

Antimicrobial activity of essential oil (cajeput) against *Streptococcus mutans*

Srigopika T¹, Dr Dinesh Kumar^{2*}

¹Undergraduate student, Saveetha Dental College and Hospital, Saveetha Institute of Medical and Technical Sciences, Saveetha University, Chennai-600077. Email: 152001029.sdc@saveetha.com

^{2*}Assistant Professor, Department of Pediatric and Preventive Dentistry, Saveetha Dental College and Hospital, Saveetha Institute of Medical and Technical Sciences, Saveetha University, Chennai-600077. Email: dineshkumarb.sdc@saveetha.com

*Corresponding author: Dr Dinesh Kumar, Assistant Professor, Department of Pediatric and Preventive Dentistry, Saveetha Dental College and Hospital, Saveetha Institute of Medical and Technical Sciences, Saveetha University, Chennai-600077
Email: dineshkumarb.sdc@saveetha.com

Received: 19th June, 2026; Revised: 19th June, 2026; Accepted: 19th June, 2026; Available Online: 19th June, 2026

ABSTRACT

Introduction

The most familiar pathogen of the oral cavity is *Streptococcus mutans* which causes dental caries, the most common noncommunicable disease worldwide, which leads to secondary infections. In order to treat this condition, we need new formulations that are both effective and do not cause toxicity. Thus, the aim of this study is to check for the antimicrobial activity of cajeput, an essential oil against *Streptococcus mutans*.

Materials and methods

Cajeput was obtained from an industry in New Delhi. *Streptococcus mutans* was inoculated at 37°C and seeded on MHA medium. Agar well diffusion assay was used to measure antibacterial activity. Zone of inhibition was measured using a vernier caliper. Minimum Inhibitory Concentration (MIC) was determined by microbroth dilution method.

Results

The well with the concentration of 40µl showed a maximum zone of inhibition of 5mm and the MIC value was 2.5mg/mL.

Conclusion

From this study, it is observed that cajeput has antimicrobial activity against *Streptococcus mutans* and more studies should be conducted in order to learn its other properties such as antioxidant and anti inflammatory activity.

Keywords: Antimicrobial activity, Cajeput, Dental caries, Essential oil, *Streptococcus mutans*.

How to cite this article: Srigopika T, Kumar D. Antimicrobial activity of essential oil (cajeput) against *Streptococcus mutans*. Int J Drug Deliv Technol. 2026;16(61s):1529-1533. DOI: 10.25258/ijddt.16.61s.172

Source of support: Nil.

Conflict of interest: None

Introduction

Essential oils are volatile secondary metabolites of plants which give the plant a distinctive smell, taste, or both. Around 17,500 species of plants from many angiosperm families produce essential oils. However, only around 300 of them are commercially available and in use [1]. Over the years, they have become an important part of everyday life and are used as food flavorings, food additives, flavoring agents and as components of cosmetics and perfumes [2]. They are produced and stored in secretory structures such as glands, secretory cavities, and resin conduits. They are present in the leaves, stems, flowers and fruits, bark, and roots of plants as liquid drops. With respect to the chemical composition, they are complex mixtures of terpenes, terpenoids, and phenylpropanoids. Other additional

Australia [7]. It is obtained both from wild plants and those cultivated on plantations. It is obtained as a result of distillation with steam from fresh twigs. The content of cajeput oil after distillation ranges from 1.5–3.0% [8]. Cajeput oil has been used in medicine as an antiseptic agent since the eighteenth century. The most active ingredients are 1,8-cineole, linalool, and

compounds include fatty acids, oxides, and sulfur derivatives [3].

Essential oils are usually obtained as a product of hydrodistillation, steam distillation, dry distillation, or the mechanical cold pressing of plants [4]. Other ways of isolation include fermentation, crushing, extraction, or hydrolysis. Based on the method of isolation, the chemical composition of the oil can be different [5]. The oils have been used by us for thousands of years in folk medicine, because of their many different biological properties, including antimicrobial properties apart from ingredients of perfumes, seasoning etc [6].

Cajeput oil is obtained from leaves and small branches of the cajeput tree, belonging to the Myrtaceae family and is native to Southeast Asia and North East terpinen-4-ol [9]. Cajeput oil inhibits the growth of Gram-positive bacteria: *Bacillus cereus*, *Bacillus subtilis*, *Corynebacterium diphtheriae*, *Corynebacterium minutissimum*, *Enterococcus faecium*, *Listeria monocytogenes* at a concentration of 0.2–0.4%, [10] and at higher concentrations it is effective against *Streptococcus mutans*.

RESEARCH PAPER

Streptococcus mutans is considered the most cariogenic of all oral streptococci [11]. This cariogenic bacteria colonizes the tooth surface and produces large amounts of excess intracellular polysaccharides. *S.mutans* is also highly acidogenic and aciduric, and it metabolizes several salivary glycoproteins, leading to contribution of the initial stage of oral biofilm formation and caries lesions [12]. There is increasing attention to the screening of antimicrobial activity as there is more research being carried out to develop new antimicrobial agents against antimicrobial resistance. Several bioassays such as well diffusion, disk-diffusion, and broth or agar dilution are well known and commonly used methods for antimicrobial screening [13]. Minimum inhibitory concentration is a method by which the lowest concentration of antimicrobial agent completely inhibits growth of the organism in micro-dilution wells or tubes as detected by the unaided eye is calculated [14].

inoculating loop. The mother inoculum was prepared first followed by primary and secondary inoculum. Three wells were made with a sterilized cork borer and the essential oil was added to each of these wells in concentrations of 20 μ l, 30 μ l and 40 μ l. The agar medium was incubated at 37°C for 24 hours. The zone of inhibition that developed around the wells in all the plates was examined the next day.

3. Minimum Inhibitory Concentration (MIC)

A tube dilution method was adopted to understand the MIC of *Streptococcus mutans*. Cajeput was diluted in 10% DMSO to obtain various concentrations ranging from 5 to 100 μ L of test solutions. Inoculation of 0.05 mL of bacterial culture was done by the addition of 5 mL of sterile Mueller–Hinton broth. To all the test tubes 1 mL of cajeput was added and incubated for 24 hours in order to observe any development of turbidity. The minimal concentration that could inhibit complete growth was considered to be the MIC.

Results

It was noted that in the MHA, the essential oil cajeput, shows antimicrobial activity against *Streptococcus mutans* and the zone of inhibition increases with increase in concentration of the essential oil. The diameter of the zones of inhibition are 3mm, 4mm and 5mm, in the wells having concentrations of 20 μ l, 30 μ l and 40 μ l respectively as shown in Figure 1. This proves that higher the concentration of the essential oil, greater is the antimicrobial activity. As for the minimum inhibitory concentration (MIC), growth was seen from the 4th tube, showing that the MIC of cajeput against *Streptococcus mutans* is 2.5mg. This can be observed by noticing the color change from transparent to pale pink as shown in Figure 2.

Thus the aim of the study is to check for antimicrobial resistance of cajeput essential oil against *S. mutans* using MIC.

Materials and method

1. Collection of materials

The essential oil, cajeput, was obtained from an industry in New Delhi. The oil was checked for authenticity and was not diluted or altered chemically by any solvent or processing. The bacterial specimen was obtained from Saveetha Dental College and Hospitals, Chennai.

2. Agar Diffusion Method

MHA agar was the culture medium used. The obtained specimen was inoculated using an

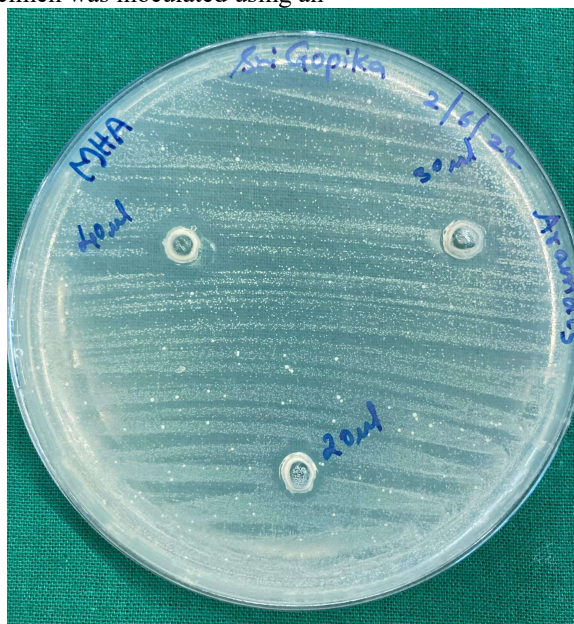


Figure 1 - The above figure shows the zone of inhibition of cajeput against *S. mutans* in wells with different concentrations.



Figure 2 - The above figure shows the MIC of Streptococcus mutans. Growth is seen only from the 4th tube which is noticed by the change in color.

Discussion

Currently, there is an increasing amount of bacterial resistance shown by various microorganisms, leading us to find alternative methods such as new formulations and antibiotics which can counteract the resistance. However, these novel methods seem to contribute to more side effects and toxicity, causing researchers and scientists to produce drugs from natural plant sources such as essential oils. In this study, we have used one such essential oil named cajeput and checked for its antimicrobial resistance against *Streptococcus mutans*, one of the most common pathogens in the oral cavity, causing dental caries.

Our results show that increasing concentration of cajeput shows a higher antimicrobial activity against the bacteria. Similarly, as reported by Carson et al, cajeput, along with jamrosa oils showed medium to strong antimicrobial activity against *Staphylococcus aureus*, *Aspergillus niger* etc. Apart from the antimicrobial activity, he also reported on the antifungal activity of cajeput against *Candida albicans* [15].

A study conducted in 2015 observed the antibacterial and antioxidant properties of the flower and leaf extract of *Melaleuca cajuputi*. It was found that both the leaf and flower extract possessed antibacterial activity against *S. aureus*, *S. epidermidis*, and *B. cereus* and had significant and free radical scavenging activity. The most susceptible bacteria was *Staphylococcus aureus*, with MIC value of 12.5 g/mL and the leaf extract was generally more efficient than the flower extract [16]. However, other extracts such as hexane, dichloromethane and acetone extracts did not show antibacterial activity against *S. aureus*, methicillin-resistant *S. aureus*, *E. coli*, and *P. aeruginosa* [17].

Cajeput has been tested against 23 strains of *S. aureus*, out of which (-)-linalool was found to be the most potent and the other compounds like (1,8-cineole, (-)-terpinen- 4-ol and (±)-a-terpineol) were equally potent but less effective. Out of the 11 strains of *Escherichia coli* tested, all substances showed maximal effectiveness, whereas the 17 strains of *Pseudomonas aeruginosa* showed variable zones of inhibition [18].

In a study where cajeput oil and marine derived chitosan were infused together, it was noted that cajeput showed improved mechanical properties than chitosan alone [19 - 29]. Thus, from the above mentioned articles, it is confirmed that cajeput has antimicrobial activity against *S. mutans*. Apart from this, it shows activities against various other microorganisms such as *Staphylococcus aureus*, *Aspergillus niger*, *Escherichia coli* and *Pseudomonas aeruginosa*. It also shows antioxidant activity and free radical scavenging.

The limitation of this study is that we have used only one essential oil and checked its antimicrobial efficacy against the most common oral pathogen. For further studies, we can check for antioxidant and anti-inflammatory properties of this essential oil against more oral pathogens. Moreover, we can check for the antimicrobial activity of various other oils which can be more potent and effective when compared to cajeput. In addition to this, further in vivo studies can be carried out.

Conclusion

The present study successfully demonstrates that cajeput essential oil possesses significant antimicrobial activity against *Streptococcus mutans*, the primary pathogen responsible for dental caries. Results from the agar well diffusion assay indicate a dose-dependent relationship, where increasing the concentration of the oil led to a larger zone of inhibition, peaking at 5mm for a 40µl concentration. Furthermore, the Minimum Inhibitory Concentration (MIC) was determined to be 2.5mg/mL, confirming its efficacy at relatively low doses. While these findings are encouraging, further research is necessary to explore the oil's antioxidant and anti-inflammatory properties, as well as its effectiveness against a broader range of oral pathogens through in vivo clinical trials.

Acknowledgements

We express our sincere gratitude to Saveetha Dental College and Hospitals and Saveetha Institute of Technical and Medical Sciences for their constant support and encouragement.

Source of funding

The present study was supported by the following agencies.

- Saveetha Dental College,
- Saveetha Institute of Medical and Technical Science, Saveetha University.
- S and S Impex

RESEARCH PAPER

Conflict of interest

The authors hereby declare that there is no conflict of interest in this study.

References

1. Mérillon JM, Riviere C. Natural Antimicrobial Agents. Springer; 2018. 337 p.
2. Available from: <https://doi.org/10.22377/ijgp.v10i1.602>
3. Stringaro A, Colone M, Angiolella L. Antioxidant, Antifungal, Antibiofilm, and Cytotoxic Activities of spp. Essential Oils. Medicines (Basel) [Internet]. 2018 Oct 21;5(4). Available from: <http://dx.doi.org/10.3390/medicines5040112>
4. Arora R, Singh B, Vig AP, Arora S. Conventional and modified hydrodistillation method for the extraction of glucosinolate hydrolytic products: a comparative account. Springerplus. 2016 Apr 18;5:479.
5. Wińska K, Mączka W, Łyczko J, Grabarczyk M, Czubaszek A, Szumny A. Essential Oils as Antimicrobial Agents-Myth or Real Alternative? Molecules [Internet]. 2019 Jun 5 [cited 2022 Sep 20];24(11). Available from: <https://pubmed.ncbi.nlm.nih.gov/31195752/>
6. Brnawi WI, Hettiarachchy NS, Horax R, Kumar-Phillips G, Seo HS, Marcy J. Comparison of Cinnamon Essential Oils from Leaf and Bark with Respect to Antimicrobial Activity and Sensory Acceptability in Strawberry Shake. J Food Sci. 2018 Feb;83(2):475–80.
7. Hashemi SMB, Khaneghah AM, de Souza Sant'Ana A. Essential Oils in Food Processing: Chemistry, Safety and Applications. John Wiley & Sons; 2017. 392 p.
8. deGroot A, Schmidt E. Essential Oils: Contact Allergy and Chemical Composition. Routledge; 2021. 1058 p.
9. Dugo G, Mondello L. Citrus Oils: Composition, Advanced Analytical Techniques, Contaminants, and Biological Activity. CRC Press; 2010. 586 p.
10. França, K. R. S., Silva, T. L., Cardoso, T. A. L., Ugolino, A. L. N., Rodrigues, A. P. M., & Júnior, A. F. de M. (2018). In vitro Effect of Essential Oil of Peppermint (*Mentha x piperita* L.) on the Mycelial Growth of *Alternaria alternata*. Journal of Experimental Agriculture International, 26(5), 1-7. <https://doi.org/10.9734/JEAI/2018/44243>
11. Ajdić D, McShan WM, McLaughlin RE, Savić G, Chang J, Carson MB, et al. Genome sequence of *Streptococcus mutans* UA159, a cariogenic dental pathogen. Proc Natl Acad Sci U S A. 2002 Oct 29;99(22):14434–9.
12. Available from: <https://doi.org/10.4034/1519.0501.2010.0102.0013>
13. Balouiri M, Sadiki M, Ibsouda SK. Methods for evaluating antimicrobial activity: A review. J Pharm Anal. 2016 Apr;6(2):71–9.
14. Ferraro MJ. Methods for Dilution Antimicrobial Susceptibility Tests for Bacteria that Grow Aerobically: Approved Standard. 2003. 50 p.
15. Carson CF, Hammer KA, Riley TV. Melaleuca alternifolia (Tea Tree) oil: a review of antimicrobial and other medicinal properties. Clin Microbiol Rev. 2006 Jan;19(1):50–62.
16. Al-Abd NM, Mohamed Nor Z, Mansor M, Azhar F, Hasan MS, Kassim M. Antioxidant, antibacterial activity, and phytochemical characterization of Melaleuca cajuputi extract. BMC Complement Altern Med. 2015 Oct 24;15:385.
17. Rattanaburi S, Mahabusarakam W, Phongpaichit S, Carroll AR. A new chromone from the leaves of Melaleuca cajuputi Powell. Nat Prod Res. 2013;27(3):221–5.
18. Cuong ND, Xuyen TT, Motl O, Stránský K, Presslová J, Jedlicková Z, et al. Antibacterial Properties of Vietnamese Cajuputi Oil [Internet]. Vol. 6, Journal of Essential Oil Research. 1994. p. 63–7. Available from: <http://dx.doi.org/10.1080/10412905.1994.9698326>
19. Antunes JC, Homem NC, Teixeira MA, Amorim MTP, Felgueiras HP, Tavares T. Antibacterial activity of marine-derived chitosan and plant-derived cajuputi oil as loaded blended films in *Staphylococcus aureus* and *Pseudomonas aeruginosa*-enriched settings [Internet]. Proceedings of 1st International Electronic Conference on Biomolecules: Natural and Bio-Inspired Therapeutics for Human Diseases. 2020.
20. Aldhuwayhi, Sami, Sreekanth Kumar Mallineni, Srinivasulu Sakhmuri, Amar Ashok Thakare, Sahana Mallineni, Rishitha Sajja, Mallika Sethi, Venkatesh Nettam, and Azher Mohiuddin Mohammad. 2021. “Covid-19 Knowledge and Perceptions Among Dental Specialists: A Cross-Sectional Online Questionnaire Survey.” Risk Management and Healthcare Policy 14 (July): 2851–61.
21. Dua, Kamal, Ridhima Wadhwa, Gautam Singhvi, Vamshikrishna Rapalli, Shakti Dhar Shukla, Madhur D. Shastri, Gaurav Gupta, et al. 2019. “The Potential of siRNA Based Drug Delivery in Respiratory Disorders: Recent Advances and Progress.” Drug Development Research 80 (6): 714–30.
22. Gan, Hongyun, Yaqing Zhang, Qingyun Zhou, Lierui Zheng, Xiaofeng Xie, Vishnu Priya Veeraraghavan, and Surapaneni Krishna Mohan. 2019. “Zingerone Induced Caspase-Dependent Apoptosis in MCF-7 Cells and Prevents 7,12-Dimethylbenz(a)anthracene-Induced Mammary Carcinogenesis in Experimental Rats.” Journal of Biochemical and Molecular Toxicology 33 (10): e22387.
23. Jayaraj, Gifrina, Pratibha Ramani, Herald J. Sherlin, Priya Premkumar, and N. Anuja. 2015. “Inter-Observer Agreement in Grading Oral Epithelial Dysplasia – A Systematic Review.” Journal of Oral and Maxillofacial Surgery, Medicine, and Pathology. <https://doi.org/10.1016/j.ajoms.2014.01.006>.
24. Li, Zhenjiang, Vishnu Priya Veeraraghavan, Surapaneni Krishna Mohan, Srinivasa Rao Bolla, Hariprasath Lakshmanan, Subramanian Kumaran, Wilson Aruni, et al. 2020. “Apoptotic Induction and Anti-Metastatic Activity of Eugenol Encapsulated Chitosan Nanopolymer on Rat Glioma C6 Cells via Alleviating the MMP Signaling Pathway.” Journal of Photochemistry and Photobiology B: Biology. <https://doi.org/10.1016/j.jphotobiol.2019.111773>.
25. Markov, Alexander, Lakshmi Thangavelu, Surendar Aravindhan, Angelina Olegovna Zekiy, Mostafa Jarahian, Max Stanley Chartrand, Yashwant Pathak, Farooq Marofi, Somayeh Shamlou, and Ali Hassanzadeh. 2021. “Mesenchymal

RESEARCH PAPER

Stem/stromal Cells as a Valuable Source for the Treatment of Immune-Mediated Disorders.” *Stem Cell Research & Therapy* 12 (1): 192.

26. Mohan, Meenakshi, and Nithya Jagannathan. 2014. “Oral Field Cancerization: An Update on Current Concepts.” *Oncology Reviews* 8 (1): 244.

27. Neelakantan, Prasanna, Deeksha Grotra, and Subash Sharma. 2013. “Retreatability of 2 Mineral Trioxide Aggregate-Based Root Canal Sealers: A Cone-Beam Computed Tomography Analysis.” *Journal of Endodontia* 39 (7): 893–96.

28. Paramasivam, Arumugam, Jayaseelan Vijayashree Priyadharsini, Subramanian Raghunandhakumar, and Perumal Elumalai. 2020. “A Novel COVID-19 and Its Effects on Cardiovascular Disease.” *Hypertension Research: Official Journal of the Japanese Society of Hypertension*.

29. Sheriff, K. Ahmed Hilal, K. Ahmed Hilal Sheriff, and Archana Santhanam. 2018. “Knowledge and Awareness towards Oral Biopsy among Students of Saveetha Dental College.” *Research Journal of Pharmacy and Technology*. <https://doi.org/10.5958/0974-360x.2018.00101.4>.