IJKG INTERDENTAL Jurnal Kedokteran Gigi

Interdental Jurnal Kedokteran Gigi
Website: https://e-journal.unmas.ac.id/index.php/interdental
ISSN 1979-9144 (print), ISSN 2685-5208 (online)

Research Article

Antibacterial Activity of *Cymbopogon citratus* Extract Against Post-Endodontic Bacteria: A Disc Diffusion Study

[1]Rina Permatasari, [2]Nasywa Khabiza Zauhayr, [2]Syarla Feonisa Alzena

[1]Department of Conservative Dentistry, Faculty of Dentistry, Universitas Prof. Dr. Moestopo (B), Jakarta, Indonesia
[2]Faculty of Dentistry, Universitas Prof. Dr. Moestopo (B), Jakarta, Indonesia

Received date: May 28, 2026 **Accepted date: July 14, 2026** **Published date: August 12, 2026**

KEYWORDS

Antibacterial activity; Cymbopogon citratus; Enterococcus faecalis; root canal treatment; Staphylococcus aureus.

ABSTRACT

Introduction: Root canal treatment failure is frequently associated with persistent microbial infection, particularly by *Enterococcus faecalis* and *Staphylococcus aureus*. Sodium hypochlorite remains the gold standard irrigant; however, its cytotoxicity has encouraged the exploration of herbal alternatives. *Cymbopogon citratus* contains bioactive compounds with potential antibacterial properties.

Material and Methods: This laboratory experimental study evaluated the antibacterial activity of *Cymbopogon citratus extract* at concentrations of 10%, 20%, and 30% against *E. faecalis* ATCC 29212 and *S. aureus* ATCC 29213 using the disc diffusion method. Sodium hypochlorite 2.5% was used as the positive control and 96% ethanol as the negative control. Data were analyzed using one-way ANOVA followed by Bonferroni post hoc test.

Results and Discussion: The highest inhibition zone for *E. faecalis* was observed at 20% concentration (1.63 ± 0.48 mm), while for *S. aureus*, the highest value was found at 10% concentration (2.06 ± 1.15 mm). No statistically significant differences were found among extract concentrations ($p>0.05$), whereas sodium hypochlorite demonstrated significantly higher antibacterial activity ($p<0.001$).

Conclusion: *Cymbopogon citratus* extract demonstrated weak antibacterial activity and was not comparable to sodium hypochlorite. Its potential as an alternative root canal irrigant requires further optimization and validation

DOI: 10.46862/interdental.v22i2.14311

Corresponding Author:
Rina Permatasari
Department of Conservative Dentistry, Faculty of Dentistry
Universitas Prof. Dr. Moestopo (B), Jakarta, Indonesia
Email: rinapermatasari@gmail.com

How to cite this article: Permatasari R, Zauhayr NK, Alzena SF. Antibacterial Activity of Cymbopogon citratus Extract Against Post-Endodontic Bacteria: A Disc Diffusion Study. Interdental Jurnal Kedokteran Gigi. 2026;22(2):316-21. doi: 10.46862/interdental.v22i2.14311

INTRODUCTION

Dental caries remains one of the most prevalent oral health problems worldwide and is a major cause of pulp disease and tooth loss. In Indonesia, national health data have reported a high prevalence of caries and related complications. Progressive caries may lead to pulpal inflammation and necrosis, ultimately requiring endodontic intervention.[1,2]

Root canal treatment aims to eliminate infection within the root canal system and preserve the natural tooth. However, treatment failure may still occur, with reported rates ranging from 14% to 16%, primarily due to persistent microbial infection. *Enterococcus faecalis* and *Staphylococcus aureus* are commonly associated with secondary endodontic infections and are known for their resistance and ability to survive in adverse conditions.[3,4]

Root canal irrigation plays a crucial role in eliminating microorganisms, removing debris, and dissolving organic tissue within the canal system. According to the American Association of Endodontists, successful root canal treatment depends on the synergistic effect of mechanical instrumentation and chemical irrigation to effectively eliminate microorganisms and prevent reinfection.[5] Sodium hypochlorite is the most commonly used irrigation solution for disinfection due to its antibacterial capacity and its ability to break down necrotic tissue, organic components, and biofilm. However, its cytotoxicity and potential adverse effects, including tissue irritation and allergic reactions, have prompted the search for safer alternatives.[6]

The growing interest in plant-based endodontic irrigants has led to the investigation of various herbal extracts as potential antimicrobial agents. One of Indonesia's medicinal plants with promising antibacterial properties is lemongrass (*Cymbopogon citratus*).[7] *Cymbopogon citratus* is widely distributed in Indonesia and has been reported to exhibit various pharmacological activities, including antioxidant, antimicrobial, anti-inflammatory, and antidiabetic properties.[8,9] These effects are attributed to its bioactive secondary metabolites, such as flavonoids, saponins, terpenoids, tannins, and alkaloids. Previous studies have demonstrated its antibacterial activity against oral pathogens, including *Streptococcus mutans*.[7,9]

To date, evidence regarding the antibacterial efficacy of *C. citratus*, particularly at low concentrations relevant to clinical application, remains limited. Therefore, this study aimed to evaluate its antibacterial potential against *E. faecalis* and *S. aureus* within a concentration range applicable for future clinical translation.

MATERIALS AND METHODS

This study was a laboratory experimental study using a post-test only control group design. The bacterial samples used were *Enterococcus faecalis* ATCC 29212 and *Staphylococcus aureus* ATCC 29213. Lemongrass (*Cymbopogon citratus*) extract was prepared using a stepwise maceration method with 96% ethanol as the solvent. The plant material was obtained from Kulur Village, Majalengka District, Majalengka Regency, West Java, Indonesia.

Prior to the experimental procedures, all equipment was sterilized. The instruments were thoroughly washed, dried, and wrapped in aluminum foil, followed by autoclave sterilization at 121°C for 15 minutes. Additional instruments, such as L-shaped spreaders and inoculation loops, were sterilized by flaming using a spirit lamp.

A total of 6 kg of fresh lemongrass was thoroughly washed and cut into small pieces to facilitate

drying. The plant material was air-dried under sunlight for 7 days, yielding 540 g of dried lemongrass. The dried lemongrass was then ground into a coarse powder using an electric grinder before maceration. The powdered material was macerated in 2 L of 96% ethanol for 72 hours with periodic stirring. The macerate was filtered, and the filtrate was concentrated using a rotary evaporator at 50°C, followed by further filtration to obtain a thick extract.

The lemongrass extract was prepared at concentrations of 10%, 20%, and 30% (v/v) by diluting the crude extract with 96% ethanol using appropriate volumetric ratios. Antibacterial activity was evaluated using the Kirby-Bauer disc diffusion method by measuring the diameter of inhibition zones formed around the discs.

The experimental design consisted of five groups: 10%, 20%, and 30% *Cymbopogon citratus* extract, 2.5% sodium hypochlorite as a positive control, and 96% ethanol as a negative control. Each group was tested in five repetitions based on Federer's formula.

Bacterial suspensions of *E. faecalis* ATCC 29212 and *S. aureus* ATCC 29213 were prepared by inoculating a loopful of culture into 5 mL of Tryptone Soya Broth, followed by incubation at 37°C for 24 hours. The turbidity was adjusted to a 0.5 McFarland standard.

The standardized suspension was evenly spread onto Tryptone Soya Agar using a sterile L-shaped spreader and allowed to stand for 5 minutes. Subsequently, each sterile paper disc (6 mm in diameter) was impregnated with 20 µL of the respective test solution and placed on the inoculated agar surface. The plates were incubated in an anaerobic jar at 37°C for 24 hours. All procedures were performed under aseptic conditions.

The data were analyzed using IBM SPSS software. Normality was assessed using the Shapiro-Wilk test. Since the negative control showed identical values (0 mm) in all replicates with no variance, it was presented descriptively and was not included in the one-way ANOVA analysis. As the remaining data were normally distributed ($p > 0.05$), comparisons among groups were performed using one-way ANOVA, followed by the Bonferroni post hoc test to determine pairwise differences between groups.

RESULTS AND DISCUSSIONS

The antibacterial activity of *Cymbopogon citratus* extract against *E. faecalis* ATCC 29212 and *S. aureus* ATCC 29213 was evaluated using the disc diffusion method. Antibacterial activity was indicated by the formation of inhibition zones around the discs, which were measured in millimeters using a digital caliper. The results of the antibacterial activity test are presented in Tables 1 and 2.

Table 1. Mean inhibition zone (mm) and one-way ANOVA results of *Enterococcus faecalis* across treatment groups

Treatment group	1	2	3	4	5	Mean ± SD	p-value
Lemongrass extract 10%	1.70	1.10	1.00	1.00	1.50	1.26 ± 0.32	<0.001
Lemongrass extract 20%	1.70	2.40	1.10	1.00	1.55	1.63 ± 0.48	
Lemongrass extract 30%	2.10	1.10	1.10	1.40	1.00	1.34 ± 0.45	
NaOCl 2.5%	7.30	8.40	5.50	6.80	8.90	7.38 ± 1.34	

Note: $p < 0.05$ indicates statistical significance. The negative control was presented descriptively and excluded from one-way ANOVA because it showed no variance.

Table 2. Mean inhibition zone (mm) and one-way ANOVA results of *Staphylococcus aureus* across treatment groups

Treatment group	1	2	3	4	5	Mean ± SD	p-value
Lemongrass extract 10%	2.10	1.10	4.00	1.30	1.80	2.06 ± 1.15	<0.001
Lemongrass extract 20%	2.00	1.10	3.30	0.60	0.60	1.52 ± 1.15	
Lemongrass extract 30%	2.10	2.00	2.60	0.90	1.10	1.74 ± 0.72	
NaOCl 2.5%	22.00	20.40	21.40	16.90	21.00	20.34 ± 2.01	

Note: $p < 0.05$ indicates statistical significance. The negative control was presented descriptively and excluded from one-way ANOVA because it showed no variance.

The negative control group using 96% ethanol showed no inhibition zone in all replicates (0.00 ± 0.00 mm), indicating that the solvent did not contribute to antibacterial activity. Since all values were identical and showed no variability, the negative control was presented descriptively and was not included in the one-way ANOVA analysis.

Based on Table 1, the highest mean inhibition zone against *E. faecalis* was observed at 20% concentration (1.63 ± 0.48 mm), followed by 30% (1.34 ± 0.45 mm) and 10% (1.26 ± 0.32 mm). In contrast, the positive control, 2.5% sodium hypochlorite, demonstrated a substantially larger inhibition zone (7.38 ± 1.34 mm).

As shown in Table 2, the highest mean inhibition zone against *S. aureus* was observed at 10% concentration (2.06 ± 1.15 mm), followed by 30% (1.74 ± 0.72 mm) and 20% (1.52 ± 1.15 mm). The positive control, 2.5% sodium hypochlorite, showed markedly higher antibacterial activity, with a mean inhibition zone of 20.34 ± 2.01 mm.

Bonferroni post hoc analysis demonstrated significant differences between all *Cymbopogon citratus* extract groups and the positive control ($p < 0.001$). However, no statistically significant differences were found among the extract concentrations ($p > 0.05$), indicating the absence of a dose-dependent effect within the tested concentration range (Tables 3 and 4).

Table 3. Bonferroni post hoc analysis of inhibition zones against *Enterococcus faecalis*

No.	Group	Group	Sig.
1.	Lemongrass extract 10%	Lemongrass extract 20%	1,000
		NaOCl 2.5%	<0.001
2.	Lemongrass extract 20%	Lemongrass extract 30%	1,000
		NaOCl 2.5%	<0.001
3.	Lemongrass extract 30%	Lemongrass extract 10%	1,000
		NaOCl 2.5%	<0.001

Table 4. Bonferroni post hoc analysis of inhibition zones against *Staphylococcus aureus*

No.	Group	Group	Sig.
1.	Lemongrass extract 10%	Lemongrass extract 20%	1.000
		NaOCl 2.5%	<0.001
2.	Lemongrass extract 20%	Lemongrass extract 30%	1,000
		NaOCl 2.5%	<0.001
3.	Lemongrass extract 30%	Lemongrass extract 10%	1,000
		NaOCl 2.5%	<0.001

Cymbopogon citratus is a medicinal plant widely used in Indonesia and has been reported to exhibit antibacterial properties. These effects are attributed to bioactive compounds such as flavonoids, saponins, terpenoids, tannins, and alkaloids. These compounds act through multiple

antibacterial mechanisms, including disruption of bacterial cell membranes, inhibition of cell wall synthesis, and interference with metabolic processes.[10]

The present study demonstrated that *Cymbopogon citratus* extract exhibited limited antibacterial activity against *E. faecalis* and *S. aureus*. The magnitude of inhibition was low, suggesting weak antibacterial potency. This may be influenced by several factors, including the use of crude extract, limited diffusion capacity in agar media, and variability in the concentration of active compounds.[11]

Previous studies have reported stronger antibacterial activity of *Cymbopogon citratus* extract at higher concentrations. Andayani et al.[9] demonstrated increased inhibition zones against S. mutans with increasing extract concentration, while Tutik et al. showed antibacterial effects of lemongrass extract against *S. aureus* and E. coli at higher concentrations.[9,12] These findings suggest that the antibacterial efficacy of lemongrass extract may not be optimal at the lower concentrations used in the present study.

The type of bacterial species may also influence the antibacterial response. *E. faecalis* is known for its resistance and ability to survive in harsh environmental conditions, contributing to persistent endodontic infections. *S. aureus* is a resilient gram-positive bacterium associated with various infections. These characteristics may explain the limited inhibitory effect observed in this study.[13]

The weak inhibitory effect observed in this study may also be attributed to the use of crude extract, which can limit the availability and concentration of active antibacterial compounds.[14] In addition, factors such as solvent type, extraction method, and diffusion capacity in agar media may influence the antibacterial efficacy of plant extracts. Extraction conditions have been shown to significantly affect the yield and activity of bioactive compounds.[15]

Although *Cymbopogon citratus* contains various antibacterial constituents, including flavonoids, terpenoids, and essential oils, the concentration and bioavailability of these compounds in crude extracts may be insufficient to produce strong antibacterial effects. In contrast, the significantly greater antibacterial activity of sodium hypochlorite observed in this study aligns with the American Association of Endodontists guidelines, which recognize sodium hypochlorite as the gold standard irrigant due to its tissue-dissolving capacity and ability to disrupt microbial biofilms.[5]

Clinically, these findings indicate that *Cymbopogon citratus* extract, in its current formulation, cannot replace sodium hypochlorite as an endodontic irrigant. However, it may still have potential as an adjunctive agent following further optimization, such as increasing concentration, fractionation, or formulation enhancement. Future studies should investigate minimum inhibitory concentration, minimum bactericidal concentration, and biofilm-based models to better reflect clinical conditions.

CONCLUSION

Cymbopogon citratus extract demonstrated weak antibacterial activity against *E. faecalis* and *S. aureus*, with no significant differences among the tested concentrations. The antibacterial effect was substantially lower than that of 2.5% sodium hypochlorite. Therefore, within the limitations of this study, *Cymbopogon citratus* extract cannot be considered a substitute for conventional endodontic irrigants. Although promising, its potential as an

alternative root canal irrigant requires further development. Future studies should investigate higher concentrations, advanced formulations, and alternative testing models to better evaluate its clinical applicability.

REFERENCES

1. Kementerian Kesehatan Republik Indonesia. Laporan Nasional RISKESDAS 2018. Jakarta: Badan Penelitian dan Pengembangan Kesehatan; 2018.
2. Bjørndal L, Simon S, Tomson PL, Duncan HF. Management of deep caries and the exposed pulp. Int Endod J. 2019;52(7):949-73. DOI: 10.1111/iej.13128.
3. Gopikrishna V. Grossman's Endodontic Practice. 14th ed. New Delhi: Wolters Kluwer; 2021.
4. Chopra V. Clinical Atlas of Retreatment in Endodontics. Hoboken: Wiley Blackwell; 2021.
5. American Association of Endodontists. Guide to Clinical Endodontics. 6th ed. Chicago: American Association of Endodontists; 2019.
6. Torabinejad M, Fouad AF, Shabahang S. Endodontics: Principles and Practice. 6th ed. St Louis: Elsevier; 2020.
7. Kawengian SAF, Wuisan J, Leman MA. Uji daya hambat ekstrak daun serai (Cymbopogon citratus L.) terhadap pertumbuhan Streptococcus mutans. J e-Gigi. 2017;5(1):7-11.
8. Kuete V. Medicinal Spices and Vegetables from Africa: Therapeutic Potential Against Metabolic, Inflammatory, Infectious and Systemic Diseases. London: Academic Press; 2017.
9. Andayani L, Ridwan A, Aryandi R, S S. Uji efektivitas antibakteri ekstrak daun serai terhadap pertumbuhan Streptococcus mutans. J TLM Blood Smear. 2022;3(1):36-43.
10. Soraya D, Wijaya S, Silaen M. Efektivitas antibakteri ekstrak daun serai (Cymbopogon citratus) konsentrasi 20%, 30%, 40%, dan 50% terhadap Streptococcus mutans. Prima J Oral Dent Sci. 2022;15(1):18-20.
11. Moomin A, Russell WR, Knott RM, Scobbie L, Mensah KB, Gyamfi PKTA, et al. Season, storage and extraction method impact on the phytochemical profile of Terminalia ivorensis. BMC Plant Biol. 2023;23(1):162. DOI: 10.1186/s12870-023-04144-8.
12. Tutik T, Chusniasih D, Rahayu RY. Formulasi sediaan sabun cair antiseptik ekstrak etanol serai dapur (Cymbopogon citratus (DC.) Stapf) terhadap Staphylococcus aureus dan Escherichia coli. J Farm Malahayati. 2022;5(1):49-63. DOI: 10.33024/jfm.v5i1.6726.
13. Gunawan RT, Giri PRK, Ambarawati IGAD. Perbandingan efektivitas ekstrak daun kemangi (Ocimum sanctum L.) 75% dengan natrium hipoklorit (NaOCl) 2,5% terhadap Enterococcus faecalis: studi in vitro. Bali Dent J. 2023;7(2):69-73. DOI: 10.37466/bdj.v7i2.231.
14. Silalahi M. Essential oil pada Cymbopogon citratus (DC.) Stapf dan bioaktivitasnya. Titian Ilmu J Ilm Multi Sci. 2020;12(1):7-13. DOI: 10.30599/jti.v12i1.538.
15. Tazi A, Zinedine A, Rocha JM, Errachidi F. Review on the pharmacological properties of lemongrass (Cymbopogon citratus) as a promising source of bioactive compounds. Pharmacol Res Nat Prod. 2024;3(1):100046. DOI: 10.1016/j.prenap.2024.100046.