ROLE OF HERBAL EXTRACTS IN ROOT CANAL DISINFECTION AND REMOVAL OF SMEAR LAYER: A REVIEW

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INTRODUCTION

The prime motto of any endodontic procedure is to avert the occurrence of apical periodontitis or to make suitable environment for periodical healing in the presence of disease. Thus, the logic of root canal treatment is to eliminate the infection and to further prevent the microorganisms from infecting or reinfection of the root canal system.¹ To accomplish complete eradication of the infection and to enhance periapical healing, “bio-mechanical preparation” of the root canal is done by mechanical instrumentation of the root canals along with simultaneous utilization of chemical agents.²

The complex root canal anatomy which harbors microbes and tissue debris in root canal ramifications poses difficulty in effective root canal disinfection.¹ The most challenging part of root canal disinfection are the presence of smear layer and the biofilm. There is smear layer formation on root canal walls subsequently post instrumentation. This film contains inorganic and organic dentin, necrotic and vital pulp tissue, tissue debris, microbes, and blood cells. It is shown that the smear layer inhibits the penetration of antimicrobial irrigants and intracanal medicaments (ICM’s) into the dentinal tubules.³⁴ Therefore, for enhancing penetration of antimicrobial agents into dentinal tubules, for proper adhesion of obturating agents to the walls of the root canal and to lessen microleakage coronally and apically, the smear layer must be preferably cleaned. Thus, the elimination of the smear from the canal walls is highly desirable to obtain long-term endodontic success.⁵

Endodontic microbiota is diverse and exists in the form of biofilm. It is reported that the microbes in the biofilm pose the greatest resistance due to the protective extracellular polymeric matrix (EPM) of the biofilm. The root canal morphology, structure, and composition of the biofilm, characteristics of different microorganisms within biofilm affects thorough endodontic disinfection. Therefore, irrigants and intracanal medicaments (ICM) play an important role in root canal disinfection.⁶

The regularly employed endodontic irrigating agents are chlorhexidine (CHX), sodium hypochlorite (NaOCl), and ethylene-diamine-tetra-acetic acid (EDTA) solution.⁶⁷ Despite the widespread use of these irrigants, they have certain limitations which is a great concern. The drawbacks of sodium hypochlorite are inadequate penetrability in the intricate root canal system, toxicity, the menace of emphysema, allergic
reaction, unpleasant odor and flavor, and also its failure to eliminate the smear layer.\textsuperscript{10} It is seen that, prolonged contact of sodium hypochlorite disturb the elasticity and flexural strength of root dentine so, making the tooth more susceptible to vertical fracture, which has forlorn outcomes.\textsuperscript{11, 12}

Chlorhexidine (CHX) is used efficiently as a substitute for sodium hypochlorite for root canal irrigation owing to its broad-spectrum antimicrobial activity and substantivity effect. However, the disadvantages include discoloration of the tooth, dryness and burning perception in oral mucosa, and form brown precipitate if it interacts with NaOCl which is proved to be carcinogenic.\textsuperscript{13} Intracanal drugs such as Ca (OH)\textsubscript{2}, cause collagen breakdown that weakens the root dentin. A triple antibiotic paste consisting of ciprofloxacin, minocycline, and metronidazole have latent adverse effects such as tooth discoloration and demineralization of dentin.\textsuperscript{8}

Chelating agents such as 17% ethylene diamine tetra acetic acid (EDTA),\textsuperscript{14, 10} 10% citric acid,\textsuperscript{24} tannin, and maleic acid are applied for removal of smear layer. Nevertheless, repeated irrigation using EDTA can demineralize the dentine and cause erosions in the root canal esp. in coronal third and middle third.\textsuperscript{16}

Despite significant development in the field of dentistry, there is no ideal root canal irrigant and hence there is an ongoing search for alternative antimicrobial agents that are more biocompatible, dentin friendly, and combat the growing microbial resistance and can overcome the limitations of the conventional irrigants. Herbal extracts are attaining fame in all branches of medicine, because of their biocompatibility.\textsuperscript{15} Many plants and their extracts are used as Phytomedicines in dentistry. These herbal medicines are obtained from the roots, seeds, leaves, flowers, and stems of medicinal plants. The herbal extracts possess high anti-oxidant, anti-inflammatory, and antibiotic properties that have favored their application in Endodontics for root canal decontamination; such as intracanal medicament and irrigant.

Various researches and studies have been done for the valuation of herbal extracts as irrigant and/or intra-canal medicament and in removal of the smear layer. To date, several studies have shown the indications of herbal agents in root canal disinfection. This article reviews and discusses the role of several herbal extracts that are utilized for canal disinfection, antimicrobial efficacy to eliminate \textit{E. faecalis} and smear layer removal.

**METHODS**

**Search strategy**

Studies were selected by a search on the below mentioned electronic databases like PubMed, Scopus, Google Scholar, and Science direct. The terms that were used as keywords were Enterococcus faecalis, endodontics, root canal failure, root canal disinfectants, biofilm, smear layer, herbal extracts, and antimicrobial activity. The literature was reviewed for past 30 years (1990-June 2020).

**Study selection**

By the inclusion criteria, studies were mandatorily: (a) published in peer-reviewed journals in the English language (b) provided original data and (c) overtly report on antimicrobial effectiveness of herbal extracts on \textit{E. faecalis} in root canals and removal of smear layer. Articles published as abstracts only and literature published in other languages were excluded.

**Commonly used Herbal extracts in endodontics:**

**Propolis (Beeswax)**

Pharmacologically vigorous constituents in propolis are flavonoids, phenolics, and aromatics. It displays certain biologic actions such as antimicrobial, anti-inflammatory, antioxidant, sedating, and cytotoxic properties. Propolis is commonly employed in root canal disinfection as intracanal medicament and irrigant. It can be effectually used alongside Ca (OH)\textsubscript{2} as dressing for eradication of endodontic pathogens mainly to counter \textit{E. faecalis}.\textsuperscript{19, 20}

**Aloe Vera (Vera Aloe barbadensis miller)**

\textit{Aloe Vera} extract possesses potent antibacterial, antifungal, and anti-inflammatory activity.\textsuperscript{21} The aloin and aloe-emodin are the active constituents of the gel. Owing to its curative ability, Aloe vera has been used in Endodontics both as a medicament and irrigant.\textsuperscript{22}

**Ginger (Zingiber officinale)**

Ginger is known to have anti-inflammatory, analgesic, antipyretic, antimicrobial, and hypoglycemic properties.\textsuperscript{23} Ginger exhibited the highest antibacterial efficacy against \textit{E. faecalis} compared with chlorhexidine and garlic extract.\textsuperscript{24}

**Liquorice (Glycyrrhiza glabra)**

Liquorice is known for its anti-inflammatory, antiviral and anticarcinogenic activities.\textsuperscript{25} Glycyrrhizin, a triterpenoid compound, imparts the sugary flavor of licorice root. The antimicrobial activity of licorice against \textit{E. faecalis} may be linked to the glycyrrhizin. The biocompatibility of liquorice was good with fibroblast cells when compared to calcium hydroxide, which was noxiousto the cells.\textsuperscript{26}

**Neem (Azadirachta indica)**

It is commonly branded as the margosa tree or Indian neem.\textsuperscript{27} Neem is counted on as one of the predominant medicinal herb in naturopathy. The antioxidant and antimicrobial properties of neem extract makes it a potent root canal irrigant alternative to sodium hypochlorite. Advantages of neem for root canal irrigation include its biocompatibility, act as an antioxidant and thus it’s not expected to cause the
major injuries to patients that occur when NaOCl is used.  

Indian mulberry (Morinda citrifolia)

Morinda citrifolia juice (MCJ) has an extensive range of therapeutic properties such as antibacterial, antiviral, antifungal as well as palliative effects.  

MCJ seems to be one of the first liquid to be recognized as a potential substitute to the use of NaOCl as an intracanal irrigant. It has also been found to be an herbal irrigant that is effective in smear layer removal when used at a concentration of 6%. The use of MCJ may potentially be advantageous as a root canal irrigant since it is biocompatible, antioxidant, and has no adverse effects. MCJ comprises milder acids which may be responsible for its reported smear layer removal action.  

Triphala

Triphala is a powder that is made up of alike portions of Emblica officinalis, Terminalia chebula, and Terminalia belerica. It is a proven antioxidant, anti-inflammatory agent, and has radical scavenging activities. Triphala has chelating action due to the presence of fruits rich in citric acid and thus may assist in the elimination of smear layer.  

Miswak (Salvadora persica L)

Miswak is a chewing stick routinely used as a brush to clean the teeth and the oral cavity. It is prepared from the fragrant root of a bush called Arrak. The chewing sticks comprise of trimethyl amine, salvadorime chloride, and fluoride in high volumes. Studies have shown the antimicrobial action of S. Persica and also found that 5 mg/ml solution of S. persica was as effective as 17% EDTA in removing the smear layer from the canal wall.  

Wild sage (Casearia sylvestris)

It is a Brazilian herb in the Salicaceae family. Its popular name is “guataconga.” The C. sylvestris extract forms a rich source of phospholipase A2 inhibitors which reduces the acute stage of inflammation and extends the regenerative stage. A preliminary study reported that the natural medicaments Propolis and Casearia sylvestris may offer a good alternative as short-term intracanal medicaments.  

Lime juice (Citrus aurantifolia)

Citrus aurantifolia (lime juice) extract as the final irrigant, since it comprises of citric acid alongside with an additional antimicrobial feature. Lime juice comprises 88% water, 6–8% citric acid, 2% potassium citrate, and other substances. Owing to the citric acid as a basic constituent in C. aurantifolia, researchers have evaluated it for its possible role in the endodontic smear layer removal and open the dentinal tubules. Furthermore, the role of natural fruit juices including C. aurantifolia on the exposed root dentin surfaces in the elicitation of dentinal hypersensitivity has been confirmed and is linked with the removal of existing smear layer on the exposed dentin.  

Ritha (Sapindus mukorossi)

Sapindus mukorossi (Sapindaceae), widely called as “ritha,” “arithea” otherwise “soapnut” is found all over India. The chief components of the fruit’s pericarp are saponins (10–11.5%), sugars (10%), and mucilage. Higher content of saponins results in greater surfactant action.  

A combination of C. aurantifolia and S. mukorossi in 2:1 concentration has been studied to be highly efficient in removal of smear layer. Emulsification activity of the bio-surfactants like S. mukorossi is one of the important properties that dissolve the water-insoluble substances/hydrocarbons. This property may be primarily responsible for the better smear layer removal effect when used in combination.  

German chamomile (Matricaria recutita)

GCE is an extract of the dried flowers of the plant Matricaria recutita, commonly known as “German chamomile.” It is one of the most commonly used herbs for medicinal purposes. It also contains acids like capric acid, o-coumaric acid, p-coumaric acid, dihydroxybenzoic acid, and caprylic acid, with a pH of 7.6 and effectively removes the smear layer. This extract has antimicrobial activity, anti-inflammatory effect and antioxidant property.  

Role of herbal extracts as root canal irrigant, intracanal medicament and removal of smear layer

From the safety and side effects point of view, continual upsurge in antibiotics insensitivity and futility of conventional drug formulation, researchers are fascinated by herbal substitutes that are widely used in medical preparations subsequently from numerous years owing to their biocompatibility, great anti-inflammatory, antimicrobial, and antioxidant properties, minimum toxicity and antimicrobial resistance. The most commonly studied plant extracts as endodontic irrigants, intracanal medicaments, and smear layer removal have been summarized in Table 1.  

Role of Herbal Extracts against Enterococcus faecalis.

Enterococcus faecalis (E. faecalis) is a gram-positive facultative microorganism commonly associated with endodontic diseases. Its elimination from root canal is of paramount importance, as it is the most resistant microbe usually associated with failure of root canal treatment. E. faecalis possess virulence factors such as cytolytic, lytic enzymes, aggregation substance, pheromones, and lipoteichoic acid. It can invade dentinal tubules and cementum. It produces the collagen-binding proteins such as Adhesin, Ace, and serine protease which help in adhesion to the collagen present in dentin and cementum. It can survive even after meticulous root canal instrumentation.
and root canal disinfection. *E. faecalis* forms a biofilm in the root canal and is more resistant to available antibacterial agents. It can survive even in the presence of intracanal medication. It penetrates root dentin, cementum and survive longer period seven in nutrient-depleted conditions such as an obturated canal and lead to persistent or reinfections. Studies show herbal extracts exhibit effective antimicrobial activity against this resistant microbe due to their unique properties.

### Table 1: Herbal extracts and their role in root canal disinfection

<table>
<thead>
<tr>
<th>Scientific name</th>
<th>Common name</th>
<th>Pharmacological active components</th>
<th>Endodontic purpose</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>Propolis</td>
<td>Beeswax, Blue glue</td>
<td>Flavonoids, Aromatic acids, Esters present in Resins, Galangin, Pinocembrin</td>
<td>Irrigant</td>
<td>Al-Qathami H et al44 Kandaswamy et al45</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>ICM</td>
<td>Oncag O et al52 Banskota et al53</td>
</tr>
<tr>
<td>Aloe vera</td>
<td>Star cactus, Barbados</td>
<td>Latex, Glucomannan, mannose derivatives, hemicellulose, calcium oxalate</td>
<td>ICM</td>
<td>Bazvand et al46</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Irrigant</td>
<td>Sahebi et al57 Bharadwaj et al48</td>
</tr>
<tr>
<td>Allium sativum</td>
<td>Garlic</td>
<td>Allicin</td>
<td>ICM</td>
<td>Eswar et al49</td>
</tr>
<tr>
<td>Zingiber officinale</td>
<td>Ginger</td>
<td>flavanoids</td>
<td>ICM</td>
<td>Maekawa et al50</td>
</tr>
<tr>
<td>Glycyrrhiza glabra</td>
<td>Liquorice</td>
<td>Glycyrrhizin</td>
<td>ICM</td>
<td>Badr et al52 Kumar D et al51</td>
</tr>
<tr>
<td>Azadirachta indica</td>
<td>Neem</td>
<td>Azadirachitin, Nimbin, gallic acid, catechin</td>
<td>Irrigant</td>
<td>Nayak et al52 Vinoth Kumar et al53</td>
</tr>
<tr>
<td>Salvadora persica L</td>
<td>Miswak</td>
<td>trimethyl amine, salvadorime chloride and fluoride</td>
<td>ICM</td>
<td>Al Sabawi et al54 Al Obaida et al55</td>
</tr>
<tr>
<td>Passiflora edulis</td>
<td>Passion Fruit</td>
<td>flavonoids, alkaloids, cyanogenic compounds</td>
<td>Irrigant</td>
<td>Jayahari et al55</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Smear layer removal</td>
<td>Balto et al56</td>
</tr>
<tr>
<td>Morinda citrifolia</td>
<td>Indian mulberry, Painkiller bush, Cheese fruit</td>
<td>L-asperuloside, Acubin, Alizarin kaempferol, Octanoic acid, Ascorbic acid, Ricinoleic acid</td>
<td>Smear layer removal</td>
<td>Murray et al50 Prabhakar et al54</td>
</tr>
<tr>
<td>Triphala</td>
<td></td>
<td>Citric acid</td>
<td>Smear layer removal</td>
<td>Pujar et al57 Prabhakar et al54</td>
</tr>
<tr>
<td>Marticaria recutita</td>
<td>German chamomile</td>
<td>(caprylic acid, caprylic acid, chlorogenic acid, o-caumaric acid, p-caumaricacid, dihydroxybenzoic acid</td>
<td>Smear layer removal</td>
<td>Sadr et al59 Shah S G et al51 GangulyS et al57</td>
</tr>
<tr>
<td>Casearia sylvestris</td>
<td>Wild Sage</td>
<td>phospholipase A2 inhibitors</td>
<td>ICM</td>
<td>Da Silva et al57</td>
</tr>
<tr>
<td>Melaleuca alternifolia L</td>
<td>Tea extract, fruit teas, Tea tree oil</td>
<td>Terpinen-4-ol</td>
<td>Smear layer removal</td>
<td>Sadr et al59 Jeremy S et al59</td>
</tr>
</tbody>
</table>

The role of various herbal agents against *Enterococcus faecalis* is summarized in table 2.

### Table 2: Herbal extracts against endodontic pathogen *Enterococcus faecalis*

<table>
<thead>
<tr>
<th>Reference</th>
<th>Herbal agent/ s studied</th>
<th>Type of study</th>
<th>Method of evaluation</th>
<th>Conclusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kandaswamy D et al65</td>
<td><em>Propolis and Morinda citrifolia</em> (MJC)</td>
<td>Invitro study</td>
<td>CFU/mL was determined.</td>
<td>*Propolis and MJC were effective against <em>E. faecalis</em>.</td>
</tr>
<tr>
<td>Kamath U et al66</td>
<td><em>Melaleuca alternifolia L</em> (Tea tree oil)</td>
<td>Agar well diffusion method</td>
<td></td>
<td><em>Melaleuca alternifolia L</em> is effective against <em>E. faecalis</em>.</td>
</tr>
</tbody>
</table>
DISCUSSION

The good prognosis of endodontic treatment over the years, rests on the complete cleaning and disinfection of pulpal space. The main reason for endodontic failure is incomplete cleaning canal system. The intricate root canal structure makes elimination of micro-organisms problematic. Many chemical substances have been suggested in various studies for root canal disinfection. However, due to the adverse effects, toxicity issues, inability to completely remove the smear layer, growing microbial resistance to the routinely used conventional root canal disinfectants and inability to eliminate the microbes such as Enterococcus faecalis which flourish in periapical abscesses and granulomas, causing catastrophe of the endodontic treatment lead to development of alternative modalities.  

Many herbal products with biological and antimicrobial properties have been studied and recommended for root canal disinfection. The major advantages of using herbal extracts as alternative antimicrobial agents for root canal disinfection are ease of availability of these extracts, cost efficiency, augmented shelf life, low toxicity, and absence of microbial resistance.

The findings of our review show that herbal agents are widely used for root canal disinfection. They are effectively studied as an ICM, irrigant, and for elimination of the smear layer. Most of the studies are pertinent to the evaluation of antibacterial activity against E. faecalis; as it is responsible for root canal failure and persistent infections. The results of our search are summarized in tables 1 and 2 which clearly show that different herbal agents were studied for endodontic disinfection.

Extracts of Azadirachta indica, Ocimum sanctum, Syzygium aromaticum, Cinnamomum zeylanicum, and Citrus aurantifolia have been explored as possible endodontic irrigating agent. However most of the literature suggests that Propolis and Azadirachta indica (AI) are effective for root canal irrigation. Studies have shown promising results of propolis against E. faecalis biofilms in contrast to other natural irrigants and NaOCl. Aloe vera has been reported to exhibit active antimicrobial activity against E. faecalis. Aloe vera was inefficient in combating Enterococcus faecalis; as it is responsible for root canal failure and persistent infections. However most of the literature suggests that Propolis and Azadirachta indica (AI) are effective for root canal irrigation. Aloe vera was inefficient in combating Enterococcus faecalis and thus was not mentioned as irrigating solution.

Aloe vera was found more effective against E. faecalis. Neem extract is effective against E. faecalis, followed by Tulsi. Neem and Propolis showed less growth of E. faecalis. Babool and clove extracts are effective against E. faecalis.

Aloe vera has been reported to exhibit active antimicrobial activity against E. faecalis; as it is responsible for root canal failure and persistent infections. The results of our search are summarized in tables 1 and 2 which clearly show that different herbal agents were studied for endodontic disinfection.

Aloe vera was found more effective against E. faecalis.

<table>
<thead>
<tr>
<th>Authors</th>
<th>Herbs/Cultivars</th>
<th>Method</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chandrappa PM et al</td>
<td>Azadirachta indica (Neem) and Tulsi (Ocimum sanctum)</td>
<td>Agar diffusion method</td>
<td>Neem extract is effective against E. faecalis, followed by Tulsi.</td>
</tr>
<tr>
<td>Mahendra M et al</td>
<td>Azadirachta indica (Neem) and Tulsi (Ocimum sanctum)</td>
<td>CFU/mL was determined</td>
<td>Neem and Propolis showed less growth of E. faecalis.</td>
</tr>
<tr>
<td>Neelakantan P et al</td>
<td>Curcumin</td>
<td>Invitro study</td>
<td>Curcumin is effective against E. faecalis.</td>
</tr>
<tr>
<td>Kumar D et al</td>
<td>Azadirachta indica (Neem), Glicyrrihiza glabra (Liquorice), cinnamonum, zeylanicum, Syzygium aromaticum (Clove), and Accacianilotica (Babool)</td>
<td>Antimicrobial zone of inhibitions against E. faecalis and Streptococcus mutants.</td>
<td>Babool and clove extracts are effective against E. faecalis.</td>
</tr>
<tr>
<td>Awodaa E M and Abdelkarim et al</td>
<td>Ginger and cinnamon</td>
<td>Ex vivo study</td>
<td>The colony-forming units (CFU/mL) and the minimum inhibitory concentration</td>
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<tr>
<td>Karkare SR et al</td>
<td>Aloe vera and Garlic</td>
<td>Agar diffusion method</td>
<td>A. vera exhibited antibacterial efficiency against E. faecalis</td>
</tr>
<tr>
<td>Prabhakar J et al</td>
<td>Triphala and Green Tea Polyprenols (GTP)</td>
<td>Invitro study</td>
<td>Herbal agents can be alternatively used as root canal irrigants.</td>
</tr>
<tr>
<td>Saxena D et al</td>
<td>Propolis, Azadirachta indica (AI), Triphala, Curcuma longa, and Morinda citrifolia (MC)</td>
<td>Disk diffusion method</td>
<td>Propolis and Al have important antimicrobial activity against E. faecalis.</td>
</tr>
<tr>
<td>Kalaiselvam R et al</td>
<td>Piper nigrum (Piperaceae), Piper longum (Piperaceae) and Zingiber officinal Roscoe (Zingiberaceae)</td>
<td>Real-time PCR</td>
<td>2% chlorhexidine has greater antibacterial efficacy against E. faecalis followed by Zingiberofficinale Roscoe (Zingiberaceae) extract</td>
</tr>
<tr>
<td>Podar R et al</td>
<td>Morinda itrifloa (MC), Azadirachta indica (AI)</td>
<td>CFU/mL was counted at baseline and after irrigation (posttreatment)</td>
<td>No change in the antimicrobial efficiency of 6% M. citrifolia, A. indica, and 3% NaOCl as root canal irrigants.</td>
</tr>
</tbody>
</table>
biofilms. Aloe vera was not efficient against *E. faecalis* biofilms.\(^{38}\)

Vinoth Kumar et al., assessed the antimicrobial efficiency of *Curcuma longa*, *Aloe barbadensis*, *Azadiracta indica*, *Myristica fragrans* and *Terminalia chebulaea* endodontic irrigants against *E. faecalis* and *C. albicans*. The study concluded that neem was extremely effectual in comparison to other natural irrigants against both the organisms.\(^{35}\) Dutta and Kundabala in their study evaluated the decrease in bacterial count using anaerobic culture technique in infested root canals and found that the combination of NaOCl and neem irrigant led to the maximum decrease in bacterial counts.\(^{76}\)

Most studies show that *Propolis*, *Morinda citrifolia*, *Triphala*, *German chamomile* and *Tea tree* extracts possess the ability to remove the smear layer.\(^{26,41,51}\) *Morinda citrifolia* (MC) 6% shows effective antimicrobial activity when used as ICM and for smear layer removal.\(^{30}\) Shah SG et al compared 6% German chamomile extract (GCE) and 6% *Morinda citrifolia* juice (MCI) for smear layer removal and concluded that GCE 6% was effective in the removal of smear layer, when used with either continuous or syringe and needle irrigation systems and does not cause demineralization of dentin whereas EDTA does.\(^{41}\) Bolhari B et al. concluded that both of the alcoholic and completed combinations of citrusaurantifolia excertps were not able to efficiently eliminate smear layer in comparison with 17% EDTA in the course of root canal treatment.\(^{73}\)

In an *in-vivo* study, comparing the antimicrobial activity of *S. persica*, propolis, NaOCl, and saline as root canal irrigants in primary teeth, it was concluded saying that 12.5% alcoholic extract of *S. persica* could be a good natural substitute to 3% sodium hypochlorite.\(^{35}\) Shakouie et al. compared the antimicrobial efficiency of triphala with various combinations of NaOCl against *E. faecalis* and stated that triphala displayed superior antimicrobial activity against *E. faecalis* when compared to 0.5 and 1% NaOCl.\(^{77}\)

The studies show that most of the herbal agents exhibit effective antimicrobial activity against *E. faecalis*, however, a majority of studies recommend *Azadirachta indica* (AI) to be most effective against *E faecalis* followed by propolis and *Morinda citrifolia* (MC).\(^{45,65,67,70}\) Aloe vera has mixed opinions regarding its antimicrobial effect on *E. faecalis*.\(^{47,48,74}\) The literature search shows that most of the studies conducted on *E faecalis* are invitro antimicrobial studies however, relatively few clinical/in-vivo studies have been conducted (Table 2).

It was found that most of the studies undertaken exhibit effective antimicrobial activity, effectively remove smear layer recommending herbal extracts for root canal disinfection. However, the search shows that there is a lack of cytotoxicity studies of these herbal extracts. Determination of cytotoxicity of these agents is important for effective clinical use. However, further studies including standardization protocols for using herbal agents, in vivo studies, in vitro studies evaluating the antimicrobial efficacy using nonculture methods, cytotoxicity studies, clinical trials, and long-term studies are to be undertaken, so that herbal extracts can be effectively and confidently employed for root canal disinfection.

CONCLUSION

Application of Herbal extracts for root canal disinfection has revolutionized the traditional concepts. The in vitro observations of herbal products appear promising, however clinical studies, longitudinal studies, preclinical and clinical experiments are needed to assess the biocompatibility and safe margins of these agents is needed before they can irrebutably be suggested for root canal disinfection. Herbal extracts are usually harmless if used with appropriate knowledge, but they can be detrimental if misused. Many herbal medicines bare possible risk, side effects, and prescription exchanges that may disturb our safe practice of dentistry. Hence forward, herbal agents should only be used for treatment procedures that have been proven to be operational, and with negligible risk involved.

Herbal extracts pave a new horizon in root canal disinfection as root canal irrigants, intra-canal medicaments and as agents for removal of smear layer.

REFERENCES:


