

# Antimicrobial efficacy of calcium hydroxide, propolis, and *Aloe vera* as intracanal medicament - A review

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## ABSTRACT

The goal of endodontic treatment is to remove the diseased pulp tissue and to provide an environment that is conducive to allow the healing of periapical tissues and maintain the roots of the tooth in a healthy periodontium. Various disadvantages have been associated with chemical medicaments such as antibiotic overuse and misuse, side effects, and cytotoxic reaction. To overcome these side effects, herbal and natural products have become popular. The aim of this review is to evaluate the antimicrobial efficacy of two natural intracanal medicaments, namely, propolis and *Aloe vera*, in comparison with calcium hydroxide in a root canal system. A web-based research on MEDLINE was done using keywords, published dental journals. Keywords used for a research were antimicrobial efficacy, propolis, *A. vera*, calcium hydroxide, and intracanal medicament. This review article screened about 23 articles, and then, the relevant information was compiled. Based on the evidence available, it can be concluded that propolis and *A. vera* can be used as effective alternate intracanal medicament in comparison with calcium hydroxide in a root canal system. Although *in vitro* studies show the significant antimicrobial efficacy of these natural medicaments in comparison with calcium hydroxide, clinical trials have to be conducted to extrapolate these results in a clinical scenario.

**Keywords:** Antimicrobial efficacy, propolis, *Aloe vera*, calcium hydroxide, intracanal medicament

## Introduction

Effective disinfection and complete debridement of the root canal space are an important prerequisite for achieving long-term success of non-surgical endodontics,<sup>[1]</sup> as the treatment outcome for teeth with apical periodontitis depends on the effective disinfection of the root canal.<sup>[2,3]</sup> Chemomechanical cleaning and shaping of the root canal are of help to reduce the number of microorganisms but not completely eliminate them.<sup>[4]</sup>

Effective antimicrobial treatment protocol should be used to reduce the effect of bacterial endotoxins to a minimum allowing the defense system of the host to take over and provide a favorable environment for healing.<sup>[5,6]</sup> Applying an interappointment antimicrobial dressing in infected root canals is recommended, as instrumentation and irrigation do not reliably eradicate all of the bacteria.<sup>[7]</sup> Chemical medicaments are associated with several disadvantages such as antibiotic misuse

and overuse, cytotoxic reaction, and side effects. Owing to these side effects, natural and herbal products have become popular.<sup>[8]</sup>

The purpose of this review is to evaluate the antimicrobial efficacy of two natural intracanal medicaments, namely, propolis and *Aloe vera*, in comparison with calcium hydroxide in a root canal system.

## Materials and Methods

A web-based research on MEDLINE (www.pubmed.gov) was done. To limit our research to relevant articles, the search was filtered using keywords, published in the past 10 years and dental journals. Keywords used for research were antimicrobial efficacy, calcium hydroxide, propolis, *A. vera*, and intracanal medicament. Relevant articles were chosen to get the desired knowledge update. This review article screened about 23 articles comparing the antimicrobial efficacy of calcium hydroxide, propolis, and *A. vera*, and then, the relevant information was compiled.

## Background on *Enterococcus faecalis*

*E. faecalis* is a Gram-positive bacterium, which is a facultative anaerobic bacterium, recovered from previously root-filled teeth with persistent periapical lesions.<sup>[9,10]</sup> The characteristics of this bacterium that makes it a persisting endodontic pathogen are its ability to invade dentinal tubules, withstand the ecologically demanding conditions of the root canal, and adapt to lethal challenges.<sup>[11]</sup> Numerous studies have

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shown that calcium hydroxide [ $\text{Ca}(\text{OH})_2$ ] cannot eliminate *E. faecalis* completely, though currently it is the most common endodontic disinfectant in use.<sup>[12-14]</sup> On the other hand, disinfectants such as iodine potassium iodide, chlorhexidine, or their combinations with  $\text{Ca}(\text{OH})_2$  have been found to be superior to  $\text{Ca}(\text{OH})_2$  alone in reducing the number of viable cells of *E. faecalis*.<sup>[14-16]</sup> Complete elimination of the bacteria is not guaranteed with the use of these agents.

### Calcium hydroxide as intracanal medicament

Calcium hydroxide is one of the most commonly used intracanal medicaments. Its high pH (about 12.5) alters the biological properties in the cell walls of Gram-negative species, namely, the bacterial lipopolysaccharides, thus inactivating the membrane transport mechanisms. However, the buffering action of dentin neutralizes the action of calcium hydroxide at deeper layers of dentinal tubules, resulting in the survival of microorganisms.<sup>[17,18]</sup> Several studies have reported the failure of  $\text{Ca}(\text{OH})_2$  to eliminate enterococci effectively as they tolerate high pH values, varying from 9 to 11.<sup>[19]</sup>

### Propolis as intracanal medicament

Propolis is a natural product wherein it is a resin-like substance, rich in flavonoid, which is produced from poplar and coniferous trees or *Clusia* flowers by bees. This substance can be used as an intracanal medicament as it has antibacterial, antifungal, and antiviral properties.<sup>[20]</sup> Flavonoids constitute the major components of propolis resin, which is the active ingredient with most of its properties.<sup>[21,22]</sup> Its phenolic combinations, terpene, aromatic acids, and esters have antibacterial activities.<sup>[21]</sup> Recent studies have indicated that propolis is effective against microorganisms and yet more compatible with periapical tissues than existing intracanal medicaments.<sup>[23]</sup>

### *A. vera* as intracanal medicament

*A. vera* (*Aloe barbadensis* miller) belongs to the Liliaceae family and is a cactus-like plant.<sup>[24]</sup> It is a natural medicament with a long history of usage in medicine and nutrition. The antimicrobial properties of *A. vera* against various species of microorganisms, including *E. faecalis*, have also been reported as *A. vera* has potent antibacterial, antiviral, and antifungal activities.<sup>[25,26]</sup> The possible reason for antimicrobial action of *A. vera* could be the presence of 75 potentially active constituents: vitamins, enzymes, minerals, sugars, lignin, saponins, salicylic acids, and amino acids.<sup>[27]</sup> The antimicrobial activity of *A. vera* might be attributed to the presence of carvacrol and thymol, and they are natural monoterpenes that act on the cell membrane of the organisms causing cellular death.<sup>[28]</sup>

### Comparison of antimicrobial efficacy

In the *in vitro* study done by Bhardwaj *et al.*, in 2012, antimicrobial activity of *A. vera* gel and calcium hydroxide was compared against *E. faecalis* at the days 1, 3, and 5. The overall percentage inhibition at 200 and 400  $\mu\text{m}$  depths and different time intervals were 78.9% with *A. vera* gel and 64.3% with calcium hydroxide. The inhibition of growth of *E. faecalis* at 200 and 400  $\mu\text{m}$  was uniform with no statistically significant difference for calcium hydroxide and *A. vera* gel.<sup>[27]</sup>

In the *in vitro* study done by Abbaszadegan *et al.*, in 2014, the bacterial load reduction from 7 to 14 days of incubation was significant for *A. vera* but not significant for calcium hydroxide. A statistically significant difference was observed between the medicaments after 1 and 7 days of incubation, and no significant difference was present between them after 14 days. The results of the study revealed that calcium hydroxide could not completely eradicate *E. faecalis*, even after 14 days of intracanal medication. *A. vera* had slow antimicrobial activity against *E. faecalis*, which was enhanced significantly from the day 1 to 7 and 14 days of contact time.<sup>[28]</sup>

In an *in vitro* study done by Bazvand *et al.*, in 2014, the percentage reduction in CFU/ml was  $2933.3 \pm 2880.1$  and  $9200 \pm 4601.2$  for propolis and *A. vera*, respectively. It showed that propolis and *A. vera* were relatively effective against *E. faecalis*.<sup>[29]</sup>

In the *in vitro* study done by Madhubala *et al.*, in 2011, they determined the antibacterial efficacy of propolis and calcium hydroxide as intracanal medicaments against *E. faecalis*. The percentage reduction in colony count was highest for propolis showing 100% reduction on the day 2 and 92.2% on the day 3. Calcium hydroxide showed a gradual increase in antibacterial activity with a maximum of 59.4% on the day 7. It can be concluded that propolis can be used as a short-term intracanal medicament as it was effective against *E. faecalis* in the root canal space.<sup>[20]</sup>

In the *in vitro* study done by Saha *et al.*, in 2015, a significant difference was observed between the test groups when compared to control group. With increase in time of application, the antibacterial efficacy also increased with its greatest on the 5<sup>th</sup> day. The least value of optical density ( $0.33 \pm 0.62$ ) was exhibited by propolis indicating it as the best antibacterial medicament.<sup>[30]</sup>

In the *in vitro* study done by Ahangari *et al.*, in 2012, the number of colonies was  $43,333.33 \pm 48,027.077$  and  $55,000 \pm 46,368.09$  after incubation for 72 h and using calcium hydroxide and 30% propolis extract, respectively. After 1-week incubation, the number of colonies was  $166.67 \pm 408.25$  in the propolis group and 0 in the calcium hydroxide group. No colonies were observed after 1-month incubation in both groups. No significant differences were noted between two medicaments at different time intervals.<sup>[31]</sup>

In the *in vitro* study done by Bhandari *et al.*, in 2014, the number of colony-forming units in all the experimental groups was significantly lower in comparison with saline on the day 1, 3, and 5 ( $P < 0.05$ ). Intergroup comparison between groups showed a significant difference between propolis (66.37%) and calcium hydroxide (50.89%) on the day 1 ( $P = 0.002$ ), i.e., propolis was more effective than calcium hydroxide on day 1, but there was no significant difference in their effectiveness on the day 3 and 5.<sup>[32]</sup>

In the *in vitro* study done by Carbajal Mejía in 2014, log CFU/ml after 14 days against *E. faecalis* at 200 and 400  $\mu\text{m}$  depth was 0.86 and 1.29 for propolis, respectively, and 3.68 and 1.01 for calcium hydroxide, respectively. Log CFU/ml after 14 days against *Candida albicans* at 200 and 400  $\mu\text{m}$  depth was 2.82 and 2.59 for propolis, respectively,

and 3.39 and 3.65 for calcium hydroxide, respectively. Propolis was effective against *E. faecalis*, but *C. albicans* exhibited resistance after 14 days of placement.<sup>[33]</sup>

In the *in vitro* study done by Kayaoglu and Ørstavik in 2011, the experimental agents significantly reduced the number of the cultivable bacteria. No significant reduction in the number of colonies was found for the propolis extracts at the day 1; however, there was a significant reduction at the day 7. The 2 samples of propolis were statistically similar to each other and to calcium hydroxide at day 7. The antimicrobial activity of the propolis samples tested in this study was better than calcium hydroxide.<sup>[21]</sup>

In the laboratory study done by Awawdeh *et al.*, in 2009, a significant difference was found between propolis and calcium hydroxide groups ( $P < 0.05$ ) with the later being ineffective against *E. faecalis* after such short duration as calcium hydroxide has to be applied for a longer duration for antimicrobial efficacy.<sup>[34]</sup>

In an *in vitro* study done by Sinha *et al.*, in 2015, the overall percentage inhibition of fungal growth (at 200  $\mu\text{m}$  and 400  $\mu\text{m}$  depth) was  $0.2 \pm 0.42$  and  $0.4 \pm 0.52$  at day 1,  $0.5 \pm 0.53$  and  $0.6 \pm 0.52$  at day 3, and  $3.5 \pm 0.71$  and  $4.4 \pm 0.52$  at day 5 for propolis. The overall percentage inhibition of fungal growth (at 200  $\mu\text{m}$  and 400  $\mu\text{m}$  depth) was  $28.4 \pm 0.52$  and  $42.8 \pm 0.42$  at day 1,  $55.5 \pm 0.53$  and  $69.4 \pm 0.52$  at day 3, and  $82.6 \pm 0.52$  and  $87.4 \pm 0.52$  at day 5 for calcium hydroxide. Propolis performed better than calcium hydroxide against *E. faecalis*.<sup>[35]</sup>

In an *in vitro* study done by Zare Johromi *et al.*, in 2012, minimum inhibitory concentrations of  $\text{Ca}(\text{OH})_2$  were 2500 and of propolis were 340. Propolis displayed more potency than  $\text{Ca}(\text{OH})_2$  and required a much lower concentration of propolis for inhibitory activity against *E. faecalis*. Propolis is an effective agent against *E. faecalis*, and it showed superiority over calcium hydroxide.<sup>[36]</sup>

## Result

Based on the evidence available, it can be concluded that propolis and *A. vera* can be used as effective alternate intracanal medicament in comparison with calcium hydroxide in a root canal system.

## Conclusion

Although *in vitro* studies show the significant antimicrobial efficacy of these natural medicaments in comparison with calcium hydroxide, clinical trials have to be conducted to extrapolate these results in a clinical scenario.

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