**Phytosolutions for *Enterococcus Faecalis* in Endodontics: An Update**

**Running title:** Phytosolutions in Endodontics

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**Abstract:**

*Background*: The key reason for failure of an endodontic treatment is incomplete debridement and sterilization because of complex root canal system anatomy which makes elimination of micro-organisms difficult. In spite of the chemical and mechanical debridement of root canals, studies have reported that some microbes like *Enterococcus faecalis* thrive in periapical lesions, triggering a failure of an endodontic treatment. Considering the vanity, adverse effects and toxicity issues of synthetic medications, the herbal alternatives have been sought for endodontic irrigation.

*Objectives*: To review the current evidence on the efficacy of different plant derivatives against *Enterococcus faecalis*.

*Materials and methods*: Studies were identified through systematic search of the following electronic databases: PubMed, Web of Science, Scopus, Google Scholar and Cochrane database of systematic reviews**.** The results from the relevant published literatures are discussed.

*Summary and Conclusion:*

The conclusion drawn from *in vitro* and *in vivo* studies seems encouraging and as proven in clinical studies, Propolis and *Salvadora persica* have been proven to be efficacious against *Enterococcus faecalis*. More laboratory and clinical research is required to assess the safety, efficacy and biocompatibility of other plant extracts, before finally recommending them as alternative endodontic irrigants.

**Keywords:** Endodontic pathogens, *Enterococcus faecalis*, Root canal irrigants, Endodontic failure, Plant extracts

# Introduction

One of the key reasons behind the success of root canal treatment is the chemo -mechanical preparation which aids in removal of remaining tissue, various microbes and debris from the complex root canal areas and allow the canals to be obturated to achieve a hermetic seal which will prevent future ingress of microbes into the canals [1]. Although a plethora of microbes have been found to reside in oral cavity, the lower oxygen (O2) potential inside root canals and nutrient availability leads to colony formation of facultative anaerobes predominantly. *Enterococcus faecalis*, a facultative anaerobe found in 4 to 40% of primary endodontic infections, survives unaided inside canals and periapical area and multiply by genetic polymorphism, hence triggering infection and local bone resorption [2]. *E.* *faecalis* due to its virulence factors like aggregation substance, cytolysin, lytic enzymes, can alter host responses and hence it is able to strive better than other microbes and is the only strain isolated after unsuccessful endodontic treatment [2-9]. Moreover, they invade dentinal tubules and adhere to collagen due to their ability to form biofilm and therefore it may act as a nidus for recurrence of infection in failed root canal treated teeth [3,10]. Hence, to attain lasting successful root canal treatment, it necessitates a complete sterilization of root canal and limiting the recurrence of infection.

In chemo-mechanical preparation, chemicals are used along with mechanical instrumentation to decrease the bacterial load. Numerous chemical solutions are being used to sterilize the root canals and the most effective and commonly used is sodium hypochlorite (NaOCl) in concentrations varying from 1-6% [11]. Its unique ability to dissolve pulp tissue, and outstanding antimicrobial potency makes it the irrigant of choice over other irrigants like 2% solution of chlorhexidine (CHX) and calcium hydroxide [Ca(OH)2], which have a varying grade of antimicrobial action. The disadvantages with NaOCl include limited penetrability in complex canal system, toxicity, risk of emphysema, allergy, offensive smell and taste [1,11]; and also it fails in removing the smear layer which has been suggested as a doorway for bacterial ingress and multiplication [11-13]. Recent studies show high concentrations of NaOCl can probably cause weakening of dentin by decreasing its hardness and structural reliability, thus making the tooth susceptible to a vertical fracture [12-14]. Although its efficacy is less than NaOCl, CHX has been used effectively as a possible alternative to NaOCl for irrigation of canals due to its broad spectrum antimicrobial action, biocompatibility but its disadvantage is that it can discolor the tooth and other reported concerns like it can cause dryness and burning sensation in oral mucosa [15]. In a recent Cochrane review, the authors also concluded that currently there is inadequate dependable evidence showing the efficacy of a particular irrigant over the other [16].

The safety concerns, side effects, constant increase in antibiotic resistance and ineffectiveness of conventional drug formulations has prompted investigators to shift to herbal alternatives recently [17-20]. The purpose of this review is to provide an update on the various plant extracts that are currently being researched as a possible alternative to conventional irrigants for more efficacious potential endodontic usage.

# Methods

## Search strategy

Studies were identified through systematic search of the following electronic databases: PubMed, Web of Science, Scopus and Google Scholar, Cochrane database of systematic reviews**.** The following terms were used: *Enterococcus faecalis*, root canal failure, endodontics, smear layer, biofilm, and antimicrobial activity. The literature was reviewed for past 25years (1990-2015). Additional studies were recognized and included from reference lists of original research and review articles.

## Study selection

According to selection criteria, studies were required to: (a) be published in peer reviewed journals in the English language (b) provide original data and (c) explicitly report on antimicrobial efficacy of phytochemicals on *Enterococcus faecalis* from root canals. Articles published as abstracts only, were excluded.

# Plant extracts as Endodontic Irrigants

A herbal medicine is defined as a plant extract or a preparation which contains raw or processed ingredients from one or more plants with therapeutic values [17].Owing to the safety concerns, side effects, constant increase in antibiotic resistance and ineffectiveness of conventional drug formulations, investigators are interested in herbal alternatives which have been extensively used in medical practice since many centuries and have become even more popular today due to their biocompatibility, high , anti-inflammatory, antimicrobial properties, anti-oxidant properties and least toxicity and antimicrobial resistance issues [17-20]. With this recent paradigm shift from allopathic conventional drugs to plant extracts gaining more acceptance nowadays, current research is focused on to explore these herbal products and their implications on various clinical conditions. The most commonly tested plant extracts for endodontic irrigation have been summarized in Table 1.

## *Curcuma longa* (Turmeric):

Curcumin, a member of a ginger family has been widely reported to possess anti-inflammatory, antioxidant, antimicrobial and anti-cancer activity [21-23,25].*In vitro* studies have revealed that curcumin has noteworthy antibacterial action against *E. faecalis* and can be used as a substitute to NaOCl for endodontic irrigation [23,24].

## Propolis:

Propolis possesses antibacterial activities against *S. sobrinus* and *S. mutans*. It also possesses good antioxidant and anti-inflammatory actions [26-28]. It has been used as a, cariostatic agent [27] and in the treatment of periodontitis [29]. Ethanolic extract of propolis can promote bone regeneration and induce formation of hard tissue bridge in pulpotomies or pulp capping [30]. Recent studies have concluded that antimicrobial activity of propolis is equivalent to that of sodium hypochlorite [26,29,31,32]. In a clinical study comparing the antimicrobial activity of 25% propolis extract with 0.9% isotonic saline, it was found that there was significant difference in reduction of bacterial colony counts and the authors concluded that due to low toxicity concerns and antibacterial effectiveness, water-soluble extract of 25% propolis can be promoted as a endodontic irrigant in primary teeth [33].

## Acacia nilotica (Babool):

*A. nilotica* as reported in literature possesses good antimicrobial, antioxidant, antifungal, antiviral and antibiotic activity. Khan et al. [34] in their study have proved the antibacterial action of extract of babool against *S. mutans* and *E. faecalis*. In another study, the authors reported that *A. nilotica* at a 50% concentration, had the highest activity against *E. faecalis* [35].

## Azadirachta indica (Neem):

Antimicrobial effects of neem extract against various microbes have been widely reviewed in literature [36,37]. In previous studies, aqueous and alcoholic extract of *Neem* leaf have been proved to inhibit *S. mutans* and *also E. faecalis* [37-40]*.* The minimum inhibitory concentration (MIC) of aqueous neem extract for *E. faecalis* was found to be 7.5% as against 1.88% for alcoholic neem extract [41]. In another study, the effects of herbal extracts such as *Morinda Citrifolia, Azadirachta indica* and green tea were studied and *Azadirchta indica* was found to be most effective irrigant [22].The antioxidant and antimicrobial properties of neem extract makes it a potent irrigant for endodontics as a substitute to sodium hypochlorite.

## Aloe barbadensis miller (Aloe Vera):

Aloe vera is known to possess good antibacterial and antifungal activity [42]. Karkare et al. (2015) [43] found that chloroform extract of aloe vera had substantial antimicrobial effect against *E.faecalis*. In another study, *Aloe vera* tooth gel was found to inhibit the growth of *S. mutans, L. acidophilus, P. intermedia, C. albicans, E. faecalis, and P. anaerobius* [43].

## *Morinda Citrifolia* (Indian mulberry):

*Morinda Citrifolia* is one of the first plant extracts to be tested as alternatives for an intra canal irrigant [45]. *Morinda Citrifolia* has been found to have a significant antibacterial activity[32] which is attributed due to its contents alizarin, scopoletin, aucubin and asperuloside. However its antibacterial action is lower than 0.2% Chlorhexidine [32, 46].

## Triphala and Green tea polyphenols:

Triphala and Green tea polyphenols can act as substitute for conventional endodontic irrigants due to their antimicrobial, anti-inflammatory and scavenging properties [47-49]. Various studies have found Triphala and Green tea polyphenols to have significant antimicrobial activity against *E.faecalis* [50,51].

Citric acid in Triphala has been reported to help in removing the smear layer and hence enhanced sterilization of canal system. Its chelating property makes it an effective substitute to NaOCl for endodontic irrigation [51].

## German chamomile and tea tree oil (*Melaleuca alternifolia*):

Terpinen-4-ol, an active component in tea tree oil is responsible for its antiseptic, antifungal and antibacterial properties [18]. In a recent study comparing the antibacterial efficacy of tea tree oil, it was concluded that maximum antimicrobial activity was shown by 2% Chlorhexidine followed by tea tree oil and then 3% sodium hypochlorite [52].

German chamomile also has been reported to possess anti-inflammatory, analgesic and antimicrobial properties. Sadr et al. [53] in their SEM study, observed that chamomile when used as an irrigant was more effective in removing smear layer when compared to NaOCl used alone but less effective when NaOCl is used in combination with 17% Ethylenediaminetetraacetic acid (EDTA).

## *Salvadora Persica* Solution (Miswak):

Previous studies have proved the antimicrobial action of *S. Persica* [32,54,55]and have also found that 5 mg/ml solution of *S. persica* was as effective as 17% EDTA in eliminating the smear layer from the canal wall [54]. In a clinical study comparing the antimicrobial activity of *S. persica*, propolis, NaOCl and saline as root canal irrigants in primary teeth, it was concluded that 12.5% alcoholic extract of *S. persica* could be a good natural substitute to 3% sodium hypochlorite [56].

# What this review contributes and why this paper is important to field of Phytomedicine and Phytotherapy:

* This reviewprovides the clinical update about the selective plant extracts.
* This update opens the avenues in the field of phytomedicine to investigate further for more alternative natural endodontic irrigants
* The importance of multidisciplinary treatment is highlighted taking into consideration the safety, cost effectiveness, accessibility and efficacy of plant extracts.

# Conclusion

Plant extracts are safe when used with credible evidence and clinical judgement. The benefits like easy accessibility, cost-effective, minimal toxicity, improved shelf life and lack of microbial resistance, have made plant extracts a potential alternative to conventional endodontic irrigants.

The conclusion drawn from *in vitro* and *in vivo* studies seems encouraging and as proven in clinical studies, Propolis and *S. persica* have been proven to be efficacious against *E. faecalis*. More laboratory and clinical research is required to assess the safety, efficacy and biocompatibility of other plant extracts, before finally recommending them as alternative endodontic irrigants. Finally, clinically tested plant extracts should only be used for treatment procedures that have been established.

# Declarations

## List of abbreviations

CHX – Chlorhexidine

[Ca(OH)2] – Calcium hydroxide

EDTA – Ethylene diamine tetra acetic acid

MIC – Minimum inhibitory concentration

NaOCl – Sodium hypochlorite

## Conflict of interest

The authors declare that there are no known conflicts of interest associated with this publication and there has been no financial support for this work that could have influenced its outcome.

## Authors’ Contributions

1. **ASA**: contributed to the conception and design of the study, analysis and article writing
2. **SB**: contributed to the design of the study, analysis of data for the work, drafting the article and submission
3. **KA**: drafting and revising the article critically for important intellectual content

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# References

1. Siqueira JF Jr, Rôças IN, Riche FN, et al. Clinical outcome of the endodontic treatment of teeth with apical periodontitis using an antimicrobial protocol. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2008;106:757–62.
2. Love RM. *Enterococcus faecalis*- a mechanism for its role in endodontic failure. [Int Endod J.](http://www.ncbi.nlm.nih.gov/pubmed/?term=Enterococcus+faecalis-+a+mechanism+for+its+role+in+endodontic+failure) 2001;34(5):399-405.
3. [Davis JM](http://www.ncbi.nlm.nih.gov/pubmed/?term=Davis%20JM%5BAuthor%5D&cauthor=true&cauthor_uid=17437873), [Maki J](http://www.ncbi.nlm.nih.gov/pubmed/?term=Maki%20J%5BAuthor%5D&cauthor=true&cauthor_uid=17437873), [Bahcall JK](http://www.ncbi.nlm.nih.gov/pubmed/?term=Bahcall%20JK%5BAuthor%5D&cauthor=true&cauthor_uid=17437873). An *in vitro* comparison of the antimicrobial effects of various endodontic medicaments on *Enterococcus faecalis*. [J Endod.](http://www.ncbi.nlm.nih.gov/pubmed/?term=An+in+vitro+comparison+of+antimicrobial+effects+of+various+endodontic+medicaments+on+Enterococcus+faecalis) 2007;33(5):567-9.
4. [Hancock HH 3rd](http://www.ncbi.nlm.nih.gov/pubmed/?term=Hancock%20HH%203rd%5BAuthor%5D&cauthor=true&cauthor_uid=11346739), [Sigurdsson A](http://www.ncbi.nlm.nih.gov/pubmed/?term=Sigurdsson%20A%5BAuthor%5D&cauthor=true&cauthor_uid=11346739), [Trope M](http://www.ncbi.nlm.nih.gov/pubmed/?term=Trope%20M%5BAuthor%5D&cauthor=true&cauthor_uid=11346739), [Moiseiwitsch J](http://www.ncbi.nlm.nih.gov/pubmed/?term=Moiseiwitsch%20J%5BAuthor%5D&cauthor=true&cauthor_uid=11346739). Bacteria isolated after unsuccessful endodontic treatment in a North American population. [Oral Surg Oral Med Oral Pathol Oral Radiol Endod.](http://www.ncbi.nlm.nih.gov/pubmed/?term=Bacteria+isolated+after+unsuccessful+endodontic+treatment+in+a+North+American+population) 2001;91(5):579-86.
5. [Stuart CH](http://www.ncbi.nlm.nih.gov/pubmed/?term=Stuart%20CH%5BAuthor%5D&cauthor=true&cauthor_uid=16427453), [Schwartz SA](http://www.ncbi.nlm.nih.gov/pubmed/?term=Schwartz%20SA%5BAuthor%5D&cauthor=true&cauthor_uid=16427453), [Beeson TJ](http://www.ncbi.nlm.nih.gov/pubmed/?term=Beeson%20TJ%5BAuthor%5D&cauthor=true&cauthor_uid=16427453), [Owatz CB](http://www.ncbi.nlm.nih.gov/pubmed/?term=Owatz%20CB%5BAuthor%5D&cauthor=true&cauthor_uid=16427453). *Enterococcus faecalis*: its role in root canal treatment failure and current concepts in retreatment. [J Endod.](http://www.ncbi.nlm.nih.gov/pubmed/?term=Enterococcus+faecalis%3A+its+role+in+root+canal+treatment+failure+and+current+concepts+and+retreatment) 2006;32(2):93-8.
6. [Gomes BP](http://www.ncbi.nlm.nih.gov/pubmed/?term=Gomes%20BP%5BAuthor%5D&cauthor=true&cauthor_uid=14871344), [Pinheiro ET](http://www.ncbi.nlm.nih.gov/pubmed/?term=Pinheiro%20ET%5BAuthor%5D&cauthor=true&cauthor_uid=14871344), [Gadê-Neto CR](http://www.ncbi.nlm.nih.gov/pubmed/?term=Gad%C3%AA-Neto%20CR%5BAuthor%5D&cauthor=true&cauthor_uid=14871344), [Sousa EL](http://www.ncbi.nlm.nih.gov/pubmed/?term=Sousa%20EL%5BAuthor%5D&cauthor=true&cauthor_uid=14871344), [Ferraz CC](http://www.ncbi.nlm.nih.gov/pubmed/?term=Ferraz%20CC%5BAuthor%5D&cauthor=true&cauthor_uid=14871344), [Zaia AA](http://www.ncbi.nlm.nih.gov/pubmed/?term=Zaia%20AA%5BAuthor%5D&cauthor=true&cauthor_uid=14871344), [Teixeira FB](http://www.ncbi.nlm.nih.gov/pubmed/?term=Teixeira%20FB%5BAuthor%5D&cauthor=true&cauthor_uid=14871344), [Souza-Filho FJ](http://www.ncbi.nlm.nih.gov/pubmed/?term=Souza-Filho%20FJ%5BAuthor%5D&cauthor=true&cauthor_uid=14871344). Microbiological examination of infected dental root canals. [Oral Microbiol Immunol.](http://www.ncbi.nlm.nih.gov/pubmed/14871344) 2004;19(2):71-6.
7. Pinheiro ET, Gomes BPFA, Ferraz CCR, Teixeira FB, Zaia AA, Souza-Filho FJ. Evaluation of root canal microorganisms isolated from teeth with endodontic failure and their antimicrobial susceptibility. Oral Microbiol Immunol 2003;18:100 –3.
8. [Sundqvist G](http://www.ncbi.nlm.nih.gov/pubmed/?term=Sundqvist%20G%5BAuthor%5D&cauthor=true&cauthor_uid=9474621), [Figdor D](http://www.ncbi.nlm.nih.gov/pubmed/?term=Figdor%20D%5BAuthor%5D&cauthor=true&cauthor_uid=9474621), [Persson S](http://www.ncbi.nlm.nih.gov/pubmed/?term=Persson%20S%5BAuthor%5D&cauthor=true&cauthor_uid=9474621), [Sjögren U](http://www.ncbi.nlm.nih.gov/pubmed/?term=Sj%C3%B6gren%20U%5BAuthor%5D&cauthor=true&cauthor_uid=9474621). Microbiologic analysis of teeth with failed endodontic treatment and the outcome of conservative re-treatment. [Oral Surg Oral Med Oral Pathol Oral Radiol Endod.](http://www.ncbi.nlm.nih.gov/pubmed/?term=Microbiologic+analysis+of+teeth+with+failed+endodontic+treatment+and+the+outcome+of+conservative+re-treatment) 1998 Jan;85(1):86-93.
9. Siqueira JF, Rôças I. Polymerase chain reaction-based analysis of microorganisms associated with failed endodontic treatment. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2004;97:85–94.
10. Rocas IN, Siqueira JF, Santos KRN. Association of *Enterococcus faecalis* with different forms of periradicular diseases. J Endod 2004;30:315–20.
11. Siqueira JF Jr., Rôças IN, Favieri A, Lima KC. Chemomechanical reduction of the bacterial population in the root canal after instrumentation and irrigation with 1%, 2.5% and 5.25% sodium hypochlorite. J Endod 2002;26:331–34.
12. Torabinejad M, Handysides R, Khademi AA, Bakland LK. Clinical implications of the smear layer in endodontics: a review. Oral Surg Oral Med Oral Pathol Oral Radiol Endodontol 2002; 94: 658-66.
13. [Violich DR](http://www.ncbi.nlm.nih.gov/pubmed/?term=Violich%20DR%5BAuthor%5D&cauthor=true&cauthor_uid=20002799), [Chandler NP](http://www.ncbi.nlm.nih.gov/pubmed/?term=Chandler%20NP%5BAuthor%5D&cauthor=true&cauthor_uid=20002799). The smear layer in endodontics - a review. [Int Endod J.](http://www.ncbi.nlm.nih.gov/pubmed/20002799) 2010;43(1):2-15.
14. Giardino L, Ambu E, Savoldi E, Rimondini R, Cassanelli C, Debbia EA. Comparative evaluation of antimicrobial efficacy of sodium hypochlorite, MTAD, and Tetraclean against *Enterococcus faecalis* biofilm. J Endod 2007;33:852-855.
15. Zehnder M. Root canal irrigants. J Endod 2006; 32: 389-98.
16. [Fedorowicz Z](http://www.ncbi.nlm.nih.gov/pubmed/?term=Fedorowicz%20Z%5BAuthor%5D&cauthor=true&cauthor_uid=22972129), [Nasser M](http://www.ncbi.nlm.nih.gov/pubmed/?term=Nasser%20M%5BAuthor%5D&cauthor=true&cauthor_uid=22972129), [Sequeira-Byron P](http://www.ncbi.nlm.nih.gov/pubmed/?term=Sequeira-Byron%20P%5BAuthor%5D&cauthor=true&cauthor_uid=22972129), [de Souza RF](http://www.ncbi.nlm.nih.gov/pubmed/?term=de%20Souza%20RF%5BAuthor%5D&cauthor=true&cauthor_uid=22972129), [Carter B](http://www.ncbi.nlm.nih.gov/pubmed/?term=Carter%20B%5BAuthor%5D&cauthor=true&cauthor_uid=22972129), [Heft M](http://www.ncbi.nlm.nih.gov/pubmed/?term=Heft%20M%5BAuthor%5D&cauthor=true&cauthor_uid=22972129). Irrigants for non-surgical root canal treatment in mature permanent teeth. [Cochrane Database Syst Rev.](http://www.ncbi.nlm.nih.gov/pubmed/?term=Irrigants+for+non-surgical+root+canal+treatment+in+mature+permanent+teeth) 2012;12(9):CD008948. <http://dx.doi.org/10.1002/14651858.CD008948.pub2>
17. Parle M, Bansal N. Herbal medicines: Are they safe? – Natural Product Radiance 2006;5: 6-14.
18. [Sinha DJ](http://www.ncbi.nlm.nih.gov/pubmed/?term=Sinha%20DJ%5BAuthor%5D&cauthor=true&cauthor_uid=25558153), [Sinha AA](http://www.ncbi.nlm.nih.gov/pubmed/?term=Sinha%20AA%5BAuthor%5D&cauthor=true&cauthor_uid=25558153). Natural medicaments in dentistry. [Ayu.](http://www.ncbi.nlm.nih.gov/pubmed/25558153) 2014;35(2):113-8. <http://dx.doi.org/10.4103/0974-8520.146198>
19. [Groppo FC](http://www.ncbi.nlm.nih.gov/pubmed/?term=Groppo%20FC%5BAuthor%5D&cauthor=true&cauthor_uid=18570269), [Bergamaschi Cde C](http://www.ncbi.nlm.nih.gov/pubmed/?term=Bergamaschi%20Cde%20C%5BAuthor%5D&cauthor=true&cauthor_uid=18570269), [Cogo K](http://www.ncbi.nlm.nih.gov/pubmed/?term=Cogo%20K%5BAuthor%5D&cauthor=true&cauthor_uid=18570269), [Franz-Montan M](http://www.ncbi.nlm.nih.gov/pubmed/?term=Franz-Montan%20M%5BAuthor%5D&cauthor=true&cauthor_uid=18570269), [Motta RH](http://www.ncbi.nlm.nih.gov/pubmed/?term=Motta%20RH%5BAuthor%5D&cauthor=true&cauthor_uid=18570269), [de Andrade ED](http://www.ncbi.nlm.nih.gov/pubmed/?term=de%20Andrade%20ED%5BAuthor%5D&cauthor=true&cauthor_uid=18570269). Use of phytotherapy in dentistry. [Phytother Res.](http://www.ncbi.nlm.nih.gov/pubmed/18570269) 2008;22(8):993-8. <http://dx.doi.org/10.1002/ptr.2471>
20. Ravishankar.P, Lakshmi.T, Aravind Kumar.S. Ethno-botanical approach for root canal treatment –an update. J. Pharm. Sci. & Res. 2011;3(10),1511-1519.
21. [Castilho AL](http://www.ncbi.nlm.nih.gov/pubmed/?term=Castilho%20AL%5BAuthor%5D&cauthor=true&cauthor_uid=23538423), [Saraceni CH](http://www.ncbi.nlm.nih.gov/pubmed/?term=Saraceni%20CH%5BAuthor%5D&cauthor=true&cauthor_uid=23538423), [Díaz IE](http://www.ncbi.nlm.nih.gov/pubmed/?term=D%C3%ADaz%20IE%5BAuthor%5D&cauthor=true&cauthor_uid=23538423), [Paciencia ML](http://www.ncbi.nlm.nih.gov/pubmed/?term=Paciencia%20ML%5BAuthor%5D&cauthor=true&cauthor_uid=23538423), [Suffredini IB](http://www.ncbi.nlm.nih.gov/pubmed/?term=Suffredini%20IB%5BAuthor%5D&cauthor=true&cauthor_uid=23538423). New trends in dentistry: plant extracts against *Enterococcus faecalis*. The efficacy compared to chlorhexidine. [Braz Oral Res.](http://www.ncbi.nlm.nih.gov/pubmed/?term=New+trends+in+dentistry%3A+plant+extracts+against+Enterococcus+faecalis.+The+efficacy+compared+to+chlorhexidine) 2013;27(2):109-15.
22. [Rosaline H](http://www.ncbi.nlm.nih.gov/pubmed/?term=Rosaline%20H%5BAuthor%5D&cauthor=true&cauthor_uid=23956540), [Kandaswamy D](http://www.ncbi.nlm.nih.gov/pubmed/?term=Kandaswamy%20D%5BAuthor%5D&cauthor=true&cauthor_uid=23956540), [Gogulnath D](http://www.ncbi.nlm.nih.gov/pubmed/?term=Gogulnath%20D%5BAuthor%5D&cauthor=true&cauthor_uid=23956540), [Rubin M](http://www.ncbi.nlm.nih.gov/pubmed/?term=Rubin%20M%5BAuthor%5D&cauthor=true&cauthor_uid=23956540). Influence of various herbal irrigants as a final rinse on the adherence of *Enterococcus faecalis* by fluorescence confocal laser scanning microscope. [J Conserv Dent.](http://www.ncbi.nlm.nih.gov/pubmed/?term=Influence+of+various+herbal+irrigants+as+a+final+rinse+on+the+adherence+of+Enterococcus+faecalis+by+fluorescence+confocal+laser+scanning+microscope) 2013;16(4):352-5.
23. [Marickar RF](http://www.ncbi.nlm.nih.gov/pubmed/?term=Marickar%20RF%5BAuthor%5D&cauthor=true&cauthor_uid=25631726), [Geetha RV](http://www.ncbi.nlm.nih.gov/pubmed/?term=Geetha%20RV%5BAuthor%5D&cauthor=true&cauthor_uid=25631726), [Neelakantan P](http://www.ncbi.nlm.nih.gov/pubmed/?term=Neelakantan%20P%5BAuthor%5D&cauthor=true&cauthor_uid=25631726). Efficacy of contemporary and novel Intracanal medicaments against *Enterococcus faecalis*. [J Clin Pediatr Dent.](http://www.ncbi.nlm.nih.gov/pubmed/25631726) 2014;39(1):47-50.
24. [Neelakantan P](http://www.ncbi.nlm.nih.gov/pubmed/?term=Neelakantan%20P%5BAuthor%5D&cauthor=true&cauthor_uid=23394209), [Subbarao C](http://www.ncbi.nlm.nih.gov/pubmed/?term=Subbarao%20C%5BAuthor%5D&cauthor=true&cauthor_uid=23394209), [Sharma S](http://www.ncbi.nlm.nih.gov/pubmed/?term=Sharma%20S%5BAuthor%5D&cauthor=true&cauthor_uid=23394209), [Subbarao CV](http://www.ncbi.nlm.nih.gov/pubmed/?term=Subbarao%20CV%5BAuthor%5D&cauthor=true&cauthor_uid=23394209), [Garcia-Godoy F](http://www.ncbi.nlm.nih.gov/pubmed/?term=Garcia-Godoy%20F%5BAuthor%5D&cauthor=true&cauthor_uid=23394209), [Gutmann JL](http://www.ncbi.nlm.nih.gov/pubmed/?term=Gutmann%20JL%5BAuthor%5D&cauthor=true&cauthor_uid=23394209). Effectiveness of *Curcumin* against *Enterococcus faecalis* biofilm. Acta Odontol Scand. 2013 Nov;71(6):1453-7. <http://dx.doi.org/10.3109/00016357.2013.769627>
25. [Silva FB](http://www.ncbi.nlm.nih.gov/pubmed/?term=Silva%20FB%5BAuthor%5D&cauthor=true&cauthor_uid=15311323), [Almeida JM](http://www.ncbi.nlm.nih.gov/pubmed/?term=Almeida%20JM%5BAuthor%5D&cauthor=true&cauthor_uid=15311323), [Sousa SM](http://www.ncbi.nlm.nih.gov/pubmed/?term=Sousa%20SM%5BAuthor%5D&cauthor=true&cauthor_uid=15311323). Natural medicaments in endodontics – a comparative study of the anti-inflammatory action. [Braz Oral Res.](http://www.ncbi.nlm.nih.gov/pubmed/?term=Natural+medicaments+in+endodontics+%E2%80%93+a+comparative+study+of+the+anti-inflammatory+action) 2004;18(2):174-9
26. [Oncag O](http://www.ncbi.nlm.nih.gov/pubmed/?term=Oncag%20O%5BAuthor%5D&cauthor=true&cauthor_uid=17004565), [Cogulu D](http://www.ncbi.nlm.nih.gov/pubmed/?term=Cogulu%20D%5BAuthor%5D&cauthor=true&cauthor_uid=17004565), [Uzel A](http://www.ncbi.nlm.nih.gov/pubmed/?term=Uzel%20A%5BAuthor%5D&cauthor=true&cauthor_uid=17004565), [Sorkun K](http://www.ncbi.nlm.nih.gov/pubmed/?term=Sorkun%20K%5BAuthor%5D&cauthor=true&cauthor_uid=17004565). Efficacy of propolis as an intracanal medicament against *Enterococcus faecalis*. Gen Dent. 2006;54(5):319-22.
27. [Hayacibara MF](http://www.ncbi.nlm.nih.gov/pubmed/?term=Hayacibara%20MF%5BAuthor%5D&cauthor=true&cauthor_uid=15913934), [Koo H](http://www.ncbi.nlm.nih.gov/pubmed/?term=Koo%20H%5BAuthor%5D&cauthor=true&cauthor_uid=15913934), [Rosalen PL](http://www.ncbi.nlm.nih.gov/pubmed/?term=Rosalen%20PL%5BAuthor%5D&cauthor=true&cauthor_uid=15913934), [Duarte S](http://www.ncbi.nlm.nih.gov/pubmed/?term=Duarte%20S%5BAuthor%5D&cauthor=true&cauthor_uid=15913934), [Franco EM](http://www.ncbi.nlm.nih.gov/pubmed/?term=Franco%20EM%5BAuthor%5D&cauthor=true&cauthor_uid=15913934), [Bowen WH](http://www.ncbi.nlm.nih.gov/pubmed/?term=Bowen%20WH%5BAuthor%5D&cauthor=true&cauthor_uid=15913934), [Ikegaki M](http://www.ncbi.nlm.nih.gov/pubmed/?term=Ikegaki%20M%5BAuthor%5D&cauthor=true&cauthor_uid=15913934), [Cury JA](http://www.ncbi.nlm.nih.gov/pubmed/?term=Cury%20JA%5BAuthor%5D&cauthor=true&cauthor_uid=15913934). *In vitro* and *in vivo* effects of isolated fractions of Brazilian propolis on caries development. [J Ethnopharmacol.](http://www.ncbi.nlm.nih.gov/pubmed/?term=In+vitro+and+in+vivo+effects+of+isolated+fractions+of+Brazilian+propolis+on+caries+development) 2005;3:101(1-3):110-5.
28. [Toker H](http://www.ncbi.nlm.nih.gov/pubmed/?term=Toker%20H%5BAuthor%5D&cauthor=true&cauthor_uid=18533788), [Ozan F](http://www.ncbi.nlm.nih.gov/pubmed/?term=Ozan%20F%5BAuthor%5D&cauthor=true&cauthor_uid=18533788), [Ozer H](http://www.ncbi.nlm.nih.gov/pubmed/?term=Ozer%20H%5BAuthor%5D&cauthor=true&cauthor_uid=18533788), [Ozdemir H](http://www.ncbi.nlm.nih.gov/pubmed/?term=Ozdemir%20H%5BAuthor%5D&cauthor=true&cauthor_uid=18533788), [Eren K](http://www.ncbi.nlm.nih.gov/pubmed/?term=Eren%20K%5BAuthor%5D&cauthor=true&cauthor_uid=18533788), [Yeler H](http://www.ncbi.nlm.nih.gov/pubmed/?term=Yeler%20H%5BAuthor%5D&cauthor=true&cauthor_uid=18533788). A morphometric and histopathologic evaluation of the effects of propolis on alveolar bone loss in experimental periodontitis in rats. [J Periodontol.](http://www.ncbi.nlm.nih.gov/pubmed/?term=A+morphometic+and+histopathologic+evaluation+of+the+effects+of+Propolis+on+alveolar+bone+loss+in+experimental+periodontitis+in+rats) 2008;79(6):1089-94.
29. Al-Qathami H, Al-Madi E, Comparison of sodium hypochlorite, propolis and saline as root canal irrigants: A pilot study, Saudi Dental J 2003;15(2):100-103.
30. [Sabir A](http://www.ncbi.nlm.nih.gov/pubmed/?term=Sabir%20A%5BAuthor%5D&cauthor=true&cauthor_uid=16313091), [Tabbu CR](http://www.ncbi.nlm.nih.gov/pubmed/?term=Tabbu%20CR%5BAuthor%5D&cauthor=true&cauthor_uid=16313091), [Agustiono P](http://www.ncbi.nlm.nih.gov/pubmed/?term=Agustiono%20P%5BAuthor%5D&cauthor=true&cauthor_uid=16313091), [Sosroseno W](http://www.ncbi.nlm.nih.gov/pubmed/?term=Sosroseno%20W%5BAuthor%5D&cauthor=true&cauthor_uid=16313091). Histological analysis of rat dental pulp tissue capped with propolis. [J Oral Sci.](http://www.ncbi.nlm.nih.gov/pubmed/?term=Histological+analysis+of+rat+dental+pulp+tissue+capped+with+propolis%2C) 2005;47(3):135-8.
31. [Carbajal Mejía JB](http://www.ncbi.nlm.nih.gov/pubmed/?term=Carbajal%20Mej%C3%ADa%20JB%5BAuthor%5D&cauthor=true&cauthor_uid=23559565). Antimicrobial effects of calcium hydroxide, chlorhexidine, and propolis on *Enterococcus faecalis* and *Candida albicans*. [J Investig Clin Dent.](http://www.ncbi.nlm.nih.gov/pubmed/23559565) 2014;5(3):194-200.
32. [Kandaswamy D](http://www.ncbi.nlm.nih.gov/pubmed/?term=Kandaswamy%20D%5BAuthor%5D&cauthor=true&cauthor_uid=20518935), [Venkateshbabu N](http://www.ncbi.nlm.nih.gov/pubmed/?term=Venkateshbabu%20N%5BAuthor%5D&cauthor=true&cauthor_uid=20518935), [Gogulnath D](http://www.ncbi.nlm.nih.gov/pubmed/?term=Gogulnath%20D%5BAuthor%5D&cauthor=true&cauthor_uid=20518935), [Kindo AJ](http://www.ncbi.nlm.nih.gov/pubmed/?term=Kindo%20AJ%5BAuthor%5D&cauthor=true&cauthor_uid=20518935). Dentinal tubule disinfection with 2% chlorhexidine gel, propolis, *morinda citrifolia* juice, 2% povidone iodine, and calcium hydroxide. [Int Endod J.](http://www.ncbi.nlm.nih.gov/pubmed/?term=Dentinal+tubule+disinfection+with+2%25+chlorhexidine+gel%2C+propolis%2C+morinda+citrifolia+juice%2C+2%25+povidone+iodine%2C+and+calcium+hydroxide.) 2010;43(5):419-23. <http://dx.doi.org/10.1111/j.1365-2591.2010.01696.x>
33. [Verma MK](http://www.ncbi.nlm.nih.gov/pubmed/?term=Verma%20MK%5BAuthor%5D&cauthor=true&cauthor_uid=24739910), [Pandey RK](http://www.ncbi.nlm.nih.gov/pubmed/?term=Pandey%20RK%5BAuthor%5D&cauthor=true&cauthor_uid=24739910), [Khanna R](http://www.ncbi.nlm.nih.gov/pubmed/?term=Khanna%20R%5BAuthor%5D&cauthor=true&cauthor_uid=24739910), [Agarwal J](http://www.ncbi.nlm.nih.gov/pubmed/?term=Agarwal%20J%5BAuthor%5D&cauthor=true&cauthor_uid=24739910). The antimicrobial effectiveness of 25% propolis extract in root canal irrigation of primary teeth. [J Indian Soc Pedod Prev Dent.](http://www.ncbi.nlm.nih.gov/pubmed/?term=The+antimicrobial+effectiveness+of+25%25+propolis+extract+in+root+canal+irrigation+of+primary+teeth) 2014;32(2):120-4. <http://dx.doi.org/10.4103/0970-4388.130786>
34. [Khan R](http://www.ncbi.nlm.nih.gov/pubmed/?term=Khan%20R%5BAuthor%5D&cauthor=true&cauthor_uid=19214149), [Islam B](http://www.ncbi.nlm.nih.gov/pubmed/?term=Islam%20B%5BAuthor%5D&cauthor=true&cauthor_uid=19214149), [Akram M](http://www.ncbi.nlm.nih.gov/pubmed/?term=Akram%20M%5BAuthor%5D&cauthor=true&cauthor_uid=19214149), [Shakil S](http://www.ncbi.nlm.nih.gov/pubmed/?term=Shakil%20S%5BAuthor%5D&cauthor=true&cauthor_uid=19214149), [Ahmad A](http://www.ncbi.nlm.nih.gov/pubmed/?term=Ahmad%20A%5BAuthor%5D&cauthor=true&cauthor_uid=19214149), [Ali SM](http://www.ncbi.nlm.nih.gov/pubmed/?term=Ali%20SM%5BAuthor%5D&cauthor=true&cauthor_uid=19214149), [Siddiqui M](http://www.ncbi.nlm.nih.gov/pubmed/?term=Siddiqui%20M%5BAuthor%5D&cauthor=true&cauthor_uid=19214149), [Khan AU](http://www.ncbi.nlm.nih.gov/pubmed/?term=Khan%20AU%5BAuthor%5D&cauthor=true&cauthor_uid=19214149). Antimicrobial activity of five herbal extracts against multi drug resistant (MDR) strains of bacteria and fungus of clinical origin. [Molecules.](http://www.ncbi.nlm.nih.gov/pubmed/?term=Antimicrobial+Activity+of+Five+Herbal+Extracts+Against+Multi+Drug+Resistant+%28MDR%29+Strains+of+Bacteria+and+Fungus+of+Clinical+Origin) 2009;14(2):586-97. <http://dx.doi.org/10.3390/molecules14020586>
35. Kumar D, Sidhu P. [The antimicrobial activity of *Azardirachta indica, Glycyrrhiza glabra, Cinnamum zeylanicum, Syzygium aromaticum, Acacia nilotica* on *Streptococcus mutans* and *Enterococcus faecalis* - An *in vitro* study](http://medind.nic.in/eaa/t11/i1/eaat11i1p16.pdf). Endodontology 2011;23(1):16‑23.
36. Almas K. The antimicrobial effects of extracts of *Azadirachta Indica* (Neem) and *Salvadora Persica* (Arak) chewing sticks. Indian J Dent Res 1999;10:23‑6.
37. [Lakshmi T](http://www.ncbi.nlm.nih.gov/pubmed/?term=Lakshmi%20T%5BAuthor%5D&cauthor=true&cauthor_uid=26009692), [Krishnan V](http://www.ncbi.nlm.nih.gov/pubmed/?term=Krishnan%20V%5BAuthor%5D&cauthor=true&cauthor_uid=26009692), [Rajendran R](http://www.ncbi.nlm.nih.gov/pubmed/?term=Rajendran%20R%5BAuthor%5D&cauthor=true&cauthor_uid=26009692), [Madhusudhanan N](http://www.ncbi.nlm.nih.gov/pubmed/?term=Madhusudhanan%20N%5BAuthor%5D&cauthor=true&cauthor_uid=26009692). *Azadirachta indica*: A herbal panacea in dentistry - An update. [Pharmacogn Rev.](http://www.ncbi.nlm.nih.gov/pubmed/?term=Azadirachta+indica%3A+A+herbal+panacea+in+dentistry+%E2%80%93+An+update) 2015;9(17):41-4. <http://dx.doi.org/10.4103/0973-7847.156337>
38. Bohora A, Hegde V, Kokate S. [Comparison of the antibacterial efficiency of neem leaf extract and 2% sodium hypochlorite against *E. faecalis*, *C. albicans* and mixed culture - An *in vitro* study.](http://medind.nic.in/eaa/t10/i1/eaat10i1p8.pdf)  Endodontology 2010;22(1):8‑12.
39. Dubey S, Chaodary M, Gupta P. Comparative study of the antimicrobial efficiency of Neem leaf extract, Sodium hypochlorite and Biopure MTAD -An *in vitro* study. Indian J Dent Adv 2012;(1):740-43.
40. [Mistry KS](http://www.ncbi.nlm.nih.gov/pubmed/?term=Mistry%20KS%5BAuthor%5D&cauthor=true&cauthor_uid=24966766), [Sanghvi Z](http://www.ncbi.nlm.nih.gov/pubmed/?term=Sanghvi%20Z%5BAuthor%5D&cauthor=true&cauthor_uid=24966766), [Parmar G](http://www.ncbi.nlm.nih.gov/pubmed/?term=Parmar%20G%5BAuthor%5D&cauthor=true&cauthor_uid=24966766), [Shah S](http://www.ncbi.nlm.nih.gov/pubmed/?term=Shah%20S%5BAuthor%5D&cauthor=true&cauthor_uid=24966766). The antimicrobial activity of *Azadirachta indica, Mimusops elengi, Tinospora cardifolia, Ocimum sanctum* and 2% chlorhexidine gluconate on common endodontic pathogens: An *in vitro* study. [Eur J Dent.](http://www.ncbi.nlm.nih.gov/pubmed/?term=The+antimicrobial+activity+of+Azadirachta+indica%2C+Mimusops+elengi%2C+Tinospora+cardifolia%2C+Ocimum+sanctum+and+2%25+chlorhexidine+gluconate+on+common+endodontic+pathogens%3A+An+in+vitro+study) 2014;8(2):172-7. <http://dx.doi.org/10.4103/1305-7456.130591>
41. Nayak A, Ranganathan N, Sowmya GB, Kishore B, Kudalkar M. Evaluation of antibacterial and anticandidial efficacy of aqueous and alcoholic effect of neem (*Azadirachta Indica*): An *In vitro* study. Int J Res Ayurveda Pharm 2011;2:230-5.
42. [George D](http://www.ncbi.nlm.nih.gov/pubmed/?term=George%20D%5BAuthor%5D&cauthor=true&cauthor_uid=19819812), [Bhat SS](http://www.ncbi.nlm.nih.gov/pubmed/?term=Bhat%20SS%5BAuthor%5D&cauthor=true&cauthor_uid=19819812), [Antony B](http://www.ncbi.nlm.nih.gov/pubmed/?term=Antony%20B%5BAuthor%5D&cauthor=true&cauthor_uid=19819812). Comparative evaluation of the antimicrobial efficacy of Aloe Vera tooth gel and two popular commercial toothpastes: an *in vitro* study. [Gen Dent.](http://www.ncbi.nlm.nih.gov/pubmed/?term=Comparitive+evaluation+of+the+antimicrobial+efficacy+of+aloe+vera+tooth+gel+and+two+popular+commercial+tooth+pastes) 2009;57(3):238-41.
43. [Karkare SR](http://www.ncbi.nlm.nih.gov/pubmed/?term=Karkare%20SR%5BAuthor%5D&cauthor=true&cauthor_uid=26381627), [Ahire NP](http://www.ncbi.nlm.nih.gov/pubmed/?term=Ahire%20NP%5BAuthor%5D&cauthor=true&cauthor_uid=26381627), [Khedkar SU](http://www.ncbi.nlm.nih.gov/pubmed/?term=Khedkar%20SU%5BAuthor%5D&cauthor=true&cauthor_uid=26381627). Comparative evaluation of antimicrobial activity of hydroalcoholic extract of Aloe Vera, garlic, and 5% sodium hypochlorite as root canal irrigants against *Enterococcus faecalis*: An *in vitro* study. [J Indian Soc Pedod Prev Dent.](http://www.ncbi.nlm.nih.gov/pubmed/?term=Comparative+evaluation+of+antimicrobial+activity+of+hydroalcoholic+extract+of+Aloe+vera%2C+garlic) 2015;33(4):274-8.
44. B. Sureshchandra, Arun JK. [Antibacterial efficacy of Aloe Vera extract on resistant antimicrobial strains in endodontics](http://medind.nic.in/eaa/t11/i1/eaat11i1p56.pdf). Endodontology 2011;23(1):56‑60.
45. Murray PE, Farber RM, [Namerow KN](http://www.ncbi.nlm.nih.gov/pubmed/?term=Namerow%20KN%5BAuthor%5D&cauthor=true&cauthor_uid=18155496), [Kuttler S](http://www.ncbi.nlm.nih.gov/pubmed/?term=Kuttler%20S%5BAuthor%5D&cauthor=true&cauthor_uid=18155496), [Garcia-Godoy F](http://www.ncbi.nlm.nih.gov/pubmed/?term=Garcia-Godoy%20F%5BAuthor%5D&cauthor=true&cauthor_uid=18155496). Evaluation of *Morinda citrifolia* as an Endodontic Irrigant. [J Endod.](http://www.ncbi.nlm.nih.gov/pubmed/?term=Evaluation+of+Morinda+citrifolia+as+an+Endodontic+Irrigant) 2008;34(1):66-70.
46. [Prabhakar](http://www.ijohsjournal.org/searchresult.asp?search=&author=AR+Prabhakar&journal=Y&but_search=Search&entries=10&pg=1&s=0) AR, [Basavraj](http://www.ijohsjournal.org/searchresult.asp?search=&author=Priyanka+Basavraj&journal=Y&but_search=Search&entries=10&pg=1&s=0) P, [Basappa](http://www.ijohsjournal.org/searchresult.asp?search=&author=N+Basappa&journal=Y&but_search=Search&entries=10&pg=1&s=0) N. Comparative evaluation of *Morinda citrifolia* with chlorhexidine as antimicrobial endodontic irrigants and their effect on micro-hardness of root canal dentin: An *in vitro* study. International Journal of Oral Health Sciences 2013;3(1):5-9.
47. [Prakash S](http://www.ncbi.nlm.nih.gov/pubmed/?term=Prakash%20S%5BAuthor%5D&cauthor=true&cauthor_uid=24872616), [Shelke AU](http://www.ncbi.nlm.nih.gov/pubmed/?term=Shelke%20AU%5BAuthor%5D&cauthor=true&cauthor_uid=24872616). Role of Triphala in dentistry. [J Indian Soc Periodontol.](http://www.ncbi.nlm.nih.gov/pubmed/?term=Role+of+Triphala+in+dentistry) 2014;18(2):132-5. <http://dx.doi.org/10.4103/0972-124X.131299>
48. [Taylor PW](http://www.ncbi.nlm.nih.gov/pubmed/?term=Taylor%20PW%5BAuthor%5D&cauthor=true&cauthor_uid=19844590), [Hamilton-Miller JM](http://www.ncbi.nlm.nih.gov/pubmed/?term=Hamilton-Miller%20JM%5BAuthor%5D&cauthor=true&cauthor_uid=19844590), [Stapleton PD](http://www.ncbi.nlm.nih.gov/pubmed/?term=Stapleton%20PD%5BAuthor%5D&cauthor=true&cauthor_uid=19844590). Antimicrobial properties of green tea catechins. [Food Sci Technol Bull.](http://www.ncbi.nlm.nih.gov/pubmed/19844590) 2005;2:71-81.
49. [Otake S](http://www.ncbi.nlm.nih.gov/pubmed/?term=Otake%20S%5BAuthor%5D&cauthor=true&cauthor_uid=1667297), [Makimura M](http://www.ncbi.nlm.nih.gov/pubmed/?term=Makimura%20M%5BAuthor%5D&cauthor=true&cauthor_uid=1667297), [Kuroki T](http://www.ncbi.nlm.nih.gov/pubmed/?term=Kuroki%20T%5BAuthor%5D&cauthor=true&cauthor_uid=1667297), [Nishihara Y](http://www.ncbi.nlm.nih.gov/pubmed/?term=Nishihara%20Y%5BAuthor%5D&cauthor=true&cauthor_uid=1667297), [Hirasawa M](http://www.ncbi.nlm.nih.gov/pubmed/?term=Hirasawa%20M%5BAuthor%5D&cauthor=true&cauthor_uid=1667297). Anticaries effects of polyphenolic compounds from Japanese green tea. [Caries Res.](http://www.ncbi.nlm.nih.gov/pubmed/?term=Anticaries+Effects+of+Polyphenolic+Compounds+from+Japanese+Green+Tea) 1991;25(6):438-43.
50. Pujar M, Patil C, Kadam A. Comparison of antimicrobial efficacy of Triphala, (GTP) Green tea polyphenols and 3% of sodium hypochlorite on *Enterococcus faecalis* biofilms formed on tooth substrate: *in vitro*. JIOH 2011;3(2):23-29.
51. [Prabhakar J](http://www.ncbi.nlm.nih.gov/pubmed/?term=Prabhakar%20J%5BAuthor%5D&cauthor=true&cauthor_uid=20003940), [Senthilkumar M](http://www.ncbi.nlm.nih.gov/pubmed/?term=Senthilkumar%20M%5BAuthor%5D&cauthor=true&cauthor_uid=20003940), [Priya MS](http://www.ncbi.nlm.nih.gov/pubmed/?term=Priya%20MS%5BAuthor%5D&cauthor=true&cauthor_uid=20003940), [Mahalakshmi K](http://www.ncbi.nlm.nih.gov/pubmed/?term=Mahalakshmi%20K%5BAuthor%5D&cauthor=true&cauthor_uid=20003940), [Sehgal PK](http://www.ncbi.nlm.nih.gov/pubmed/?term=Sehgal%20PK%5BAuthor%5D&cauthor=true&cauthor_uid=20003940), [Sukumaran VG](http://www.ncbi.nlm.nih.gov/pubmed/?term=Sukumaran%20VG%5BAuthor%5D&cauthor=true&cauthor_uid=20003940). Evaluation of Antimicrobial Efficacy of Herbal Alternatives (Triphala and Green Tea Polyphenols), MTAD, and 5% Sodium Hypochlorite against *Enterococcus faecalis* Biofilm Formed on Tooth Substrate: An *in Vitro* Study. [J Endod.](http://www.ncbi.nlm.nih.gov/pubmed/?term=Evaluation+of+Antimicrobial+Efficacy+of+Herbal+Alternatives+%28Triphala+and+Green+Tea+Polyphenols%29%2C+MTAD%2C+and+5%25+Sodium+Hypochlorite) 2010;36(1):83-6.
52. Kamath U, Sheth H, Ramesh S, Singla K. Comparison of the antibacterial efficacy of tea tree oil with 3% sodium hypochlorite and 2% Chlorhexidine against *E.faecalis*: An *in vitro* study. Journal of Contemporary Dentistry, 3(3), 2013, 117-120.
53. Sadr Lahijani MS, Raoof Kateb HR, Heady R, Yazdani D. The effect of German chamomile (*Marticaria recutitia L*.) extract and tea tree (*Melaleuca alternifolia L*.) oil used as irrigants on removal of smear layer: a scanning electron microscopy study. [Int Endod J.](http://www.ncbi.nlm.nih.gov/pubmed/?term=The+effect+of+German+chamomile+%28Marticaria+recutitia+L.%29+extract+and+tea+tree+%28+Melaleuca+alternifolia+L.%29+oil+used+as+irrigants+on+removal+of+smear+layer) 2006;39(3):190-5.
54. [Balto H](http://www.ncbi.nlm.nih.gov/pubmed/?term=Balto%20H%5BAuthor%5D&cauthor=true&cauthor_uid=23960532), [Ghandourah B](http://www.ncbi.nlm.nih.gov/pubmed/?term=Ghandourah%20B%5BAuthor%5D&cauthor=true&cauthor_uid=23960532), [Al-Sulaiman H](http://www.ncbi.nlm.nih.gov/pubmed/?term=Al-Sulaiman%20H%5BAuthor%5D&cauthor=true&cauthor_uid=23960532). The efficacy of *Salvadora persica* extract in the elimination of the intracanal smear layer: A SEM study. [Saudi Dent J.](http://www.ncbi.nlm.nih.gov/pubmed/?term=The+efficacy+of+Salvadora+persica+extract+in+the+elimination+of+the+intracanal+smear+layer%3A+A+SEM+study) 2012;24(2):71-7. <http://dx.doi.org/10.1016/j.sdentj.2012.01.002>
55. [Shingare P](http://www.ncbi.nlm.nih.gov/pubmed/?term=Shingare%20P%5BAuthor%5D&cauthor=true&cauthor_uid=24432254), [Chaugule V](http://www.ncbi.nlm.nih.gov/pubmed/?term=Chaugule%20V%5BAuthor%5D&cauthor=true&cauthor_uid=24432254). Comparative evaluation of antimicrobial activity of miswak, propolis, sodium hypochlorite and saline as root canal irrigants by microbial culturing and quantification in chronically exposed primary teeth. [Germs.](http://www.ncbi.nlm.nih.gov/pubmed/?term=Antimicrobial+Activity+miswak+as+Root+Canal+Irrigant) 2011;1(1):12-21. <http://dx.doi.org/10.11599/germs.2012.1004>
56. [Al-Obaida MI](http://www.ncbi.nlm.nih.gov/pubmed/?term=Al-Obaida%20MI%5BAuthor%5D&cauthor=true&cauthor_uid=20563361), [Al-Essa MA](http://www.ncbi.nlm.nih.gov/pubmed/?term=Al-Essa%20MA%5BAuthor%5D&cauthor=true&cauthor_uid=20563361), [Asiri AA](http://www.ncbi.nlm.nih.gov/pubmed/?term=Asiri%20AA%5BAuthor%5D&cauthor=true&cauthor_uid=20563361), [Al-Rahla AA](http://www.ncbi.nlm.nih.gov/pubmed/?term=Al-Rahla%20AA%5BAuthor%5D&cauthor=true&cauthor_uid=20563361). Effectiveness of a 20% Miswak extract against a mixture of Candida albicans and Enterococcus faecalis. [Saudi Med J.](http://www.ncbi.nlm.nih.gov/pubmed/?term=Al-Rahla%20AA%5BAuthor%5D&cauthor=true&cauthor_uid=20563361) 2010;31(6):640-3.

# Table legends

**Table 1** Plant extracts efficacious against *Enterococcus faecalis*

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| --- | --- | --- | --- | --- | --- |
| Sl. No. | Scientific name | Common name | Pharmacological active components | Type of extract | [**References**](http://www.scialert.net/asci/result.php?searchin=Keywords&cat=&ascicat=ALL&Submit=Search&keyword=antibacterial+activity) |
| 1. | ***Curcuma longa***  | Turmeric, Indian saffron, Yellow ginger | Zingiberene, curcumin, α and β turmerone | Ethyl acetate, methanol and water extracts | [Marickar](http://www.ncbi.nlm.nih.gov/pubmed/?term=Marickar%20RF%5BAuthor%5D&cauthor=true&cauthor_uid=25631726) et al (2014), [Neelakantan](http://www.ncbi.nlm.nih.gov/pubmed/?term=Neelakantan%20P%5BAuthor%5D&cauthor=true&cauthor_uid=23394209) et al (2013) |
| 2.  | ***Propolis*** | Beeswax | Flavonoids, Aromatic acids, Esters present in Resins, Galangin, Pinocembrin | Ethanol, chloroform, methanol, propylene glycol | [Oncag O](http://www.ncbi.nlm.nih.gov/pubmed/?term=Oncag%20O%5BAuthor%5D&cauthor=true&cauthor_uid=17004565) et al (2006) , Al-Qathami H et al (2003), [Kandaswamy](http://www.ncbi.nlm.nih.gov/pubmed/?term=Kandaswamy%20D%5BAuthor%5D&cauthor=true&cauthor_uid=20518935) et al (2010) |
| 3.  | ***Aloe vera*** | Star cactus, Barbados | Latex, Glucomannan, mannose derivatives, hemicellulose, calcium oxalate | Aqueous, Ethanol and methanolic extracts | George et al (2009), Karkare et al(2015), Sureshchandra et al(2011) |
| 4. | ***Azadirachta indica*** | Neem, Holy tree | Azadirachtin, nimbin, gallic acid, catechin | Aqueous, Ethanol and methanolic extracts from seeds, leaves and roots | Nayak et al (2011) |
| 5. | ***Morinda citrifolia*** | Indian mulberry, Painkiller bush, Cheese fruit, Beach mulberry | L-asperuloside, Acubin, Alizarin kaempferol, Octanoic acid, Ascorbic acid, Ricinoleic acid | Aqueous, Ethanol, chloroform and methanolic extracts from seeds, leaves, fruits and roots | Murray et al(2008) , Prabhakar et al(2013) |
| 6. | ***Salvadora persica*** | Miswak, Arak tree, Toothbrush tree | Trimethyleamine, Salvadorine, Resins, Flavodine, Saponins, Sterol, And Fluoride | Aqueous, Ethanol and methanolic extracts | Balto et al (2012), Shingare et al (2012) |