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Natural Therapeutic Options in Endodontics - A Review

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Abstract: Complete eradication of microbial biofilms and elimination of the smear layer are the key factors during endodontic treatment. Various chemical irrigants have been proposed in the literature for the same. The major setback with these chemical irrigants is that they are not bio-friendly to the dental and peri-radicular tissues. In the recent years, research to use natural products for root canal disinfection has gained importance. The aim of this article is to compile various herbal products that have been used as an irrigants and intracanal medicaments in the field of Endodontics to eradicate the biofilm and remove smear layer.

Keywords: Endodontics, Herbs, Intracanal medicament, Irrigants.

INTRODUCTION

The main goal of root canal treatment is to achieve maximum disinfection of the root canals, which is a challenging task owing to the complex anatomy of the root canals. The bacterial reduction is achieved partly through shaping of the canals but predominantly through irrigation and intra-canal medicaments. Irrigation is principally done to achieve the removal of intracanal smear layer, elimination of bacterial biofilms, reduction in bacterial counts and neutralising the toxins produced by microorganisms [1, 2]. The most common irrigants used are Sodium hypochlorite (NaOCl), Ethylene di amine tetra acetic acid (EDTA) solution and Chlorhexidine (CHX) [2]. The above mentioned irrigants, though effective against the pathogens, have undesirable properties. For example, NaOCl is toxic to the periradicular tissues [3], causes a reduction in dentin strength due to its proteolytic effect [4], has allergic potential and has an unacceptable taste and odour. CHX can cause staining of the tooth and forms precipitates with NaOCl [5].

The search for more biocompatible and dentin friendly irrigants that can overcome the limitations of these chemical antimicrobial irrigants is on the rise. Herbal products are gaining popularity in every field of medicine, mainly due to their biocompatibility [6]. The herbal extracts also possess high medicinal properties such as anti-oxidant, anti-microbial, and anti-inflammatory properties which have favoured their use in Endodontics for canal disinfection [7]. Numerous studies have been performed for the evaluation of a wide variety of natural products as an irrigant and/or intra-canal medicament. The focus of this review article is to discuss about the various herbal products that have been used for root canal disinfection.

Aloe Vera (*Aloe Barbadensis* Miller)

This herb belongs to the *Asphodelaceae* (*Liliaceae*) family. Aloe vera extract possesses potent antibacterial [8], antifungal [9] and anti-inflammatory activity [10]. Due to its medicinal value, aloe vera has been tried in Endodontics

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both as a medicament and irrigant. Bazvand *et al.* evaluated aloe vera as an intracanal medicament against *Enterococcus faecalis* in comparison with the triantibiotic paste, CHX gel and propolis. He observed that though aloe vera was effective against *E. faecalis*, it was not as effective as the triantibiotic paste and CHX gel [11]. Sahebi *et al.* evaluated the antibacterial efficacy of aloe vera as an irrigant in comparison with 2.5% NaOCl. They also reported that aloe vera was not effective against *E. faecalis* and hence did not recommend it as an irrigant [12]. Bharadwaj *et al.* also reported that even after ultrasonic activation, aloe vera was not effective against *E. faecalis* biofilms [13].

Bee Glue (*Propolis*)

It is a natural antibiotic extracted from the honey bees [7]. *Propolis* has been used in dentistry owing to its antioxidant [14], antimicrobial [15, 16] and anti-inflammatory [17] properties. It has been tried for dentin disinfection in root canal treatment. Carbajal, study proved that in comparison with 2% CHX and calcium hydroxide (Ca(OH)₂), *propolis* possessed equally good antibacterial efficacy against *E. faecalis*; however, its antifungal efficacy was less [18]. The antimicrobial properties might be attributed to the presence of flavonoids. Other studies have also found promising results against both *C. albicans* and *E. faecalis* biofilms in comparison with other natural irrigants and NaOCl [19 - 21].

Burdock (*Arctium Lappa*)

It is commonly known as the Greater burdock. It has been popularly used in traditional Chinese medicine [22]. Gentil *et al.* [23] compared the antibacterial activity of ethyl acetate fraction extracted from *Arctium lappa* with Ca(OH)₂. They concluded that *A. lappa* inhibited the growth of all the microorganisms. The constituents of *A. lappa* was shown to have antimicrobial activity against the common endodontic microorganisms (*Candida albicans*, *Enterococcus faecalis*, *Staphylococcus aureus*, *Bacillus subtilis* and *Pseudomonas aeruginosa*) [24].

Cinnamon (*Cinnamomum zeylanicum*)

It belongs to the *Lauraceae* family. It has been commonly named as the cinnamon tree, cinnamon, Ceylon celonzimi cinnamon, cinnamon bark, blood-giving drops and cortex cinnamomi [25]. Cinnamon has been shown to have antibacterial efficacy against both *E. faecalis* and *S. mutans* [26]. Gupta *et al.* compared the antimicrobial efficacy of *Cinnamomum zeylanicum* with *Ocimum sanctum*, *Syzygium aromaticum* and NaOCl against both the forms (Planktonic form and biofilm) of *E. faecalis*. They proved that NaOCl had better efficacy, followed by herbal products. *C. zeylanicum* and *S. aromaticum* showed better antimicrobial efficacy when compared to *O. sanctum*. The antimicrobial effect has been attributed to the presence of essential oils like eugenol in the cinnamon extract and membrane disruption has been proposed to be the mechanism of action [27].

Copaiba Oil

Copaiba commonly known as turpentine is an oleoresin derived from the trunk of leguminous trees (Genus *Copaifera*). The exudate which is thick and transparent is found to have anti-bacterial [28] and anti-tumour activity [29]. Piovesani *et al.* demonstrated that though copaiba oil was not completely effective against *E. faecalis*, it did possess antibacterial efficacy when compared with propolis, Ca(OH)₂ and CHX [30]. The mechanism of action claimed for its antibacterial efficacy is its direct breaking action on the cell wall of bacteria resulting in a release of the cytoplasmic components. Copaiba oil has been incorporated into a sealer (Biosealer) and its cytotoxic properties have been proved to be mild when compared to AH-plus and Endofill [31]. This *Copaifera multijuga* oil-resin (Biosealer) showed ADA acceptable levels of property in terms of flow, solubility, dimensional stability and film thickness [32].

Ferula Gummosa

It grows widely in central Asia, Mediterranean regions and Northern Africa [33, 34]. Its medicinal properties include antimicrobial, antinociceptive, antiinflammatory, anticonvulsant, antioxidant and antispasmodic activities [35 - 40] Abbaszadegan *et al.* compared the antimicrobial efficacy of *Ferula gummosa* essential oil with NaOCl and CHX. They proved that *Ferula gummosa* essential oil was effective against *E. faecalis* than NaOCl and CHX and it was better than CHX against *C. albicans* and *S. aureus*. The antimicrobial activity might be attributed due to the presence of β-pinene and α-pinene [41]

Garlic (*Allium Sativum*)

Garlic has antimicrobial [42], anticancer [43] and antiplatelet activity [44]. Eswar *et al.* [45] investigated the

efficacy of Garlic against *E. faecalis*. Garlic showed better antibacterial efficacy compared to Ca(OH)₂ and performed less when compared to 2 % CHX. The antibacterial efficacy can be due to the presence of allicin, an organosulphur compound in garlic [45, 46].

German Chamomile (*Marticaria Recutita*)

It has antimicrobial [47], antioxidant [47], antiinflammatory [48], antihyperalgesic [49] and antiedematous [49] activity. Lahijani *et al.* [50] compared the chamomile hydroalcoholic extract and tea tree oil to 2.5% NaOCl for smear layer removal. They concluded that chamomile has the ability to remove the smear layer better when compared to NaOCl, but lesser than the combination of NaOCl and EDTA. The smear layer removal could be attributed due to the presence of acidic components (capric acid, caprylic acid, chlorogenic acid, o-caumaric acid, p-caumaric acid, dihydroxybenzoic acid) in the extract [50, 51]

Ginger (*Zingiber Officinale*)

It belongs to *Zingiberaceae* family and it has also been used as a medicine from Vedic days due to its antibacterial and antifungal properties. [52, 53] Maekawa *et al.* evaluated the antimicrobial efficacy of *Glycolic propolis*, ginger extract, Ca(OH)₂, CHX and their combinations against *E. faecalis*, *C. albicans*, *Escherichia coli* and endotoxins in root canals. The ginger extract used in this study, was the dehydrated rhizome of *Zingiber officinale Roscoe*, which contains flavonoids, with 1.50 mg/mL being the minimum standard for the whole extract. It was observed that this extract was effective in eliminating the microorganisms from the root canals. [54]

Grapefruit (*Citrus Paradisi*)

Grapefruit extract is derived from the seeds and pulp of grapefruit. It has antimicrobial [55 - 57], antiplatelet [58] and antioxidant [59, 60] property. Rees *et al.* observed that Grape fruit seed extract was able to remove the smear layer. This was considered to be an important property in enhancing the patency of dentinal tubules [61].

Green Tea (*Camellia Sinesis*)

It is the most widely consumed beverage. It has antibacterial [62, 63], antifungal [64], antioxidant [62] and anti-inflammatory [65] properties. Prabhakar *et al.* [66] evaluated the antimicrobial efficacy of *Triphala*, Green tea polyphenols and NaOCl on *E. faecalis* biofilms. They observed that NaOCl had the maximum antibacterial activity followed by *Triphala* and green tea. The properties of Green tea might be due to its flavonoid content by inhibition of bacterial enzyme gyrase by binding to Adenosine triphosphate B sub unit [67]. Epigallocatechin-3-gallate (EGCG) is the most abundant polyphenol in green tea. Lee and Tan evaluated the effects of EGCG against *E. faecalis* biofilm and its virulence. They concluded that EGCG is an effective antimicrobial agent against *E. faecalis* and its antimicrobial action might be due to the production of hydroxyl radicals [68].

Gum (*Acacia Nilotica*)

It is an Arabic tree, Babul, Egyptian thor. [69] Its medicinal properties include antimicrobial [70], antifungal [71], antiviral [72], antibiotic [73], anticancer [74], and antiplatelet activity [75]. Pai *et al.* [76] compared antifungal efficacy of *Acacia nilotica* with other natural extracts against *C. albicans*. The efficacy of the extracts were in the following order: *Tunica granatum*, *Acacia nilotica*, *Foeniculum vulgare*, *Cuminum cyminum*. It contains Methyl gallate, which possesses antimicrobial activity by altering the DNA system by a Ferric - Bleomycin system [77].

Key Lime (*Citrus Aurantifolia*)

It has antibacterial [78], antifungal [78] and antioxidant [79] properties. Bolhari *et al.* found that the extract of *Citrus aurantifolia* (CA) was not able to effectively remove the smear layer when compared to 17% EDTA. It consists of 6 -8% of citric acid which could have probably helped in the removal of the smear layer [80].

Liquorice (*Glycyrrhiza Glabra*)

It is a sweet, soothing herb [81] and is useful in the treatment of dermatitis, eczema and herpes [81 - 84]. Badr *et al.* [85] investigated the efficacy of liquorice when used as an intracanal medicament. It has been shown that liquorice extract, either by itself or with Ca(OH)₂ had a significant effect against *E. faecalis* compared with that of Ca(OH)₂ alone. The reason for its antibacterial efficacy is due to the presence of glycyrrhizin [86].

Mango (*Mangifera Indica*)

Mangiferin, a major C-glucosyl xanthone is found in the *M. indica* stem bark, leaves, roots and fruits [87, 88]. The antibacterial activity of mango kernel may be attributed to the tannins present in them. [87]. Subbiya *et al.* [89] compared the antibacterial efficacy of *Mangifera indica* L. kernel and *Ocimum sanctum* L. leaves (tulsi) extracts with NaOCl and CHX against *E. faecalis* biofilm. Mango kernel showed higher zone of inhibition when compared to the other herbs [89].

Myrobolan (*Terminalia Chebula*)

The beneficial effects of Myrobolan includes antimicrobial activity [90, 91] anticaries agent [92] and antioxidant properties [93]. Vinothkumar *et al.* [94] evaluated the efficacy of herbal extracts against *E. faecalis* and *C. albicans*. The efficiency of extracts was in the following order: *Aloe vera*, *Terminalia chebula*, *Myristica fragrans*, *Curcuma longa* and *Azadirachta indica*. The active ingredient, tannin is responsible for its antimicrobial activity.

Myrtle (*Myrtus Communis*)

It is a small ever green tree of the *Myrtaceae* family with aromatic and medicinal properties. Various parts of this herb (berries, leaves and fruits) have been used as a folk medicine [95]. It has antibacterial [95, 96], antifungal [95, 97], antioxidant [95, 98, 99], antiinflammatory [95, 100], anticancer [101] and antidiabetic [102] properties. Nabavizadeh *et al.* investigated the antimicrobial activity against persistent endodontic infections (*S. aureus*, *E. faecalis*, and *C. albicans*) [103]. *M. communis* leaves showed antimicrobial activity against organisms with MIC values in the range of 0.032 - 32 µg/mL. They also assessed the chemical composition of the essential oils of *M. communis*. The main constituents of the essential oil were 1, 8-cineole (28.62%), α -pinene (17/8%), and linalool (17.53%), which could be the reason for the antibacterial efficacy of the extract [104].

Neem (*Azadirachta Indica*)

It is also known as the margosa tree or Indian neem [105]. Neem is considered as the most important medicinal plant in naturopathy. The isoprenoid group of constituents of neem have antiinflammatory [106], antibacterial [107], antifungal [108] and immunomodulatory properties [109]. Among the extracts from different parts of the neem tree, maximum antibacterial efficacy was demonstrated for the extract from the leaf [110]. Due to its promising antibacterial efficacy, it has been tried both as an irritant and medicament for the disinfection of infected root canals. Dutta and Kundabala in their study assessed the reduction in bacterial load using anaerobic culture method in infected root canals and found that the combination of NaOCl and neem irrigant produced the maximum reduction in bacterial loads [111]. Mistry *et al.* evaluated the antimicrobial activity of *Azadirachta indica*, *Ocimum sanctum*, *Mimusops elelengi*, *Tinospora cardifolia* and CHX against *S. mutans*, *S. aureus* and *E. faecalis*. The methanolic extracts of the irrigants were studied using the agar diffusion test. Even at a lower concentration (3mg), neem was effective against *S. mutans* and *S. aureus*; however, it was effective against *E. faecalis* only at higher concentrations (50%) [112]. Vinoth Kumar *et al.* evaluated the antimicrobial efficacy of *Curcuma longa*, *Aloe barbadensis*, *Azadirachta indica*, *Myristica fragrans* and *Terminalia chebula* as an endodontic irrigant against *E. faecalis* and *C. albicans*. They found that neem was highly efficient when compared to other natural irrigants against both the organisms [94]. The antibacterial properties of neem are due to the various active phytoconstituents such as alkaloids, glycosides, terpenoids, steroids and tannins [113].

Noni plant (*Morinda Citrifolia*)

It belongs to the *Rubiaceae* family. It has analgesic, antimicrobial and anticancer effects [114 - 117]. Murray *et al.* [118] investigated the smear layer removing ability of 6% *Morinda citrifolia* juice (MCJ) compared to NaOCl and CHX. They proved that when MCJ, when used in combination with EDTA, performed equal to NaOCl and better than CHX, in removing the smear layer. The MCJ can be an alternate irrigant for NaOCl, as an initial rinse. The MCJ has antimicrobial efficacy against *E. faecalis*, which could be attributed to the presence of L-asperuloside, alizarin, acubin and scopoletin [20, 67, 117]. Das *et al.* [119] compared the effect of microhardness of the dentin when treated with MCJ and Q mix. They showed that Q Mix regimen did not hamper the micro hardness when compared to MCJ.

Nutmeg (*Myristica Fragrans*)

It produces two spices - nutmeg and mace. It has antifungal [120], antibacterial [121], antidepressant [122], antidiabetic [123], antioxidant [124] and antiangiogenic activity [116]. It exerts an antimicrobial effect against *E.*

faecalis and *C albicans*. The reason for the antimicrobial efficacy might be due to the presence of myristic acid [94].

Passion Fruit (*Passiflora Edulis*)

It has been used widely in folk medicine in South America. The constituents of different extracts include flavonoids, alkaloids, cyanogenic compounds, glycosides, vitamins, minerals and terpenoid compounds [125]. It has antibacterial, antifungal [126], antihypertensive [127] and antiinflammatory properties [128]. The ability of the passion fruit juice (PFJ) to remove smear layer has also been proven by Rees *et al.* [61]. Jayahari *et al.* [129] assessed the effectiveness of various concentrations of two forms of the passion fruit juice in the elimination of *E. faecalis*. They have also compared the antibacterial property of PFJ with NaOCl, as an irrigant. They concluded that broth dilution test showed a negative growth of *E. faecalis* by PFJ alcohol 20% at 30 min, PFJ aqueous 20% at 1 h; however, NaOCl showed much better antibacterial efficacy.

Triphala

Triphala is a powder that consists of equal parts of *Emblica officinalis*, *Terminalia chebula*, and *Terminalia bellerica* [130]. In dentistry, it has been used because of their antimicrobial [131, 132], antiplaque [133], antigingivitis [133], anticariogenic [134] and anti-collagenase properties [135]. Shakouie *et al.* compared the antimicrobial efficacy of triphala with various concentrations of NaOCl against *E. faecalis* and reported that triphala exhibited better antimicrobial activity against *E. faecalis* when compared to 0.5 and 1% NaOCl [131].

Tulsi (*Ocimum Sanctum*)

It is traditionally used as a medicinal plant. It has antimicrobial [136], antidiabetic [137], and anticancer [138] properties. Gupta *et al.* [27] compared the antimicrobial efficacy of *Syzygium aromaticum*, *Ocimum sanctum* and *Cinnamomum zeylanicum* plant extracts against *E. faecalis*. They concluded that *Cinnamomum zeylanicum*, *S. aromaticum* and *O. sanctum* demonstrated antimicrobial activity against *E. faecalis*. *O. sanctum* showed less efficacy compared to *C. zeylanicum* and *S. aromaticum*. The antimicrobial property might be due to the presence of tannins and essential oils (eugenol and methyleugenol) [27]. The reduced efficacy of *O. sanctum* as compared to other groups in this study might be attributed to the lower concentration of active ingredients. But they stated that there was no direct evidence related to this hypothesis.

Turmeric (*Curcuma Longa*)

It is a popular spice and food preservative used commonly as a medicine in India, China and countries of South East Asia. It has antimicrobial [139], antiinflammatory [140] and antioxidant [140] and antitumour [141] activity. The main bioactive ingredient is Curcumin (diferuloylmethane) in turmeric [139, 142]. In an *in vitro* study on human extracted teeth, curcumin was as efficacious as NaOCl, but superior to CHX in eradicating *E. faecalis* biofilms [143]. Curcumin was recommended in support of its desirable non-toxic properties in comparison to NaOCl. Curcumin also has been found to be a better disinfectant against *E. faecalis* both in its planktonic and biofilm forms when used as a blue light photosensitizers [144]. However, curcumin did not show any toxicity against odontoblast-like cells, undifferentiated pulp cells and human embryonic stem cells [145]. Praveenkumar *et al.* found Curcumin to be efficacious against *Streptococcus mutans*, *Actinomyces viscosus*, *Lactobacillus casei*, *Porphyromonas gingivalis* and *Prevotella intermedia* in an *in vitro* model [146]. Photoactivated curcumin had the ability to eliminate the *E. faecalis* biofilm within root canal walls [147].

Zataria Multiflora

It is a natural thyme-like plant with chemical and pharmacological properties [148]. Abbaszadegan *et al.* studied essential oils of *Z. multiflora* with that of *Aloe vera* and Ca(OH)₂ against *E. faecalis*. He concluded that essential oils of *Z. Multiflora* eliminated *E. faecalis* similar to that of *Aloe vera* and Ca(OH)₂ at the end of 14 days [149]. The antimicrobial activity might be due to the presence of thymol and carvacrol. They act on the cell membrane of the organisms and results in cell lysis [149].

CONCLUSION

The research focus is increasing more towards natural products for root canal disinfection owing to their inherent properties like easy availability, cost-effectiveness, increased shelf life and low toxicity. Although only a few of the

natural products have been shown to have promising results. More combinations and various concentrations may improve their efficacy and usage for root canal disinfection in a bio-friendly way. Further animal model and *in vivo* studies has to be done to evaluate the effect of natural extracts on the long term prognosis of root canal treatment.

CONFLICT OF INTEREST

The authors confirm that this article content has no conflict of interest.

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