

## Antibacterial Activities of *Syzygium aromaticum* Ethanolic Extract Against Opportunistic Bacteria

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### Structured Abstract

**Background:** The increasing prevalence of antibiotic resistance in opportunistic pathogens poses a significant public health threat, driving the search for natural alternatives to combat bacterial infections. *Syzygium aromaticum* (*S. aromaticum*), commonly known as clove, is rich in bioactive compounds, particularly eugenol, and is widely used as a cooking spice and traditional medicine. This study aims to determine the antibiotic susceptibility, Minimum Inhibitory Concentration (MIC), and Minimum Bactericidal Concentration (MBC) of *S. aromaticum* ethanolic extract against opportunistic bacteria, including *Staphylococcus aureus* (*S. aureus*), *Staphylococcus epidermidis* (*S. epidermidis*), and *Pseudomonas aeruginosa* (*P. aeruginosa*), to evaluate its potential as a natural antimicrobial agent.

**Methods:** *S. aromaticum* dry buds (320 grams) were processed into powder and extracted using the maceration method with ethanol. The antibiotic susceptibility was assessed using the Kirby-Bauer disk diffusion method based on Clinical and Laboratory Standards Institute (CLSI) guidelines. MIC was performed using a broth microdilution assay with two-fold serial dilutions (1000 mg/mL to 62.5 mg/mL) in Mueller-Hinton Broth (MHB) with bacterial suspensions adjusted to 0.5 McFarland standard. MBC was performed by streaking samples from MIC wells onto Mueller-Hinton Agar (MHA), with the lowest concentration showing no bacterial growth recorded as the MBC.

**Results:** The disk diffusion assay revealed that *S. aureus* and *P. aeruginosa* were resistant, while *S. epidermidis* exhibited intermediate susceptibility. The MIC value was  $\leq 62.5$  mg/mL for all bacteria tested, and the MBC value was  $\leq 125$  mg/mL. The differences between disk diffusion and MIC/MBC results may be due to the limited diffusion of phenolic compounds like eugenol in solid media and the precipitation of less polar compounds within the disk, which hinder effective diffusion, especially for *P. aeruginosa*.

**Conclusion:** This study determined that *S. aromaticum* ethanolic extract exhibits antibacterial activity, particularly against *S. epidermidis*. The MIC ( $\leq 62.5$  mg/mL) and MBC ( $\leq 125$  mg/mL) values indicate its effectiveness in inhibiting and killing *S. aureus*, *S. epidermidis*, and *P. aeruginosa* in liquid media, highlighting its potential as a natural antimicrobial agent.

**Keywords:** *Syzygium aromaticum*, ethanolic extract, *Staphylococcus epidermidis*, *Pseudomonas aeruginosa*, *Staphylococcus aureus*

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