



ANTIMICROBIAL POTENTIAL OF ALOE VERA AS AN ALTERNATIVE ROOT CANAL MEDICAL MATERIAL AGAINST *Enterococcus faecalis* BACTERIA

Dentistry

Sari Dewiyan

Lecturer, PhD – Department of Conservative Dentistry and Endodontics Dentistry University Prof. Dr. Moestopo (Beragama), Indonesia.

Dicky Alamsyah

Student - Faculty of Dental Medicine, University Prof. Dr. Moestopo (Beragama), Indonesia.

ABSTRACT

Root canal treatment consists of access preparation, root canal preparation, intracanal disinfection and root canal filling. Root canal disinfection is accomplished by irrigation and root canal medicament. In post-endodontic treatment infections, the dominant bacteria is *Enterococcus faecalis*. Intracanal medicaments that are derived from the Aloe vera plant have been widely studied for their antimicrobial potential against the pathogenic bacteria *Enterococcus faecalis*. Aloe vera gel medicament has antimicrobial effects that can inhibit the growth of *Enterococcus faecalis* bacteria. **Objective:** The aim of this study was to conduct an integrative technique study with scientific evidence relating to the antimicrobial potential of Aloe vera as an alternative root canal medicament against *Enterococcus faecalis* bacteria. **Methods:** Analyzing journals from the database of Google Scholar and Medline (PubMed). **Conclusion:** This review revealed that Aloe vera has antimicrobial action against the *Enterococcus faecalis* bacteria, but the use of Aloe vera as a root canal medicament is still controversial due to many differences in some researchers.

KEYWORDS

Potential, Aloe vera, Enterococcus faecalis, Antimicrobial, Medicament

INTRODUCTION

The success of root canal treatment depends on accurate diagnosis and treatment planning, proper disinfection, instrumentation procedures, fillings (root canal formation and coronal and apical closure) and rehabilitation.^{1,2} Root canal treatment consists of access preparation, root canal preparation and intracanal disinfection. and root canal filling. Root canal disinfection is accomplished by irrigation and root canal medicament. One of the most commonly used medicaments in root canal treatment is calcium hydroxide. The usage of calcium hydroxide drug as an intracanal medicament because it has a high pH so that it has anti-bactericidal properties that have the effect of damaging the cell membrane and protein structure of bacteria. Calcium hydroxide has broad antimicrobial activity, but calcium hydroxide is less effective against some species. Calcium hydroxide also has cytotoxicity and is difficult to remove from the root canal.^{3,4}

Reinfection that occurs after endodontic treatment was dominant by *Enterococcus faecalis* bacteria. This bacterium has properties that are resistant to $\text{Ca}(\text{OH})_2$.⁵ *Enterococcus faecalis* is an anaerobic Gram-positive bacterium and accounts for 80-90% of *Enterococcal* infections generally being the only *Enterococcus* species isolated in failed obturation of root canals. This fact indicates that *Enterococcus faecalis* plays an important role in the failure of endodontic treatment.⁶ Therefore, thorough root canal sterilization is required to achieve successful root canal treatment.¹

Several researchers conducted research to find new biological intracanal medicaments derived from plants that do not cause unwanted chemical reactions and are effective in eliminating all bacteria.⁶ *Aloe vera* is a cactus-like plant that belongs to the *Liliaceae* family. *Aloe vera* is a natural remedy with a long history of use in medicine and nutrition. *Aloe vera* is also used in dentistry in cases of *lichen planus*, *oral submucous fibrosis*, *recurrent aphthous stomatitis*, *alveolar osteitis*, *periodontitis*, dan *dry socket*.^{7,8}

Research conducted by Ghasemi N, et al. (2020) stated that *Aloe vera* gel had good antimicrobial potential against *Enterococcus faecalis* in inhibiting bacterial growth, but the results of another study by Bhardwaj A, et al. (2012) stated that the antimicrobial potential of *Aloe vera* gel against *Enterococcus faecalis* bacteria was not good.^{9,10}

METHOD

This writing is made by collecting data sources from various relevant sources and obtained through textbooks, journals, websites with the keywords "Effectivity", "Aloe vera", "Enterococcus faecalis", "Intracanal medicament" accessed through the Google scholar, pubmed database.

References taken from 2010-2020 were selected based on an analysis of relevant references.

Intracanal Medicament

Pulp chamber disinfection treatment is an important step during and after root canal cleaning and shaping. Intracanal medicaments are used for root canal disinfection as part of controlled asepsis of infected root canals and serve as a secondary disinfection in cleaning the root canal after preparation.¹¹ Intracanal medicaments are defined as the temporary placement of drugs with good biocompatibility into the root canal for the purpose of inhibiting coronal invasion of bacteria.¹²

The ideal properties that must be possessed by intracanal medicaments are that medicaments must be effective in killing bacteria, not irritate pulp tissue, remain stable in solution, must have long-lasting antimicrobial action, antimicrobial action of medicaments must remain active when there is blood or pus, must have low surface tension, must not interfere with healing or repair of periapical tissues, must not stain teeth, must not cause immune response activity, must be able to prevent coronal microleakage, and not spread through temporary restorations.^{13,14}

The goals of using intracanal medicaments are to kill microorganisms, prevent or control postoperative pain, improve anesthesia, control of persistent periapical abscesses.¹³



Figure 1 : Formocresol 14



Figure 2 : Calcium hydroxide¹⁴

Grossman (2014) explained that intracanal medicaments can be classified into essential oils (Eugenol), Phenolic compounds (Phenol, Parachlorophenol, Camphorated parachlorophenol, Cresatin, Aldehydes), Calcium hydroxide, Halogens Group (Sodium hypochlorite, Iodine), Chlorhexidine Gluconate, Corticosteroid-antibiotic combination.^{13,14}

Aloe vera

Aloe vera looks like a cactus, but it's not. The botanical name for *Aloe vera* is *Aloe barbadensis miller*, it belongs to the *Asphodelaceae* (*Liliaceae*) family, and is a plant that looks like a bush, can live a long time, contains a lot of water, has the color of a green bean plant. *Aloe vera* is up to 20 inches long and 5 inches wide, has triangular shaped, thick, succulent leaves that have spines along the edges. The sticky latex liquid comes from the pericyclic tubules that line the leaves (fruit skin), this section produces *laxative anthraquinones*. The flowers are yellow and are not used as medicine.¹⁵

Aloe vera gel contains two hormones, *auxin* and *gibberellins* which help in healing and reduce skin inflammation. *Gibberellin* in *Aloe vera* acts as a growth hormone that stimulates new cell growth thereby allowing the skin to recover quickly and naturally.¹⁶



Figure 3 : *Aloe vera*¹⁵

Classification of *Aloe vera*^{17,18}

Kingdom	: <i>Plantae</i>
Order	: <i>Asparagales</i>
Division	: <i>Spermatophyte</i>
Subdivision	: <i>Angiosperms</i>
Class	: <i>Monocotyledoneae</i>
Family	: <i>Xanthorrhoeaceae</i>
Genus	: <i>Aloe</i>
Species	: <i>Barbadensis Mill</i>

Aloe vera has various ingredients, namely amino acids (phenylalanine, arginine, tyrosine, aspartic acid and histidine), anthraquinones (emodin, aloetic acid, aloin, anthracin, anthranone, barbaloin, chrysophanic acid, ethereal oil, cinemonic acid esters, isobarbaloin, and resistanol), enzymes (aliase, alkaline phosphatase, amylase, carboxypeptidase, catalase, cellulase, lipase and peroxidase), hormones (auxin and gibberellins), minerals (calcium, chromium, copper, iron, magnesium, manganese, potassium, sodium and zinc), sterols (cholesterol, campesterol, lupeol and beta sitosterol), sugars (monosaccharides and polysaccharides, vitamins (vitamins A, C, E, B, choline and folic acid)).¹⁷

Aloe vera has several biological effects, such as wound healing, effects on the immune system, antimicrobial, skin and mucous membranes, protective effects. *Aloe vera* also has uses in dentistry, which can reduce oral lichen planus pain, reduce pain and accelerate healing of recurrent aphthous stomatitis, prevent dry socket, as an ingredient in toothpaste and mouthwash, gutta percha cone disinfection, anti-cancer agent.¹⁹

Enterococcus faecalis

Enterococci is a microbiome that originates from mammals, reptiles, birds and insects. These bacteria can multiply in the intestinal tract environment which is rich in nutrients and lacks oxygen. *Enterococcus* strains are also frequently found in soil, sewage, water, and food samples resulting from feces contamination. *Enterococcus* is a core member of the commensal gut microbiota. Induction of

bacteriophages in response to the environment appears as one of the strategies for *Enterococcal* colonization in the intestinal ecosystem. *Enterococcus* in the complex ecology of the gastrointestinal tract provides an ample reservoir where genetic exchange and selection can occur.^{20,21} *Enterococcus* are now among the top three nosocomial pathogens and strains resistant to currently available antibiotics make treatment difficult. Up to 90% of *Enterococcal* infections in humans are caused by two species of *Enterococcus*, namely *Enterococcus faecalis* and *Enterococcus faecium*.²²

Enterococcus faecalis cannot survive at a pH of 11.5 or above, but can survive at lower concentrations. *Enterococcus faecalis* has the ability to penetrate the dentinal tubules and survive in the dentin so that medicaments that have a high pH such as calcium hydroxide are difficult to reach the dentinal tubules. The pH value of the calcium hydroxide paste used in endodontic treatment is 12.3 and in the dentine of the root canal the alkaline pH achieved does not exceed 10.3.²³

There are two potential causes of *Enterococcus faecalis* causing teeth to require secondary endodontic treatment. The first shows that *Enterococcus faecalis* has the ability to colonize and infect dentinal tubules, making it difficult to remove these bacteria through chemical and mechanical cleaning due to the small diameter of the dentinal tubule anatomy. *Enterococcus faecalis* also has the ability to bind to collagen. The second shows the potential resistance these bacteria have to calcium hydroxide which is the most commonly used antimicrobial drug in the root canal system during endodontic treatment which allows these microorganisms to survive in a quiescent state in the root canals.²³

DISCUSSION

The goal of non-surgical endodontic therapy is to remove pathogenic microorganisms from the root canal system, shape the root canal system appropriately and seal the root canal with a suitable material. Thorough disinfection of the root canal is not always achievable by instrumentation alone because of the complexity of the root canal anatomy.

Retention of microorganisms in the dentinal tubules leads to persistent endodontic infections so the use of intracanal medicaments is necessary to remove remaining microbes and provide an conducive environment to periapical tissue repair. *Enterococcus faecalis* is a bacterium that plays a major role in causing periradicular lesions after root canal treatment. These bacteria are able to enter into the dentinal tubules and can survive the harsh conditions of the root canals so that they become resistant microorganisms. *Enterococcus faecalis* can survive harsh conditions due to its ability to form biofilms and make them more resistant to phagocytosis, antibodies and antimicrobial agents.²⁶

Natural products are sometimes seen as useful and attractive as substitutes for drugs because they are thought to have fewer side effects and are less expensive. *Aloe vera* has anti-inflammatory, antimicrobial, moisturizing, wound healing and pain relief properties. This plant can grow in hot and dry weather because of its ability to retain high water. *Aloe vera* has been widely used in dentistry for various treatments.²⁵

Bhardwaj A, et al. (2012) in their research showed that chlorhexidine gel showed maximum antimicrobial activity against *Enterococcus faecalis*, while calcium hydroxide showed the least. *Morinda citrifolia* gel consistently showed good inhibition up to day 5 compared to *Aloe vera* and *Papain* gel.¹⁰

Ehsani M, et al. (2013) in their research showed *Aloe vera* gel had a weak antimicrobial effect against *Enterococcus faecalis* and the antimicrobial activity of *Aloe vera* was lower than *Propolis*.²⁵

Research by Bazvand L, et al. (2014) showed that triantibiotic mixture 0.2% chlorhexidine gel and the natural ingredient *Propolis* had the same antimicrobial effect against *Enterococcus faecalis* in dentin. The antimicrobial effect of *Aloe vera* gel against *Enterococcus faecalis* is less than other medicaments.⁶

Research by Abbaszadegan A, et al. (2014) showed the antimicrobial efficiency of all tested medicaments was similar after 14 days. *Aloe vera* and *Zataria multiflora* essential oils showed similar antimicrobial efficiency against *Enterococcus faecalis* in infected root canals

comparable to calcium hydroxide tested for 14 days.⁷

Research by Kurian B, et al. (2016) carried out by testing all medicament groups for 7 days. Fungi showed the highest antimicrobial activity in all test time periods, while *Aloe vera* showed the least antimicrobial activity on day 3, but on days 5 and 7 the antimicrobial activity of *Aloe vera* was higher than the antimicrobial activity of calcium hydroxide.²⁴

Vasudeva A, et al. (2017) in their research showed that 2% chlorhexidine gel was the most effective intracanal medicament against *Enterococcus faecalis* bacteria. *Propolis* and *Curcuma longa* in gel preparations as intracanal medicaments show good efficacy against *Enterococcus faecalis* so that they can be used as effective intracanal medicaments. *Aloe vera* gel showed the least effect in disinfecting the dentinal tubules.²⁶

Kusuma CS, et al. (2018) in their research showed that *Aloe vera* extract had less antimicrobial potential against *Enterococcus faecalis* at all time intervals when compared to chlorhexidine and *Neem*, so the use of *Aloe vera* as a root canal medicament is still questionable.³

Research by Ghasemi N, et al. (2020) showed that *Aloe vera* gel has activity that can inhibit the growth of *Enterococcus faecalis* and has a strong antimicrobial effect compared to calcium hydroxide as an antioxidant and reduces free radical production.⁹

Research by Digole VR, et al. (2020) showed that the three medicaments tested in the study, namely extracts of *Curcumin*, *Aloe vera*, and calcium hydroxide were found to be effective for thorough disinfection of root canals. Antimicrobial properties *Curcumin* extract showed the highest antimicrobial properties compared to calcium hydroxide and *Aloe vera* extract as intracanal medicaments.²⁷

Several research results have shown that *Aloe vera* has been shown to have antimicrobial activity against *Enterococcus faecalis* bacteria, but the effectiveness of *Aloe vera*'s antimicrobial properties for use as a root canal medicament is still controversial.

CONCLUSION

Based on the studies that have been conducted to see the effectiveness of *Aloe vera* antimicrobial against *Enterococcus faecalis* as a root canal medicament, it can be concluded:

1. *Enterococcus faecalis* is often found in cases of reinfection after endodontic treatment.
2. *Enterococcus faecalis* has a resistance characteristic to root canal medicaments used during endodontic treatment.
3. *Aloe vera* has antimicrobial action comparable to calcium hydroxide, which is a root canal medicament commonly used in endodontic treatment.
4. *Aloe vera* has antimicrobial action against *Enterococcus faecalis* bacteria but the use of *Aloe vera* as a root canal medicament is still controversial due to many differences in some researchers

REFERENCES

1. Alag AS, Bedi S, Almas K. Phytosolutions for *Enterococcus faecalis* in Endodontics. *Oral Health and Dental Management*. 2016;15(5):332-336.
2. Estrela C, Holland R, Estrela CRA, Alencar AHG, Sousa-Neto MD, Pécora JD. Characterization of Successful Root Canal Treatment. *Brazilian Dental Journal*. 2014;25(1):3-11.
3. Kusuma CS, Manjunath V, Gehlot PM. Comparative Evaluation of *Neem*, *Aloe vera*, Chlorhexidine and Calcium Hydroxide as an Intracanal Medicament against *E. faecalis*. *Journal of Clinical and Diagnostic Research*. 2018;12(3):21-25.
4. Ba-Hattab R, Al-Jamie M, Aldreib H, Alessa L, Alonazi M. Calcium Hydroxide in Endodontics: An Overview. *Open Journal of Stomatology*. 2016;6(12):274-289.
5. Parashar V, Khan SA, Singh P, Sharma S, Kumar A, Anand K. Effect of Intracanal Medicaments (Modified Triple Antibiotic Paste, Calcium Hydroxide, and *Aloe Vera*) on Microhardness of Root Dentine. *The Journal of Contemporary Dental Practice*. 2020;21(6):633-635.
6. Bazvand L, Aminoazarbian MG, Farhad A, Noormohammadi H, Hasheminia SM, Mobasherizadeh S. Antibacterial Effect of Triantibiotic Mixture, Chlorhexidine Gel, and Two Natural Materials *Propolis* and *Aloe Vera* against *Enterococcus faecalis*. *Dental Research Journal*. 2014;11(4):469-474.
7. Abbaszadegan A, Sahebi S, Gholami A, Delroba A, Kiani A, Iraj A, Paul Vincent Abbott PV. Time-dependent Antibacterial Effects of *Aloe Vera* and *Zataria Multiflora* Plant Essential Oils Compared to Calcium Hydroxide in Teeth Infected with *Enterococcus faecalis*. *Journal of Investigative and Clinical Dentistry*. 2014;5:1-9.
8. Mangaiyarkarasi S, Manigandan T, Elumalai M, Cholan P, Kaur RP. Benefits of *Aloe vera* in Dentistry. *Journal of Pharmacy And Bioallied Sciences*. 2015;7(1):225-259.
9. Ghasemi N, Behnezhad M, Asgharzadeh M, Zeinalzadeh E, dan Kafil HS. Antibacterial Properties of *Aloe vera* on Intracanal Medicaments against *Enterococcus faecalis* Biofilm at Different Stages of Development. *International Journal of Dentistry*. 2020;1-6.
10. Bhardwaj A, Ballal S, Velmurugan N. Comparative Evaluation of the Antimicrobial Activity of Natural Extracts of *Morinda citrifolia*, *Papain* and *Aloe vera* (all in gel formulation), 2% Chlorhexidine gel and Calcium Hydroxide, against *Enterococcus*

faecalis. *Journal of Conservative Dentistry*. 2012;15(3):293-297.

11. Chandra BS dan Gopikrishna V. *Grossman's Endodontic Practice*. 13th ed. India:Wolters Kluwer Health; 2014:336-338.
12. Kumar A, Tamanna S, Ifekhar H. Intracanal Medicaments – Their Use in Modern Endodontics: A narrative review. *Journal of Oral Research and Review*. 2019;11(2):94-99.
13. Pal H, Sarkar A, Das L, Saha S, Sarkar S. Application of Intracanal Medicaments. *IOSR Journal of Dental and Medical Sciences*. 2019;18(1):14-21.
14. Garg N, Garg A. *Textbook of Endodontics*. 2nd ed. India:Jaypee Brothers Medical Publishers; 2010:223-228.
15. Sharrif Moghaddasi M, Verma SK. *Aloe Vera* Their Chemicals Composition and Applications. *International Journal of Biological & Medical Research*. 2011;2(1):466-471.
16. Tiwari M, Upadhyay M. The medicinal plant components and applications (*Aloe vera*). *Journal of Medicinal Plants Studies*. 2018;6(3):89-95.
17. Hossain MS, Mamun-Or-Rashid ANM, Towfique NM, Sen MK. A Review on Ethnopharmacological Potential of *Aloe Vera* L. *Journal of Intercultural Ethnopharmacology*. 2013;2(2):113-120.
18. Pathak D, Sharma R. Review on “*Aloe vera* – Medicinal Plant”. *International Journal of Advance Research and Innovative Ideas in Education*. 2017;3(1):661-671.
19. Tayal E, Sardana D, InduShekar KR, Saraf BG, Sheoran N. Current Perspectives on Use of *Aloe vera* in Dentistry. *European Journal of Medicinal Plants*. 2014;4(12):1408-1419.
20. Tyne DV, Martin MJ, Gilmore MS. Structure, Function, and Biology of the *Enterococcus faecalis* Cytolysin. *Toxins*. 2013;5(5):895-911.
21. Xia Z, Xichu W, Bingjiao G, Xiaolan W. Isolation and Identification of *Enterococcus faecalis* and detection of its virulence factor genes in lambs presenting with encephalitis in Xinjiang province, China. 2013;7(20):2239-2242.
22. Gajan EB, Shirmohammadi A, Abashov, Agazadeh M, Faramarzie M. Detection of *Enterococcus faecalis* in Subgingival Biofilm of Patients with Chronic Refractory Periodontitis. *Medical Oral Patologia Oral Cirugia Bucal*. 2010;1(15):e667-e670.
23. Niklitschek CR, Gonzalo H Oporto V. Clinical Implications of *Enterococcus faecalis* Microbial Contamination in Root Canals of Devitalized Teeth. *Revista Odontológica Mexicana*. 2015;19(3):e177-e182.
24. Kurian B, Swapna DV, Nadig RR, Ranjini MA, Rashmi K, Bolar SR. Efficacy of Calcium hydroxide, mushroom, and *Aloe Vera* as an Intracanal Medicament Against *Enterococcus faecalis*. *Endontology*. 2016;28(2):137-142.
25. Ehsani M, Marashi MA, Zabihi E, Issazadeh M, Khafri S. A Comparison between Antibacterial Activity of *Propolis* and *Aloe vera* on *Enterococcus faecalis*. *International Journal of Molecular and Cellular Medicine*. 2013;2(3):110-117.
26. Vasudeva A, Sinha DJ, Tyagi SP, Singh NN, Garg P, dan Upadhyay D. Disinfection of Dentinal Tubules with 2% Chlorhexidine gel, Calcium hydroxide and Herbal Intracanal Medicaments against *Enterococcus faecalis*: An in-vitro study. *Singapore Dental Journal*. 2017;38:39-44.
27. Digole VR, Dua P, Shergill SPS, Pathak P, Kumar V, Prakash P. Comparative Evaluation of Antimicrobial Efficacy of Calcium Hydroxide, *Curcumin* and *Aloe vera* as an Intracanal Medicament. *Indian Journal of Conservative and Endodontics*. 2020;5(3):114-119.