responsible for its antimicrobial activity. These compounds have been shown to exhibit broad-spectrum antibacterial properties, making thyme essential oil effective against a wide range of foodborne pathogens. Foodborne illnesses are caused by the ingestion of food contaminated with harmful microorganisms, including bacteria, viruses, fungi, and parasites. While some pathogens, such as Salmonella and E. coli, have been well-studied for their association with foodborne disease outbreaks, recent years have seen an increase in the frequency and severity of outbreaks linked to re-emerging pathogens. These include antibiotic-resistant strains of Salmonella, Listeria monocytogenes, Campylobacter jejuni, and Vibrio cholerae. The re-emergence of these pathogens is partly due to factors such as global trade, changes in food production practices, and the misuse of antibiotics in both human and animal populations.

Re-emerging foodborne pathogens are of particular concern because they can cause severe infections, especially in vulnerable populations, such as children, the elderly, and immunocompromised individuals. Moreover, the growing issue of antimicrobial resistance has made it more challenging to treat infections caused by these pathogens using conventional antibiotics. The need for effective, natural alternatives to combat these pathogens is critical in reducing the incidence of foodborne illness and the spread of antimicrobial resistance. Thyme essential oil has shown promising antimicrobial properties against a wide range of pathogenic bacteria, including those commonly found in foodborne illnesses. Several studies have demonstrated its effectiveness in inhibiting the growth of both Gram-positive and Gram-negative bacteria, including re-emerging pathogens. The key bioactive compounds in thyme essential oil, thymol and carvacrol, have been identified as the main contributors to its antibacterial activity [1,2].

The antimicrobial activity of thyme essential oil is primarily attributed to its phenolic compounds, which are known to disrupt the cell membranes of bacteria. Thymol and carvacrol penetrate the bacterial cell wall, leading to the release of cellular contents and disrupting the integrity of the membrane. This damage causes leakage of intracellular components, such as proteins and nucleic acids, ultimately leading to bacterial cell death. Additionally, these compounds can interfere with bacterial metabolism by inhibiting enzymes involved in cellular processes. The antibacterial activity of thyme essential oil is enhanced by its ability to alter the permeability of bacterial cell membranes, making it easier for other antimicrobial agents to penetrate the cells. The hydrophobic nature of thymol and carvacrol also enables them to interact with the lipid bilayer of the bacterial membrane, further enhancing their effectiveness as antibacterial agents [3].

Research has shown that thyme essential oil is effective against a variety of foodborne pathogens, including both common and re-emerging bacteria. Salmonella is a leading cause of foodborne illness worldwide, commonly associated with poultry, meat, and eggs. Several studies have demonstrated that thyme essential oil, particularly its phenolic compounds, is effective in inhibiting the growth of Salmonella strains, including antibiotic-resistant varieties. Thymol and carvacrol disrupt the bacterial cell wall and inhibit the expression of genes involved in the pathogen's virulence, making thyme essential oil a promising natural alternative to synthetic antimicrobials. Certain strains of E. coli, particularly E. coli O157:H7, are associated with foodborne illness outbreaks linked to contaminated meat and produce. Thyme essential oil has been shown to inhibit the growth of E. coli by disrupting its cell membrane and preventing biofilm formation. Additionally, thyme essential oil can reduce the pathogenicity of E. coli by interfering with the expression of virulence factors. Listeria monocytogenes is a significant concern in ready-to-eat foods, such as deli meats, cheeses, and smoked fish. It is known for its ability to grow at refrigeration temperatures, making it a challenge to control in the food industry. Studies have demonstrated that thyme essential oil exhibits strong antimicrobial activity against Listeria monocytogenes, preventing its growth and enhancing food safety. Campylobacter jejuni is a leading cause of bacterial gastroenteritis, often transmitted through contaminated poultry. Thyme essential oil has been found to effectively inhibit the growth of Campylobacter jejuni, providing a potential natural alternative to combat this pathogen in poultry processing [4].

While thyme essential oil shows great potential as an antibacterial agent, there are some challenges to its widespread use in the food industry. The strong aroma and flavor of thyme essential oil may affect the sensory properties of food products. In some cases, this may limit its use in certain food applications, especially in products where the flavor must remain neutral. The effectiveness of thyme essential oil depends on its concentration and the method of application. Determining the optimal concentration to achieve antimicrobial effects without compromising food quality is essential

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for successful implementation. The use of essential oils in food products is subject to regulatory approval in many countries. It is important to ensure that thyme essential oil meets safety and quality standards before it can be used in commercial food products. [5].

Conclusion

Thyme essential oil, with its potent antibacterial properties, presents a promising natural alternative to synthetic antimicrobial agents for controlling foodborne pathogens, particularly re-emerging strains. Its broad-spectrum activity against pathogens such as Salmonella, E. coli, Listeria monocytogenes, Campylobacter jejuni, and Vibrio species makes it a valuable tool in the fight against foodborne illness. Additionally, its natural origin, minimal toxicity, and sustainability make it an attractive option for enhancing food safety and extending shelf life. However, further research is needed to optimize its application, address challenges related to sensory impact, and establish regulatory guidelines for its safe use in food products. By harnessing the antimicrobial power of thyme essential oil, the food industry can take a significant step toward improving food safety and reducing the risks associated with foodborne diseases.

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Conflict of Interest

There is no conflict of interest by author.

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