

Role of Herbs in Endodontics: An Update

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Abstract

Review Article

Treatment involving Endodontics and root canal therapy comprises of extirpation of infected pulpal tissue along with a variety of microbial organisms from root canal spaces for prevention of any increase in infection of peri- radicular soft tissues while at the same time allowing the healing of surrounding tissues. Performing root canal therapy includes the usage of different chemical-based irrigating medications for disinfecting root canal or endodontic space. The most commonly used chemical irrigating agents are sodium hypochlorite, chlorhexidine, or EDTA. Irrigation is a repeatedly used process that is performed for reducing the total bacterial count within any root canal(s). To accomplish good irrigation, large assortments of irrigating medications are commercially available as of this day. However, these agents or drugs may prove to be toxic, have various safety concerns, and may exhibit various side effects. Due to this reason, different alternatives of herbal derivation are used as endodontic or root canal irrigants as these have distinctly high safety profiles and are less cytotoxic. Herbal irrigating products are largely popular as a result of ease of availability, greater cost-effectiveness, and increase in shelf life as well as low degree of toxicity. In recent years, an increase in the trend for seeking natural-based remedies in all types of treatment protocols in dentistry is being explored. This branch of herbal medications is known as 'ethnopharmacology' or 'phytotherapy'. Hence, the current review paper aims at an overview of various plant-derived endodontic irrigating agents along with their effectiveness in irrigating root canals during endodontic therapy.

Keywords: chlorhexidine, EDTA, sodium hypochlorite, herbal derivatives, irrigation, medicaments, root canals, endodontics, antimicrobial.

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INTRODUCTION

The primary aim of performing endodontic therapy is the removal of diseased pulpal tissue, elimination of bacterial population from within root canal systems, and prevention of root canal recontamination [1]. Hence, various agents for irrigating these root canals are used for reducing the total numbers of bacteria in root canals and for controlling periapical pathology [2].

There are varieties of antimicrobial synthetic agents that are being used for many years as endodontic irrigating agents. However, these synthetic irrigation solutions result in an increase in antibiotic-related resistance to these anti- microbial products. The toxic as well as harmful side effects of these commonly used anti-bacterial irrigating agents have developed the requirement for the availability of alternate antimicrobial agents that are comparatively less expensive, are non-toxic, and have effectiveness. Few naturally

occurring plant-based extracts are useful as good endodontic irrigating agents [3]. Ideal properties of any endodontic irrigating agents include a) they must not be toxic systemically, b) they must not cause any harm to periodontal soft tissues, c) they must not result in an anaphylactic response, d) they must possess broad antimicrobial activity spectrum, e) these irrigating solutions must have potential for dissolution of necrotic pulpal tissue, f) they must be capable of inactivation of bacterial endotoxins and g) they should be capable of either preventing smear layer formation or resulting in its dissolution after it has undergone formation [3].

Sodium hypochlorite or NaOCl is the most common irrigating agent that is used in endodontics due to its capability to destroy a wide spectrum of microbial organisms. However, sodium hypochlorite has a few undesirable side effects for example tissue related toxicity, the potential for causing allergies, unpalatable taste, and the inability to remove of smear layer [4-6].

As an alternate agent, Ethylenediamine tetra-acetic acid or EDTA has been used. This irrigating agent can cause demineralization of the smear layer however; this irrigating solution must be used along with sodium hypochlorite for removing organic components [7, 8]. Also, EDTA as an irrigating agent does not possess any ability for disinfecting these root canal systems [9].

Chlorhexidine, an anti-bacterial agent has been commonly used for irrigating root canals owing to its broad spectrum of anti-microbial activities, its biocompatible nature as well as the ability to disinfect the root canal(s). However, its disadvantage is that it lacks any capability for tissue dissolution [10].

Also, chlorhexidine use results in an unsightly side effect as it causes discoloration of the teeth can result in dryness of oral mucosa and may cause burning sensations of the oral mucosa [11, 12]. To bypass these side effects of above mentioned irrigating agents and to fulfill all requirements of any ideal irrigating solution, a novel agent termed 'MTAD' was introduced. MTAD is an aqueous-based solution comprising 3 % doxycycline which is a broad-spectrum antibiotic; 4.2 % citric acid which is a de-mineralizing agent and 0.5% poly-sorbate 80 detergent (also known as, Tween 80). However, the disadvantages of MTAD are its higher cost, decreased shelf life, and lesser bio-compatibility with dental pulpal cells [13].

Different herbal or plant-based products are increasingly becoming popular as these possess higher anti-microbial properties, bio-compatibility, anti-inflammation, and anti-oxidative properties [14]. As per the World Health Organization or WHO, herbal medications may be termed as substances or preparations that have been derived from various plants and contain raw and/or processed ingredients that have been obtained from plants with therapeutic uses [15].

Numerous herbal-based products have been traditionally used for practicing medicine. There is an increase in efforts towards incorporating these natural plant products in alleviating dental and oral diseases as well. Hence, this review was undertaken to identify and provide a detailed description of various herbal agents that are readily available for utilization as ideal irrigating agents in endodontics.

Classification of Phytotherapeutic Medicines

Phytomedicinal agents can be broadly classified into three categories according to Kamat *et al.*, a) Plant-based products, b) Animal based products and c) Mineral based origin [16].

Various herbal-based products that can be utilized as intra-canal irrigating agents are summarized as follows:

1. Triphala

Triphala is a traditional ayurvedic herbal medicinal formula that consists of equal portions of 3

plants: *Emblica officinalis*, *Terminalia beellirica*, and *Terminalia Chebula*. Triphala powder possesses bactericidal action against biofilms constituted by *Enterococcus faecalis*. *Terminalia chebula* prevents the formation of plaque on tooth surfaces. Its anti-biofilm or plaque activity is primarily because of tannic acid found in Triphala. This undergoes adsorption to bacterial cell surfaces that causes denaturation of proteins resulting in the death of bacterial cells. Triphala has no side effects that can be likened to tetracycline-based compounds and synthetic medicinal agents that are used for the treatment of periodontal diseases [17].

2. Garlic or *Allium Sativum*

Garlic belongs to the *Allium* family that contains onions as well as leeks. Garlic is enriched with various sulfur-constituted compounds that include *thiosulfinates* (for example, *allicin*), *sulfoxides* (an example is an *alliin*) as well as *dithiins* (comprises of ajoene). These inherent bio-compounds are largely responsible for the characteristic pungent smell of garlic. The botanical name of Garlic is '*Allium Sativum*'. Common names are Poor Man's Treacle and Stinking rose. Garlic extract has demonstrated sensitivity against *Porphyromonas gingivitis*, *Porphyromonas intermedia*, *A. actinomycetemcomitans*, *Fusobacterium nucleatum*, *Enterococcus faecalis* as well as various other bacteria responsible for causing infections of endodontic system or root canal [17].

Garlic provides relief in tooth pain owing to its anti-bacterial as well as analgesic properties. This herb has an excellent therapeutic effect on the control of pain, and the promotion of healing of ulcers as a result of its anti-inflammatory activity. The main component in garlic is Allicin which acts by decreasing inflammation-related factors, reduction in neutrophilic migration, inhibiting bacterial and viral growth, antagonizing cellular oxidation, and regulating immunity [17].

3. *Morinda Citrifolia*

M. citrifolia is also known as 'Indian mulberry'. It has anti-bacterial as well as anti-microbial activity and can be used as an effective root canal irrigating agent. Its primary components include L-asperuloside along with alizarin [18]. Various phytochemicals included in this plant are lignans, catechins, oligo-polysaccharides, and flavonoids. These phytoextracts display anti-tumorigenic, hypotensive, anthelmintic, analgesic, anti-inflammatory as well as immunity enhancing characteristics. It has a chelating function and causes inhibition of carcinogen and DNA adduct synthesis [19, 20].

Murray *et al.*, (2008) assessed the effectiveness of *Morinda citrifolia* extract in combination with EDTA as an alternative to sodium hypochlorite (NaOCl.). They found the equivalent

effectiveness of this combination with NaOCl as an effective intra-canal irrigating agent [20].

4. Propolis

Propolis is derived from primary sources such as Poplars, coniferous plants, and Generic clusia flowers. This phytoextract has been used for irrigating root canals, intra-canal medication, and treatment of periodontal ligaments [21- 24].

Oncag *et al.*, (2006) have evaluated the effectiveness of Propolis as an intra-canal medicinal agent against *Enterococcus faecalis*. They found that Propolis exhibited good anti-bacterial action under *in vitro* conditions against *E. faecalis* found within root canals and suggested its use as an intra-canal irrigating medicament [23].

5. Azadirachta Indica (Indian Neem or Margosa Tree)

This plant is enriched with anti-oxidants. It has been proposed to serve as an effective irrigating agent at par with sodium hypochlorite [24].

Candida albicans is the most frequently occurring fungal organism found within root canal systems. Bohora *et al.*, (2010) in their study found that both sodium hypochlorite and propolis showed maximum anti-microbial effectiveness against *Candida albicans* followed by *Azadirachta indica* [25].

A. indica when combined along with *Aloe vera* has shown effectiveness in the decontamination of Gutta-percha cones. Hence, *A. indica* extract shows excellent disinfectant properties before any root canal procedure. Ethanol extract of *A. indica* has proven efficiency in the treatment of *E. faecalis* as well as *C. albicans* [26].

6. Orange Oil

Orange oil is constituted by limonenes, aliphatic hydrocarbon alcohols as well as aldehydes, for example, octanal [27]. Orange oil can be used as a good alternative agent in place of chloroform and/or xylene to soften and remove gutta-percha and endodontic sealers during the retreatment of root canals.

Orange oil has no harmful effects, exhibits low water solubility, and shows solubility in alcohol. This plant product is routinely utilized in the pharmaceutical industry for adding fragrance as well as flavor. Orange oil shows expectorant activity [28].

7. Carvacrol

Carvacrol has been found to possess anti-bacterial properties due to its activity on bacterial cell membranes by causing their disruption. Carvacrol can be chiefly used for inhibition of *Escherichia coli* and *Pseudomonas aeruginosa*, causing repair process of peri-apical tissues and stimulation of pulp collagenous

fibers. Hence, Carvacrol may be used as an ideal material in endodontic treatment [29].

8. Green Tea

Low concentration of Green tea has exhibited an ability for creating a zone of inhibition surrounding colonies of *E. faecalis* although this zone of inhibition is lesser than 1 % solution of NaOCl. This anti-microbial activity has been shown to increase with high concentrations of green tea extracts [30].

Green tea is derived from the herb, *Camellia sinensis*. This tea has wide distribution though it originated in Japan and China. Green Tea Extract or preparations are rich with anti-oxidative agents; they demonstrate anti-cariogenic activity and also, have anti-inflammatory properties. These extracts are thermogenic, have probiotic properties, and also, have an anti-microbial activity which causes inhibition of biofilm formation. Green tea contains naturally occurring fluoride, thus, it has good anti-plaque as well as chelating properties [30].

9. Salvadora Persica or Miswak-Siwak Solution

Miswak is derived from trees that have bitter-tasting roots. These are enriched with trimethyl amines, salvadorime chloride as well as fluoride. Alcoholic Miswak extracts contain various active anti-microbial compounds that prevent biofilm formation. Miswak acts as a good substitute product for sodium hypochlorite solution for irrigation of root canals. Alcohol-based extracts with a 15% concentration of Miswak have demonstrated maximal anti-microbial activity. Miswak is used as a substitute for sodium hypochlorite as well as chlorhexidine for irrigating root canals [31].

Rani *et al.*, (2014) compared the efficacy of chlorhexidine with an herbal mouth rinse which was prepared from *Salvadora persica*, *T. bellirica*, *Piper betle*, *Mentha* spp, and *Carum copticum* for reduction of toxicity or bacterial load in aerosols that are produced while performing ultrasonic oral prophylaxis.

No statistical significance was noted in Colony Forming Units between Chlorhexidine and herbal test groups. Hence, it was concluded that the Miswak solution is equally effective as an irrigating agent during endodontic procedures [32].

10. German Chamomile

German chamomile is a chelating agent that cleans the smear layer in a better manner when compared to sodium hypochlorite before irrigating root canals. German chamomile contains constituents like capric acid, chamazulene, caprylic acid, and chlorogenic acid. Traditionally, German Chamomile has an anti-inflammatory, analgesic, anti- spasmodic, anti-microbial, and sedative activity. These properties allow German Chamomile to be used as an ideal irrigation product for use in endodontics. Additionally,

the extract of this plant effectively inhibits infections affecting gingiva along with oral mucosa for the treatment of mucositis [28].

11. Tea Tree Oil

Tea tree oil is derived from an evergreen type of tree that is native to wet low-land areas of Australia. This plant product has excellent anti-bacterial as well as anti-fungal activities because of an active constituent, 'terpinen-4-ol'. Tea tree oil may be used as an effective irrigant for root canal treatment although it cannot substitute EDTA and/or NaOCl. Other uses of Tea tree oil are for treating irritation of the throat, insect stings, burn wounds, cut wounds, and infections of the skin. It has demonstrated effectiveness in the healing of periodontal tissues [28].

12. Lime

Lime contains citric acid that can clear the smear layer. Hence, it can be used as a chelating molecule. Lime has anti-bacterial action specifically against *E. faecalis* which makes it a good medicament to be used for root canal treatment with no side effects [28].

13. Rhus

This plant contains tannins that exhibit anti-bacterial, anti-fungal, anti-oxidative, and anti-inflammatory functions. Tannins have also been shown to unblock dentin tubules [28].

14. 30 % Jieeryin Extract

30% concentration of Jieeryin can be used as a perfect alternative for sodium hypochlorite. This solution can detoxify, and also possesses anti-inflammatory action. Hence, this herbal product can be used for irrigation purposes in endodontics.

15. Aloe Vera in Gel form

Aloe vera contains aloins as well as aloe-emodin which are the active compounds. *Aloe vera* may be used for Gutta Percha decontamination and also, for storing Gutta Percha cones [33].

16. Turmeric or *Curcuma Longa*

Curcumin or diferuloylmethane, demethoxycurcumin, and bis-demethoxycurcumin are the primary yellow-colored bio-active compound in

turmeric. Curcumin possesses anti-microbial, anti-inflammatory, and anti-oxidative properties. These are polyphenols that have strong anti-oxidation, anti-microbial and anti-inflammatory activities.

Curcumin causes inhibition of assembly of mutant Z proto-filaments alongside an increase in GTPase function which demonstrates lethality for bacterial cells. Aqueous preparation of Curcumin has been shown to exhibit phototoxicity against a variety of Gram-positive (for example, *E. faecalis*) as well as negative bacteria (for example, *E. coli*). Curcumin when used as a surfactant has been shown to act as a photosensitizing agent in photodynamic therapies under in vitro conditions [34].

The cytotoxic effect of curcumin is dependent on its concentration, exposure, incubation period of respective bacterial species, and type of pharmacological preparation. The postulated mechanism for curcumin activity is the binding of the molecule with the outer cell membrane [34].

17. Licorice

Liquorice has anti-inflammatory, anti-viral, and anti-carcinogenic activities. Its extract has shown inhibition of growth as well as adherence of cariogenic bacterial population namely, *Streptococcus mutans*.

Glycyrrhizin which is tri-terpenoid molecule has been shown to impart sweetness to its taste. Glycyrrhizin is a mixture comprised of potassium, calcium, and magnesium glycyrrhizic acid salts. The concentration of this compound falls between 2 % to 25 %. Glycyrrhizic acid, a saponin is composed of a hydrophilic portion comprising of 2 molecules of glucuronic acid and a hydrophobic portion, glycyrrhetic acid.

Glycyrrhizin is the main compound responsible for *E. faecalis* anti-activity. All saponins exhibit membranolytic potential which is the main reason for its anti-bacterial action. Flavonoids are responsible for strongly inhibiting the consumption of oxygen by bacteria. The main site for inhibitory activity is localized in between Coenzyme Q and cytochrome C within the electron transport chain responsible for cell respiration [35].

Table 1: Summarizing the herbs that can be used as a replacement of root canal irrigation materials

Herbs	Products or active principle
Triphala	Tannic acid
Garlic	Allicin
Morinda citrifolia	L-asperuloside, alizarin
Propolis	Plant extract
Azadirachta indica	Leaf extract
Orange oil	limonenes, aliphatic hydrocarbon alcohols, aldehydes
Carvacrol	Plant extract
Green tea	Leaf extract
Miswak-Siwak	Trimethyl amines, salvadorime chloride, and fluoride

Herbs	Products or active principle
German chamomile	Capric acid, caprylic acid, chamazulene, and chlorogenic acid
Tea tree oil	terpinen-4-ol
Lime	Citric acid
Rhus	Tannins
30 % Jieeryin extract	Plant extract
Aloe vera	Aloe emodin
Turmeric	Curcumin or diferuloylmethane, demethoxycurcumin and bis-demethoxycurcumin
Licorice	Glycyrrhizin

CONCLUSION

The scientific literature has many herbal products that have demonstrated potential to be used as anti-bacterial, anti-fungal, and anti-inflammatory agents. However, the majority of investigations that have been carried out are ex vivo and/or in vitro in nature. Hence, there is a need for in vivo clinical trials to prove the efficacy of herbal extracts to be used as ideal root canal irrigation medications or agents. Since these are non-synthetic and natural products they have little to nil chances of producing any side effects in the patients.

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