Evaluation of Antibacterial Properties of Bark Extracts of *Symplocos racemosa* Against Oral Pathogens

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Abstract

Symplocos racemosa, commonly known as Lodhra, is a deciduous tree from the *Symplocaceae* family, found mainly in the Indian subcontinent and Southeast Asia. The bark of *S.racemosa* has been widely used in Ayurvedic and traditional medicine for its antimicrobial, anti-inflammatory, and antioxidant properties. This study aims to evaluate the antibacterial potential of *S. racemosa* bark extracts against oral pathogens, specifically *Streptococcus mutans* and *Staphylococcus aureus*. The minimum inhibitory concentration (MIC) was determined for ethanolic and aqueous extracts at varying concentrations (500-2500 µg/ml). The ethanolic extract at 2500 µg/ml demonstrated the highest zone of inhibition: 15 mm against *S. mutans* and 12 mm against *S. aureus*. Aqueous extract at the same concentration showed inhibition zones of 10 mm against *S. mutans* and 11 mm against *S. aureus*. Phytochemical screening revealed the presence of flavonoids, alkaloids, tannins, steroids, saponins, and resins, which may contribute to the antibacterial activity. These findings suggest that *S. racemosa* bark extract could be a potential alternative or adjunct in the treatment of oral infections.

Keywords: *Symplocos racemosa*, antibacterial activity, oral pathogens, *Streptococcus mutans*, *Staphylococcus aureus*

Introduction

Symplocos racemosa, widely known as Lodhra, has been extensively used in traditional medicine for various therapeutic applications. It is primarily found in the Indian subcontinent and Southeast Asia and is well recognized for its medicinal properties. The bark of *S. racemosa* reported

pharmacological activities, including antibacterial, anti-inflammatory, antioxidant, and wound-healing effects (Sharma et al., 2018; Prakash et al., 2016). Traditional Ayurvedic texts describe the use of *S. racemosa* in treating conditions such as oral diseases, skin infections, liver disorders, and gynecological ailments (Tripathi et al., 2015).

Study reported by Ghosh et al., have highlighted the importance of medicinal plants in the development of new antimicrobial agents, especially considering the rise in antibiotic-resistant pathogens (Ghosh et al., 2017). Herbal extracts rich in bioactive compounds such as flavonoids, tannins, and alkaloids have been recognized for their antibacterial effects against various bacterial strains, including oral pathogens (Bharat et al., 2015; Gulati et al., 2013). Among these, *S. racemosa* bark extracts have been reported to inhibit bacterial growth, particularly against *Streptococcus mutans* and *Staphylococcus aureus*, which are responsible for dental caries and periodontal infections (Sood et al., 2020).

The mechanism of action of *S. racemosa* bark extract against bacterial pathogens has been attributed to its bioactive constituents. Flavonoids and tannins, for example, have demonstrated the ability to disrupt bacterial cell walls, inhibit bacterial enzymes, and interfere with quorum sensing mechanisms, thereby reducing bacterial virulence (Singh et al., 2019). Studies have also suggested that phenolic compounds present in *S. racemosa* contribute to its antibacterial activity by generating reactive oxygen species, which damage bacterial membranes and proteins (Mishra et al., 2016).

Furthermore, the increasing resistance of bacteria to conventional antibiotics has prompted researchers to explore plant-based alternatives for treating microbial infections (Kumar et al., 2021). Herbal extracts such as those from *S. racemosa* offer a promising alternative due to their

multi-targeted approach and lower likelihood of inducing bacterial resistance. This study aims to investigate the antibacterial efficacy of ethanolic and aqueous extracts of *S. racemosa* against *S. mutans* and *S. aureus* to explore its potential application in oral healthcare.

Materials and Methods

Collection and Authentication

The bark of *S. racemosa* was collected from Khari Baoli, New Delhi, and authenticated by Dr. M. P. Sharma, Department of Botany, Jamia Hamdard University. A voucher specimen (PRL/JH/05/24) was deposited at the Phytochemical Research Laboratory, Jamia Hamdard University, India.

Extraction Process

The bark was oven-dried at 45°C for 2-3 days and coarsely powdered. Soxhlet extraction was performed using ethanol and water. The extracts were concentrated under reduced pressure, yielding ethanol extract (375 g, 12.5%) and aqueous extract (425 g, 14.16%).

Phytochemical Screening

Qualitative analysis of the extracts identified various phytochemicals, including alkaloids, phenolics, tannins, flavonoids, steroids, saponins, and resins. These phytochemicals are known to have antimicrobial and antioxidant properties, contributing to the effectiveness of the extracts against bacterial pathogens.

Preparation of Sample Solution

Ethanolic and aqueous extracts were dissolved in dimethyl sulfoxide (DMSO) at concentrations of 500-2500 µg/ml. Amikacin (30 µg/disc) was used as a standard for *S. aureus*, and chloramphenicol (30 µg/disc) for *S. mutans*.

Antibacterial Activity Assessment

Minimum Inhibitory Concentration (MIC): MIC was determined using the agar dilution method as per NCCLS guidelines. The lowest concentration inhibiting microbial growth was recorded. The agar diffusion method was employed to determine the antimicrobial activity of extracts, wherein bacterial cultures were spread on agar plates, and wells containing the extracts were incubated at 37°C for 24 hours before measuring inhibition zones.

Statistical Analysis

Experiments were performed in triplicate, and results were expressed as mean ± standard deviation. Data were analyzed using statistical software, and significance was determined using ANOVA.

Results and Discussion

Antibacterial Activity of *S. racemosa*

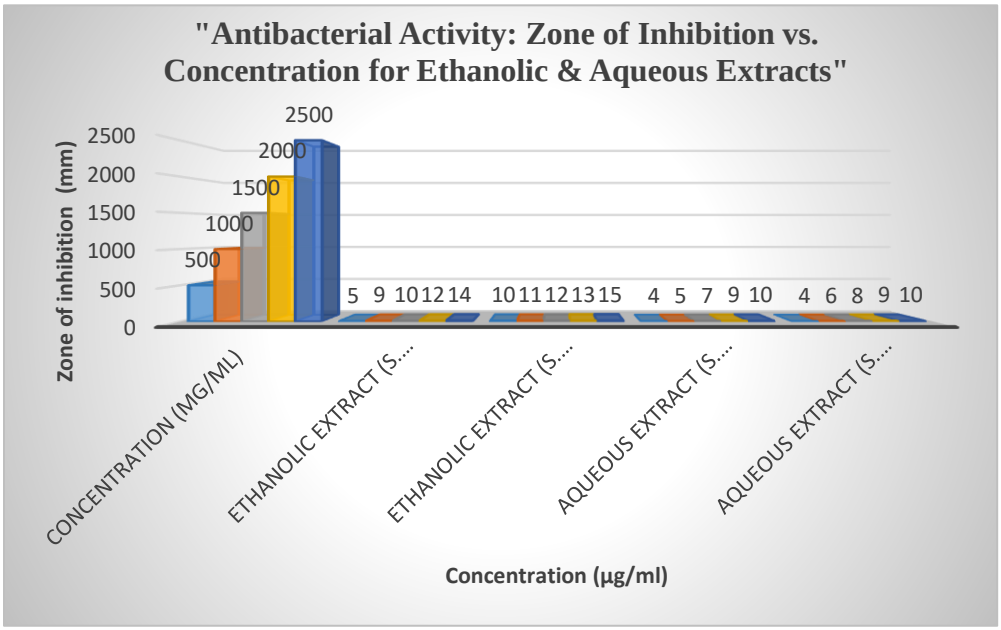
The antibacterial activity of *S. racemosa* bark extracts was assessed using the well diffusion method. The results demonstrate a significant inhibitory effect of the ethanolic extract compared to the aqueous extract. The highest zone of inhibition was observed at a concentration of 2500 µg/ml for both pathogens, with ethanolic extract showing superior activity.

Table 1: Zone of Inhibition (mm) of *S. racemosa* Bark Extracts

Concentration (µg/ml)	Ethanolic Extract (*S. aureus*)	Ethanolic Extract (*S. mutans*)	Aqueous Extract (*S. aureus*)	Aqueous Extract (*S. mutans*)
500	5	10	4	4
1000	9	11	5	6
1500	10	12	7	8

2000	12	13	9	9
2500	14	15	10	10

Graph 1: Antibacterial Activity of Ethanolic and Aqueous Extracts



Effectiveness of Ethanolic vs. Aqueous Extracts

The superior antibacterial activity of the ethanolic extract is likely due to the enhanced solubility and extraction of bioactive compounds such as flavonoids, tannins, and alkaloids in ethanol. Previous studies indicate that ethanol effectively extracts antimicrobial compounds, leading to higher antibacterial efficacy (Mishra et al., 2016; Singh et al., 2019).

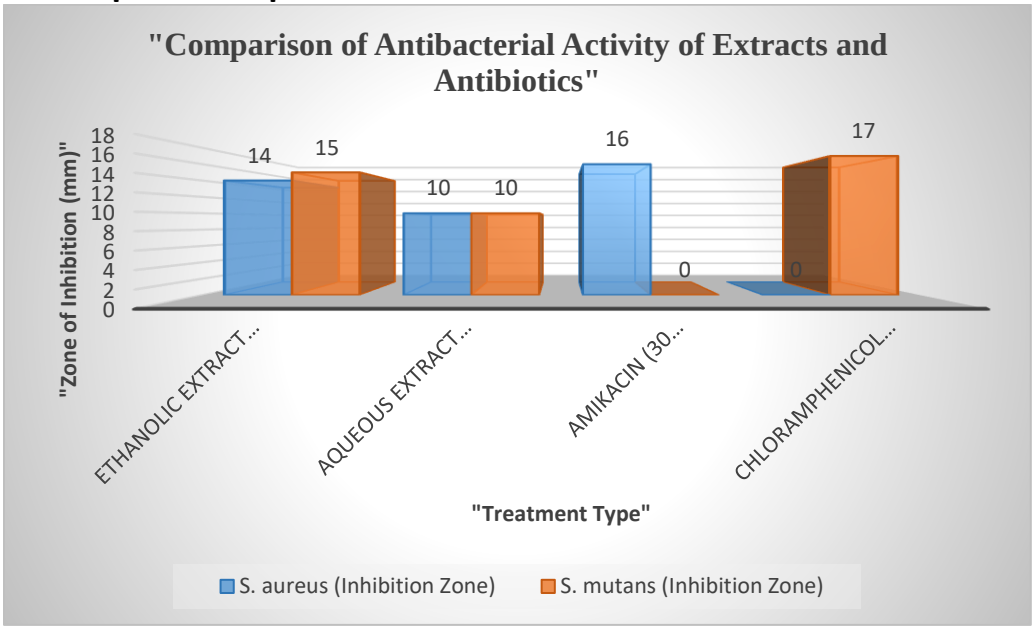
Comparison with Standard Antibiotics

To further evaluate the antibacterial efficacy of *S. racemosa* extracts, their activity was compared with standard antibiotics. Ethanolic extract at 2500 µg/ml exhibited a comparable inhibitory effect to chloramphenicol (30 µg/disc) against *S. mutans* and amikacin (30 µg/disc) against *S. aureus*.

Table 2: Comparative Antibacterial Effect of Extracts and Standard Antibiotics

Treatment	***S. aureus* (Inhibition Zone)**	***S. mutans* (Inhibition Zone)**
Ethanolic Extract (2500 µg/ml)	14 mm	15 mm
Aqueous Extract (2500 µg/ml)	10 mm	10 mm
Amikacin (30 µg/disc)	16 mm	-
Chloramphenicol (30 µg/disc)	-	17 mm

Graph 2: Comparison of Extracts and Standard Antibiotics



Phytochemical Basis of Antibacterial Activity

Phytochemical analysis revealed the presence of alkaloids, flavonoids, tannins, and saponins, which are well-documented for their antibacterial properties. Flavonoids and tannins interfere with bacterial cell walls, while alkaloids disrupt bacterial metabolism (Bharat et al., 2015; Ghosh et al., 2017).

Potential Application in Oral Healthcare

Given its strong antibacterial effects, *S. racemosa* could be formulated into oral care products such as mouthwashes and toothpaste. Its ability to inhibit *S. mutans*, a primary causative agent of dental caries, makes it a promising alternative to synthetic antimicrobial agents. (M.S.S Zarger et al., 2014)

Conclusion

The study confirmed the antibacterial potential of *Symplocos racemosa* bark extracts, with ethanolic extracts showing significantly higher efficacy than aqueous extracts. The presence of bioactive compounds such as flavonoids, tannins, and alkaloids is likely responsible for its antimicrobial action. These findings suggest that *S. racemosa* could be developed as a natural antimicrobial agent for oral healthcare applications, particularly against *S. mutans* and *S. aureus*. The ethanolic extract demonstrated a higher zone of inhibition, which supports the hypothesis that ethanol is a more effective solvent in extracting bioactive compounds responsible for antibacterial properties. The significant inhibition of *S. mutans* suggests that *S. racemosa* could serve as a potent natural alternative in oral care formulations, such as mouthwashes or herbal toothpaste, to combat dental caries and plaque formation.

Moreover, when compared to standard antibiotics, the ethanolic extract of *S. racemosa* showed comparable efficacy against the tested pathogens. This result indicates the potential for *S. racemosa* to be used as an adjunct or alternative to conventional antibiotics, especially in addressing antibiotic resistance concerns. The phytochemical composition of the bark, particularly flavonoids and tannins, has been identified as key contributors to its antimicrobial action by disrupting bacterial membranes and inhibiting bacterial enzymes.

Implications for Future Research

Further research should be conducted to isolate and characterize the active constituents of *S. racemosa* responsible for its antibacterial activity. Advanced techniques such as gas chromatography-mass spectrometry (GC-MS) and high-performance liquid chromatography (HPLC) can be utilized for this purpose. Additionally, in vivo studies and clinical trials should be undertaken to evaluate the safety and effectiveness of *S. racemosa* extracts in humans.

Future studies should focus on its potential synergistic effects with existing antibiotics, which could help mitigate antibiotic resistance and enhance therapeutic efficacy.

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Conflict of Interest

The Authors declare no conflict of interest in this work.

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