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A Systematic Review on Antimicrobial Activity of *Piper betle* Linn Leaves

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Abstract

Piper betle Linn (PBL) is a well-known medicinal plant used in traditional medicine for various ailments. The leaves of *P. betle* Linn have been reported to exhibit broad-spectrum antimicrobial activity against various pathogenic microorganisms. The major active compounds responsible for the antimicrobial activity of *P. betle* Linn are phenolics, alkaloids, terpenoids, and flavonoids. This review article aims to summarize the current knowledge on the antimicrobial activity of *P. betle* Linn leaf extracts against bacteria, fungi, viruses, and parasites. The article also discusses the major active compounds responsible for the antimicrobial activity of *P. betle* Linn and their mechanism of action. Further, the potential use of *P. betle* Linn as a natural antimicrobial agent to combat antimicrobial resistance (AMR) is discussed. The review highlights the need for further studies to evaluate the efficacy and safety of *P. betle* Linn extracts as a potential antimicrobial agent.

Keywords: PBL; Antimicrobial Activity; Phenolics; Alkaloids; Terpenoids; Flavonoids; Mechanism of Action; Antimicrobial Resistance

Abbreviations: AMR: Antimicrobial Resistance; MDR: Multidrug-Resistant; HSV: Herpes Simplex Virus; HIV: Human Immunodeficiency Virus.

Introduction

Antimicrobial resistance (AMR) is a global public health threat that has led to the emergence of multidrug-resistant (MDR) microorganisms. The development of new antimicrobial agents is crucial to combat AMR and protect public health. Medicinal plants have been used for centuries in traditional medicine to treat various ailments, including infectious diseases. The leaves of *P. betle* Linn, a member of the Piperaceae family, have been used in traditional medicine for their antimicrobial, anti-inflammatory, and analgesic properties. *P. betle* Linn is a climbing vine that is widely distributed in Southeast Asia, India, and China. The leaves of *P. betle* Linn contain various bioactive compounds, including phenolics, alkaloids, terpenoids, and flavonoids, which have been reported to exhibit antimicrobial activity against various pathogenic microorganisms [1].

Antibacterial Activity

P. betle Linn leaf extracts have been reported to exhibit antibacterial activity against various pathogenic bacteria, including Staphylococcus aureus, *Escherichia coli, Salmonella typhi*, and *Pseudomonas aeruginosa*. The antibacterial activity of *P. betle* Linn is attributed to its phenolic and alkaloid content. The phenolic compounds present in *P. betle* Linn, such as eugenol and hydroxychavicol, have been reported to exhibit antibacterial activity by inhibiting bacterial growth and biofilm formation. The alkaloids present in *P. betle*

Linn, such as piperine and pellitorine, have been reported to exhibit antibacterial activity by disrupting bacterial cell membrane and inhibiting bacterial growth [2].

Antifungal Activity

P. betle Linn leaf extracts have also been reported to exhibit antifungal activity against various pathogenic fungi, including *Candida albicans, Aspergillus niger*, and *Trichophyton mentagrophytes*. The antifungal activity of *P. betle* Linn is attributed to its phenolic and flavonoid content. The phenolic compounds present in PBL, such as eugenol and hydroxychavicol, have been reported to exhibit antifungal activity by inhibiting fungal growth and biofilm formation. The flavonoids present in PBL, such as quinazoline and quercetin, have also been reported to exhibit antifungal activity by disrupting fungal cell membrane and inhibiting fungal growth [3].

Antiviral Activity

P. betle Linn leaf extracts have been reported to exhibit antiviral activity against various viruses, including herpes simplex virus (HSV), human immunodeficiency virus (HIV), and influenza virus. The antiviral activity of *P. betle* Linn is attributed to its phenolic and flavonoid content. The phenolic compounds present in PBL, such as eugenol and hydroxychavicol, have been reported to exhibit antiviral activity by inhibiting viral replication and entry into host cells. The flavonoids present in PBL, such as quercetin and catechin, have also been reported to exhibit antiviral activity by inhibiting viral replication and entry into host cells [4,5].

Antiparasitic Activity

P. betle Linn leaf extracts have also been reported to exhibit antiparasitic activity against various parasites, including *Plasmodium falciparum, Trypanosoma cruzi*, and *Leishmania donovani*. The antiparasitic activity of *P. betle* Linn is attributed to its alkaloid and terpenoid content. The alkaloids present in PBL, such as piperine and pellitorine, have been reported to exhibit antiparasitic activity by disrupting the parasite cell membrane and inhibiting parasite growth. The terpenoids present in PBL, such as β- caryophyllene and α-humulene, have also been reported to exhibit antiparasitic activity by disrupting parasite cell membrane and inhibiting parasite growth [6,7].

Mechanism of Action

The antimicrobial activity of *P. betle* Linn is attributed to the presence of various bioactive compounds, including phenolics, alkaloids, terpenoids, and flavonoids. These compounds have been reported to exhibit antimicrobial activity by disrupting microbial cell membrane, inhibiting microbial growth, and inhibiting biofilm formation. The phenolic compounds present in PBL, such as eugenol and hydroxychavicol, have been reported to exhibit antimicrobial activity by disrupting microbial cell membrane and inhibiting microbial growth. The alkaloids present in PBL, such as piperine and pellitorine, have been reported to exhibit antimicrobial activity by disrupting microbial cell membrane and inhibiting microbial growth. The terpenoids present in PBL, such as β-caryophyllene and α-humulene, have also been reported to exhibit antimicrobial activity by disrupting microbial cell membrane and inhibiting microbial growth [8, 9].

Antimicrobial Resistance

Antimicrobial resistance (AMR) is a global public health threat that has led to the emergence of multidrug-resistant (MDR) microorganisms. The development of new antimicrobial agents is crucial to combat AMR and protect public health. *P. betle* Linn has been proposed as a potential natural antimicrobial agent to combat AMR due to its broad-spectrum antimicrobial activity and low toxicity. However, further studies are needed to evaluate the efficacy and safety of *P. betle* Linn extracts as a potential antimicrobial agent [10-12].

Conclusion

P. betle Linn is a well-known medicinal plant used in traditional medicine for various ailments. The leaves of *P. betle* Linn have been reported to exhibit broad-spectrum antimicrobial activity against various pathogenic microorganisms. The major active compounds responsible for the antimicrobial activity of *P. betle* Linn are phenolics, alkaloids, terpenoids, and flavonoids. The antimicrobial activity of *P. betle* Linn is attributed to the disruption of microbial cell membrane, inhibition of microbial growth, and inhibition of biofilm formation. In addition to its antimicrobial activity, *P. betle* Linn has also been reported to exhibit antiviral and antiparasitic activity [13-17].

The antimicrobial activity of *P. betle* Linn suggests its potential use as a natural antimicrobial agent to combat AMR. However, further studies are needed to evaluate the efficacy and safety of *P. betle* Linn extracts as a potential antimicrobial agent. Moreover, the development of standardized protocols for the extraction and characterization of active compounds from PBL leaves is essential to ensure the reproducibility of results [17,18].

In conclusion, the antimicrobial activity of *P. betle* Linn leaves highlights its potential use as a natural antimicrobial agent. Further studies are needed to evaluate its efficacy and safety and to develop standardized protocols for the extraction and characterization of active compounds. The use of *P. betle* Linn leaves in combination with conventional antimicrobial

agents may also provide a synergistic effect and reduce the emergence of AMR [19,20].

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