



Phytoendodontics: Novel Vista in Endodontics- A Review

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ABSTRACT:

Herbs have been used as a traditional form of medicine since ancient times to cure various diseases due to their medicinal properties. These are safe, easily available, and economical. Herbal extracts derived from medicinal plants' roots, leaves, seeds, stems, and flowers, have been used as anti-inflammatory agents, antiseptics, antibacterial, antimicrobial, antifungal, antibiofilm, antivirals, and analgesics. The field of dentistry has also begun to use herbal extracts to relieve tooth pain, gum inflammation, canker sores, etc. In endodontics, plants and their extracts can be used as irrigants, intracanal medicaments, pulp capping agents, and storage media for avulsed teeth. These were explored to prevent the potential side effects caused by conventional chemical agents. This article provides insight into the phytotherapeutic agents that can provide clinicians a road map to use safer alternatives to chemical agents used in endodontics and a baseline to conduct further trials using similar or combination herbal irrigants in larger sample sizes with long-term follow-ups.

Introduction:

The use of herbal extracts for curing various diseases is known as "Phytotherapy or Phytomedicine or Ethnopharmacology". The concept of phytotherapy originated with French physician **Henri Leclerc in 1913 and published " Handbook of Phytotherapy" in 1922.** In 1960 German herbalist Rudolf Fritz Weiss published *Lehrbuch der Phytotherapie*(1960; Herbal Medicine), which became the definitive German textbook on the topic. ¹

Thorough canal disinfection is crucial for the success of endodontic treatment, for which endodontic irrigants are used. The most commonly used irrigants are sodium hypochlorite (NaOCl), ethylenediamine-tetra-acetic acid (EDTA) solution, and chlorhexidine (CHX) can cause harmful side effects. Intracanal medicaments such as calcium hydroxide [Ca(OH)₂] cause collagen breakdown and lead to the weakening of radicular dentin. Triple antibiotic paste (TAP) containing minocycline, metronidazole, and ciprofloxacin have potential side effects of tooth discoloration and demineralization of dentin.²⁻³ NaOCl is recommended as the main irrigant

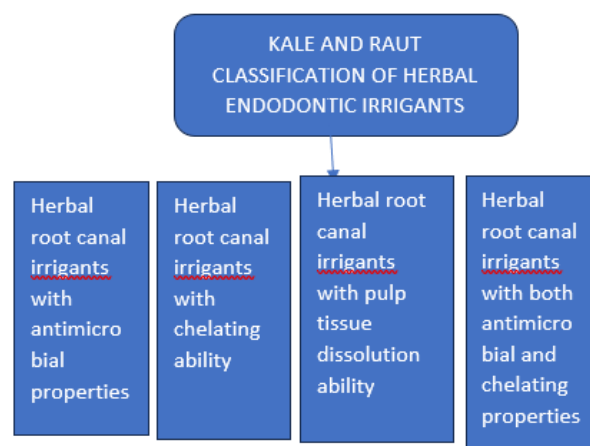


used due to its broad-spectrum antimicrobial activity and its unique capacity to dissolve necrotic tissue remnants.⁴ In addition, chelating solutions are recommended as adjunct irrigants to remove smear layer before filling the root canal system. However, in the dental literature several mishaps during root canal irrigation have been described, ranging from damage to the patient's clothing, splashing of irrigant into the patient's/operator's eye, extrusion through the apical foramen, or air emphysema and allergic reactions to the irrigant.⁵ Shovelton presented cases that had signs of emphysema of the face, the suborbital region and neck. Severe tissue reactions with pain, swelling, haemorrhage and potentially secondary infection or lasting paraesthesia was observed. If secondarily infected by pathogenic flora, there is a risk for sepsis and endocarditis.⁶ These toxicological concerns related to their use have renewed the interest in search of newer alternatives. This article reviews the herbal agents that are used in endodontics covering their mode of action, advantages and their efficacy when compared to conventional agents that are used.

The **use of phytotherapeutic agents** in endodontics can be in the form of:

- Root canal irrigants
- Intracanal medicaments
- Retreatment agents
- Pulp capping agents and
- Storage media for avulsed tooth

Purva Pravin Kale, Ambar W. Raut proposed classification system for herbal endodontic irrigants as follows:



HERBAL IRRIGANTS IN ENDODONTICS

1. Azadiarachta indica – Neem

It is also called as “Indian neem / Margosa tree / Indian lilac”. This tree in India is considered holy and cultivated in various parts for religious and medicinal reasons. Tetranortriterpenes extracted from neem are nimbin, nimbidinin, nimbolide, and nimbidinic acid. It possesses a significant antibacterial action against many gram positive and gram-negative microorganisms such as *S.mutans*, *M.tuberculosis*, streptomycin-resistant strains, *M.pyogenes*, *V.cholera* & *Klebsiella pneumonia*.⁷ Hegde et al. compared antibacterial efficacy of 2%NaOCl, neem leaf extract (NLE) with other herbal irrigants against *E. faecalis* and *C. albicans*, using the agar diffusion method and results showed that NLE showed the highest zone of inhibition against *E. faecalis* and *C. albicans* ⁸ which was in accordance with other studies.^{9,10} Setia et al compared the smear layer removal efficacy of NLE and other herbal irrigants using SEM where NLE performed significantly better in removing the smear layer at coronal, middle, and apical levels.¹¹

2. Curcuma longa (Turmeric)

It is extensively used as a spice, food preservative, coloring material, and traditional medicine in India and



Southeast Asia. *C. longa*, botanically related to the Zingiberaceae family. Turmeric contains polyphenols like curcuminoids [curcumin (diferuloylmethane), dimethoxycurcumin & bisdimethoxycurcumin] and various volatile oils like tumerone, atlantone & zingiberone¹³. In this curcumin is the main yellow pigment which enhances the GTPase activity of protein-filamenting temperature-sensitive mutant Z (FTSZ) FTSZ, which is detrimental to bacteria and is responsible for its therapeutic effects. As an irrigating solution, turmeric prevents the further formation of biofilms as it eliminates the extracellular polymeric matrix which serves as the source of nutrients/substrate for further cell growth of bacteria.¹² Neelakanthan et.al showed that NaOCl (3%) showed maximum antibacterial activity compared to *C.longa* against *E.faecalis* biofilm formed on the tooth substrate.¹³ An in vitro study also proved the antimicrobial activity of white turmeric extracts against *S.viridans*.¹⁴ Slem et al evaluated the effect of bleached turmeric extract on dentin microhardness which had a comparable effect to NaOCl.¹⁵ However, bleaching of turmeric affected its chemical properties and lowered its active agents and polyphenols content. Another study proved that Curcumin irrigant and cryotherapy reduced post operative pain as a final irrigant in reducing post endodontic pain in primary teeth.¹⁶

3. Melaleuca alternifolia – Tea tree oil

This tree is native to wet lowland locations of Australia with a height of 10-25 feet and has a papery white bark, dark green needle-like leaves, and colourful blossoms. It possesses great antibacterial and antifungal properties due to the presence of its major active component terpinene 4-ol (30%-40%). It has also mild tissue solvent action that can dissolve necrotic pulp tissue.¹⁷ An in vitro study showed that tea tree oil which might disinfect the root canal system as effective as NaOCl. Further, the toxicity

of tea tree oil is lesser than NaOCl. It showed invitro effectiveness against *E.faecalis* in comparison with 3% sodium hypochlorite.¹⁸ A study also proved that it can be used as an alternative root canal irrigant, although long-term in vivo studies are warranted.¹⁸ In an in vitro study done by Sadr Lahijani, it is demonstrated that tea tree oil is as effective as NaOCl and less toxic than NaOCl.

4. German chamomile (Matricaria recutitia)

It has been used for centuries as a medicinal plant mostly for its anti-inflammatory, analgesic, antimicrobial, antispasmodic and sedative properties. It is an annual plant, native to Europe and Western Asia, and is used in parts of the world as a table tea. The flower of the chamomile plant contains variety of active chemical components, which are responsible for its medicinal applications.¹² Lahijani et.al studied the effect of its hydroalcoholic extract and tea tree oil used as irrigants on removal of smear layer under SEM. They concluded that effective removal of smear layer of chamomile extract was found to be significantly more effective than distilled water and tea tree oil.¹⁸

5. Triphala

Triphala is an Indian ayurvedic herbal formulation consisting of dried and powdered fruits of three medicinal plants Terminalia bellerica, Terminalia chebula, and Emblica officinalis. Triphala has been proven to be safe, containing active constituents that have antioxidant and radical scavenging activity that has an added advantage over traditional endodontic irrigants.¹² A recent study showed that Triphala was as effective as NaOCl and a doxycycline-based irrigant on root canal biofilms that were 3 weeks old which was not in accordance with previous study that proved NaOCl performed better.¹⁹ It is also a very good chelating agent because of the fruits that are rich in citric acid and holds promise in the removal of the smear layer. Pujar et al. showed the antimicrobial



efficacy of Triphala, against *E. faecalis* biofilm but lesser than Sodium hypochlorite. Another study showed that the overall antimicrobial effects of CHX were superior to Triphala.²⁰

6. Morinda citrifolia (Noni)

It has been reported to have a broad range of health benefits for cancer, infection, arthritis, diabetes, hypertension, and pain.²¹ Murray et.al showed the efficacy of MCJ was similar to NaOCl in conjunction with EDTA as an intracanal irrigant. MCJ appears to be the first fruit juice to be identified as a possible alternative to the use of NaOCl as an intracanal irrigant.²² Another study evaluated its smear layer removal capacity and microhardness value of root canal dentin and concluded that 6% MCJ followed by a final flush of 17% EDTA can be regarded as an effective solution for smear layer removal without adversely affecting microhardness property of root canal dentin.²³

7. Green tea polyphenols (GTPs)

It is a widely consumed beverage throughout the world. It is a traditional drink of Japan and China. GTPs have significant antioxidant, anti-inflammatory, thermogenic and antimicrobial properties in numerous human, animal, and in vitro studies. Tea also contains natural fluoride, which may help prevent dental caries.²⁴ Agarwal et.al showed that both ozonated water and green tea could be considered good alternatives to conventional root canal irrigants in the primary teeth.²⁵ Another study compared the antimicrobial effect of different concentrations of GTE (green tea extracts) with that of two commonly used irrigants on *E. faecalis* in the root canal system. The results showed that green tea extract can be used in endodontic treatment as the final root canal irrigant considering its natural and antimicrobial ability.²⁶

8. Liquorice

Liquorice is the most commonly used crude drug and flavoring agent in kampo medicines [traditional Chinese medicines modified in Japan]. Liquorice was found to inhibit the growth and adherence of the cariogenic bacteria *S. mutans*.¹² A study reported that Liquorice extract was as effective as triamcinolone acetonide but safer and may be used as an alternative treatment for lichen planus.¹² Satti et al studied the antimicrobial efficacy of Triphala and liquorice against *E. faecalis* and concluded that triphala showed the highest antimicrobial efficacy followed liquorice.²⁷

9. Allium sativum (Garlic)

It is a species in the onion genus, *Allium*. It has been used throughout its history for both culinary and medicinal purposes. The active ingredient of garlic is allicin which is responsible for and produces immunological functions which has detrimental action on the cell wall and cell membrane of the bacteria. It is proven to exhibit tissue dissolving properties which makes it a good root canal irrigant.²¹ It was found that the ethanolic extract of garlic is effective against *S. aureus* and it exhibits both bacteriostatic and bactericidal activity. Also, it was shown that the aqueous solution of garlic has an antibacterial effect against 17-multidrug-resistant bacterial isolates. So, this can be utilized as an herbal alternative to NaOCl.²⁸ Mehta et al showed significant antibacterial activity against aerobic and anaerobic bacteria.²⁹ Another study has shown that the clinical and radiographic success rate of Garlic extract as an irrigant for pulpectomy of primary molar root canals was found mildly lower than NaOCl.³⁰



10. Ginger

The rhizomes of Zingiberaceae are commonly used ingredients in a large number of foods & beverages across the world. They were found to have anti-inflammatory, analgesic, antipyretic, antimicrobial, and hypoglycemic actions. It is reported to have tissue dissolving capacity.²¹ Ethanol and n-hexane extracts of ginger exhibit antibacterial activities against aerobic bacteria associated with periodontitis. It was found that the ethanolic extract was effective against *Candida albicans* and *E. faecalis*. Basma et.al showed that ethanolic extracts of both garlic bulbs and ginger rhizomes can be used as endodontic irrigants.³¹ Park et al in 2008 revealed that the ethanol and n-hexane extracts of ginger exhibited antibacterial activities against three anaerobic Gram-negative bacteria.³² Giriraju et al proved the *in vitro* antimicrobial potential of 10% ethanolic ginger extract against *S. mutans*, *E. faecalis*, and *C. albicans*.³³

11. Aloe barbadensis – Aloe vera

Aloe vera contains clear gel surrounded by the green part of a leaf. Its antibacterial action is due to protein synthesis in the bacterial cells and it is rich in vitamins, minerals, enzymes, lignin, saponins, salicylic acids, and amino acids.²¹ An *in vitro* study showed aloe vera can be used as an antibacterial agent in novel drugs. Noushad et al showed that Aloe vera has the least zone of inhibition with *E. faecalis* & no zone of inhibition with *C. albicans* when compared to cashew apple extract, papaya leaf extract, and guava leaf extract.³⁴

12. Acacia nilotica – Babool

Babool also called as Gum Arabic tree is common species found in the Indian and African sub-continent. It consists of tannins, phenolic compounds, essential oils & flavonoids which are all responsible for its antimicrobial,

antioxidant, antifungal, antiviral, and antibiotic functions.²¹ Active constituent of babool is tannins, it acts by Inhibiting oxidative phosphorylation by mitochondria and inhibiting the electron transport system in mitochondria.²⁸ Gupta et al showed that *Acacia nilotica* demonstrated significant antibacterial activity against *E. faecalis* and can be employed as an alternative to NaOCl.³⁵

13. Hybanthus enneaspermus Muell (Ratnapurus)

This belongs to the family Violaceae, popularly known as Ratanpurus (Hindi) is an herb seen in the tropical and subtropical regions of the world. It has been reported to have anti-inflammatory, antitussive, anti-plasmodial, anticonvulsant, and free radical scavenging activity.²¹ This plant extract was tested for its antibacterial activity against selected *E. faecalis* of the urinary tract, it showed significant effect in ethanol form and moderate effect in aqueous form. Hence this herb was selected to test against the same organism that resides in the root canals also. Vamsi et al showed that 50% aqueous extract inhibits the most resistant anaerobe *E. faecalis* and its effect is comparable with that of CHX.³⁶

14. Orange (Citrus sinensis)

Orange oil does not have any harmful effects, has low solubility in water, and is soluble in alcohol. It is used in pharmaceuticals for fragrance and flavor. It also has an expectorant action.

The mechanism of action is due to their hydrophobicity, it punctures the cell membrane which in turn ruptures cell structure and turn causes leakage of components within bacteria.²⁸ An *Invitro* study showed that *C. aurantifolia* extract of orange removed more smear layer in coronal and middle parts compared with the alcoholic extract but not higher than EDTA. However, there was no



significant difference in the removal of the smear layer in the apical third.³⁷

15. Myristica fragrans (Nutmeg)

It is commonly used spicy in Indian households and is known for its antimicrobial and anti-inflammatory. It possesses anti-bacterial properties which is mainly due to its chief constituent myristic acid. In a study conducted by Vinothkumar et al²⁸, five different herbal extracts were evaluated as anti-microbial endodontic irrigants. *Myristica fragrans* showed good antibacterial efficacy but was inferior to neem.³⁸

16. Tulsi (Ocimum sanctum)

Tulsi has been used in ayurvedic medicine since ancient times. It possesses antibacterial, antioxidant, analgesic, antipyretic, anti-ulcer, antidiabetic and anticancer activities.²⁸ Tulsi is composed of 71% eugenol and 20% methyl eugenol where eugenol is the key phytochemical constituent responsible for antimicrobial activity.²⁸ A rise in antibacterial activity against *E. faecalis* was elicited by an increase in its concentration. Phytochemical screening of tulsi revealed that it contains alkaloids, steroids, and tannins. The combination of tulsi and CHX yielded a dark greenish precipitate possibly due to the interaction of steroids with components of CHX.³⁹ It possesses hydrophobicity, which enables it to break down the lipids of bacterial cell membranes and mitochondria, disturbing the structures and rendering them more permeable as a result of which leakage of ions and other cell contents can occur.³⁹ Ranjitha et. al showed that Tulsi has highest amount of smear layer removal efficacy in the apical third of the root canal than neem, NaOCl, and orange peel. Tulsi showed reduction in CFU against *E. faecalis* but lower than CHX, Neem.⁴⁰

HERBAL ALTERNATIVES USED AS INTRACANAL MEDICAMENTS IN ENDODONTICS:

1. Agaricus bisporus – Mushroom

It possesses medicinal properties like immune-modulatory, anti-inflammatory, antiviral, antioxidant, and antimicrobial properties.⁴⁰ The gel form of mushroom is used as intracanal medicament. This is prepared by sun drying, grinding, and boiling it with distilled water, followed by adding hydroxyl ethyl cellulose as a thickening agent in a 2:1 ratio and injected into the canal with a syringe. It has been revealed that the gel form of the extract increases the contact time which enhances its performance.⁴¹ It has the highest efficacy against gram-negative bacteria. Kurian et al revealed that the antibacterial activity of the mushroom extract was highest followed by *A. vera* extract and then calcium hydroxide. The antibacterial activity of all the groups increased with time.⁴¹

2. Arctium lappa – Burdock

It possesses antibacterial, antifungal, antiplatelet, antioxidant, diuretic, anxiolytic and HIV inhibitory effect. It contains sterols, tannins, sulphur-containing polyacetylene, volatile fatty oils & polysaccharides.⁴² The antimicrobial properties of *A. lappa* was studied and it was concluded that it showed a great effect against most organisms like *E. faecalis*, *S. aureus*, *P. aeruginosa* & *C. albicans*.⁴² Gentil et al evaluated the antibacterial activity of agent prepared from an ethyl acetate fraction (AcOEt) extracted from *Arctium lappa*, it was compared with Ca(OH)_2 as an intracanal dressing. The phototherapeutic agent extracted from an AcOEt fraction of *A. lappa* inhibited the growth of all the microorganisms.⁴³



3. Acacia nilotica (Babool)

The plant is a richer source of cysteine, methionine, threonine, lysine, tryptophan, Potassium, phosphorus, magnesium, iron and manganese. Babool is also used for the treatment of skin, sexual, stomach and tooth problems .it has been proved as effective medicine in treatment of malaria, sore throat (aerial Part) and toothache (bark).²¹ Khan et.al suggested that babool has shown to possess antibacterial activity against S.mutans and E.faecalis.⁴⁴ Kumar suggested that its extracts have strong antimicrobial activity against E.faecalis but babool at a concentration of 50% had the highest antimicrobial activity against E.faecalis.⁴⁵

3. Carvacrol

Carvacrol (thymol isomer) is present in the essential oil of Origanum vulgare, which is edible plant oil used in food products. It has a broad spectrum of antibacterial activity; it works by inhibiting ATPase activity and increasing the nonselective permeability of bacterial cell membranes. Therefore, it inhibits microbial colonization and makes microbes more sensitive to antibacterial agents. It has an antibacterial effect against enterobacteriaceae family including E.coli, Salmonella species. It also helps in repair of periapical tissues. This property is due to the presence of phenolic component, which stimulates pulpal fibers, phenomena known as hormesis.⁴⁶ Sharifian et.al concluded that Carvacrol can be used as an intra appointment intracanal medicament.⁴⁷ Gayathri et.al concluded that anti-inflammatory activity of the Intracanal Medicament Containing Oregano Essential Oil (OEO) and hence can be used clinically to treat infected root canals.⁴⁸

4. Brazilian Casearia sylvestris.

Very common in America and Brazil popularly known as 'Guacatonga'. Alcoholic extract of C. sylvestris

constitutes a rich source of phospholipase A2 inhibitors, which reduce the acute phase of the inflammatory process and prolong the regenerative phase. It offers healing, antiseptic, anti-ulcerative, diuretic, tonic, stimulant, and antimicrobial properties. It is shown as an alternative intracanal medicament. Silva et al conducted a study on Wistar rats and concluded that it may offer a good alternative as short term intracanal medicaments.⁴⁹

5. Psidium guajava (Perukam - Guava)

The fruits and leaves of this shrub contain essential oil rich in cineol, tannins, tripentnes and flavonoids. Ethanol extracts of it has higher antimicrobial activity, especially against E. faecalis. The leaf extracts of P. guajava have anti-inflammatory and antimicrobial activities, also been used extensively as a hypoglycaemic agent.²¹ The active flavonoid compound gujaverin isolated from the methanol leaf extract of P. guajava has been demonstrated by one of the researchers to be a potential antiplaque agent by inhibiting the growth of S.mutans. In an invitro study Guava leaf extract showed significant inhibitory effects against E.faecalis and C. albicans.⁵⁰ Vijaya et al used dried and powdered leaves and ethanolic and water extracts at 5% and 20% was prepared. Results showed that 20% ethanolic guava leaf extract was better than other 5% ehanalolic and water extracts, and control groups.⁵¹

6. Salavadora persica (Peelu – Mustard tree)

Many studies have demonstrated that extracts of S.persica possess various antiplaque, antiperiopathic, anticaries, anti-inflammatory, and antimycotic effects. Its chewing sticks contain trimethyl amine, salvadorime chloride, and fluoride in large amounts.⁵⁰ 15% alcoholic extracts of it have maximum antimicrobial action. It can be used as a substitute for NaOCl and chlorhexidine as a root canal irrigant.⁵⁰ Samir et.al tested the biocompatibility and antibacterial properties of S. persica extract as an



intracanal medication in comparison with calcium hydroxide. *S. persica* showed better antibacterial effects against *E. faecalis* and *S. mutans* which was comparable to those of Metapaste. It was concluded that *S. persica* extract is a promising material that can be utilized as an intracanal medication, but its use requires further research.⁵²

7. Citrus limonum (Nimbuka - Lemon)

Fresh lemon solution is used as root canal medicament due to its wide antibacterial efficiency including *E. faecalis*. Oil of lemon is topically used for the treatment of oral thrush and stomatitis.⁵⁰ Lemon solution has pH of 2.21. It is effective in clearing the smear layer thereby acting as a chelating agent. Fresh lemon solution has antibacterial has shown antibacterial efficiency against *E. faecalis* and hence can be used as an intracanal medicament. Studies shows that complete elimination of *E. faecalis* was not achieved and $\text{Ca}(\text{OH})_2$ was more effective.⁵³

8. Vaccinium macrocarpon– Cranberry

In ancient times, cranberry was used to treat stomach aches, scurvy and other liver diseases. They have antibacterial properties. The compounds present in cranberry prevents acid formation & reduces the incidence of dental caries. As cranberry juice is naturally very acidic, it may cause erosion of the teeth if used too often which can lead to pain & sensitivity in the teeth.²¹ Shakir et.al showed that the addition of cranberry and grape seed extract into the intracanal medicaments improves the fracture resistance property.⁵⁴ Pushpalatha et.al has shown that ICM containing Grape seed, and cranberry extract showed good biocompatibility and can be used as an alternate to commercially available chlorhexidine gel ICM.⁵⁵

9. Eucalyptus globulus – Eucalyptus

It is an essential oil obtained from the leaf of Eucalyptus tree. It has anti-inflammatory and antibacterial activities which can be used as a vehicle for intracanal medicaments. Studies have reported that Eucalyptus oil in pure concentration were effective on *P.aeruginosa* and *Escherichia coli*. Considering its antimicrobial potential against resistant microorganisms, it is expected that its association with $\text{Ca}(\text{OH})_2$ contributes to the control of endodontic infections.⁵⁶

10. Psoralea corylifolia

Bakuchiol was isolated from seeds and leaves of *P. corylifolia*, its extract contains a number of bioactive compounds including flavonoids, coumarins, meroterpenes and benzofuran glycosides that are the molecular basis of its action. Neobavaisoflavone is isolated from fruits and seeds of *P. corylifolia*. This is found to be effective against *E. faecalis*. It acts by causing injury to the cell membrane and inhibiting DNA polymerase.⁵⁰

HERBAL EXTRACTS IN VITAL PULP THERAPY:

1. Propolis

Recently Propolis has been recognized as a useful material for human health and veterinary medicine. Made by the honeybee, it is a potent antimicrobial and anti-inflammatory agent. Honeybees collect the resin from cracks in the bark of trees and leaf buds. In general, Propolis is composed of 50% resin and vegetable balsam, 30% wax, 10% essential and aromatic oils, 5% pollen and 5% other various substances, including organic debris depending on the place and time of its collection.⁵⁷ The



most important pharmacologically active constituents are flavonoids, which are well-known plant compounds that have antioxidant, antibacterial, antifungal, antiviral, and anti-inflammatory properties. A study by Ahangari et al provides evidence that Propolis has advantages over calcium hydroxide as a capping agent in vital pulp therapy and this material induces the production of a tubular and high-quality dentin.⁵⁷ Hhamdy et al concluded that push out bond strength and dentinal penetration depth were improved with time except for the MTA group testing its dentinal penetration depth.⁵⁸

2. Nigella Sativa

Nigella sativa is an annual flowering plant in the family Ranunculaceae also called black cumin, black seed, is native to the south and southwest Asia. Researchers have attributed the health-promoting benefits of the black seed to its active components and high nutritional content. The seeds comprise 28-36% fixed oils, proteins, alkaloids, saponins, and 0.4-2.5% essential oils. Many pharmacologically active compounds have been isolated from black seeds, but the most reported active constituents are thymoquinone (TQ), dithymoquinone, thymol, and thymohydroquinone. A study searched for a new capping medicament in pediatric dentistry to replace formocresol because of its reported side effects. The results showed that NS specimens histologically revealed mild to moderate vasodilatation with few inflammatory cells and a continuous odontoblastic layer. Faour et al showed that NS caused less severe inflammatory reactions than CH, it was concluded that NS paste can be as a direct pulp capping material as it led to a faster hard tissue formation than calcium hydroxide with less inflammation.⁵⁹

RETREATMENT AGENTS:

Solvents are essential for the thorough cleaning of filling material/debris and effective disinfection of the root canal system. Many herbal preparations like Blue-Gum tree oil and Orange oil have been investigated for endodontic retreatment utilizing the solvent actions of the oil.⁶⁰ Oyama et al reported Eucalyptus oil and orange oil as effective as chloroform and xylene to dissolve or soften gutta-percha. Orange oil is readily available, inexpensive, and displays a solvent effect that is close to that of chloroform. In addition, it has antimicrobial activity.⁶¹ Orange solvent has the advantage over other plant derived solvents that its viscosity is closer to that of water and it can thus easily be administered through an endodontic irrigating syringe. In addition, it has a pleasant smell, which is easily acceptable to patients.⁶² Jantararat et al revealed that chloroform was significantly the best solvent in softening gutta-percha, followed by grapefruit oil and tangerine oil, while the least effective solvents were lime oil and lemon oil.⁶³

STORAGE MEDIA FOR AVULSED TOOTH:

Healing following avulsion and replantation is dependent on the extent of pulpal and periodontal ligament tissue damage. Therefore, immediate replantation is the recommended treatment of choice for an avulsed permanent tooth. Use of an appropriate interim transport medium is required for better prognosis. Numerous studies have researched and advocated the use of media like saliva, milk, Hank's balanced salt solution (HBSS) and ViaSpan. However, current research has indicated the use of newer herbal agents as promising interim transport media for an avulsed tooth. The plant-based herbal media in this regard includes propolis, red mulberry juice, garden sage extracts, coconut water, and GTEs.⁶⁴



The efficacy of propolis extract in maintaining the viability of human periodontal ligament (PDL) cells was evaluated in dogs after storage in this extract. The in vitro results showed that the efficacy of propolis in maintaining the functional viability of PDL cells was similar to that of milk. The in vivo results showed that teeth maintained in propolis medium exhibited replacement resorption with a significant reduction in tooth length, similar to teeth maintained in saliva and dried teeth.⁶⁵

Mori et al. evaluated propolis as storage media for avulsed teeth and the ideal time period for keeping the tooth inside it. According to the results of this study, the use of propolis as a storage media for maintaining avulsed teeth could be highlighted, and the 6-h period was more appropriate.⁶⁶

Ozan et al. determined the ability of the juice of Morus rubra fruit to serve as a temporary storage medium for the maintenance of PDL cell viability of avulsed teeth. Results showed that the efficacy of 4.0% and 2.5% M. rubra at 3, 6, and 12 h was found to be significantly better than HBSS. At 24 h, 4% M. rubra was found to be similar to HBSS. Thus the results showed that the juice of the fruit sample of M. rubra studied at a concentration of 4% was a more effective storage medium than other groups. Hence the juice of the fruit of M. rubra can be recommended as a suitable transport medium for avulsed teeth.⁶⁷

In another investigation, skimmed and whole milk, followed by natural coconut water and HBSS, were the most effective media in maintaining cell viability of PDL fibroblasts.⁶⁸

GTE (Green tea extracts) has been reported to have remarkable anti-inflammatory, antioxidant and anticarcinogenic effects.⁶⁹

Hwang et al. investigated in vitro the efficacy of GTE as a storage medium for avulsed teeth. The result indicates that there was no difference in cell viability between GTE and HBSS media, whereas GTE showed higher cell viability than other media. Thus, the efficacy of GTE in maintaining the viability of human PDL cells is similar to that of HBSS and higher than milk. It was concluded that GTE could be a suitable, alternative storage medium for avulsed teeth.⁶⁹

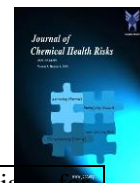


Summary

❖ Sl.no	Botanical name	Common name	Active constituents	Application in endodontics
1	Azadiarachta indica	Neem	Nimbin, nimbidinin, nimbolide and nimbidinic acid	Irrigant
2	Melaleuca alternifolia	Tea tree oil	Terpinen-4-ol	Irrigant
3	Curcuma longa	Turmeric	Curcuminoids, tumerone, atlantone & zingiberone	Irrigant
4	Morinda citrifolia	Noni fruit	Acubin, L-asperuloside, atizarin & anthraquinone	Irrigant
5	Triphala	Triphala	Tannins, quinones, flavonoids, gallic acid and vitamin C	Irrigant
6	Syzigium aromaticum	Clove	Eugenol, isoeugenol and vanillin	Intracanal medicament
7	Acacia nilotica	Babool	Tannins, phenolic compounds, essential oils & flavonoids. Secondary metabolites including <u>amines and alkaloids</u> , <u>cyanogenic glycosides</u> , cyclitols, fatty acids and seed oils, fluoroacetate, gums, <u>hydrolyzable tannins</u> , <u>flavonoids and condensed tannins</u>	Irrigant and medicament.



8	Allium sativa	Garlic	Allicin	Irrigant and intracanal medicament
9	Zingiber officinale	Ginger	Zingerone, gingerol & 6-shagoal	Irrigant and intracanal medicament
10	Propolis	Honey bee wax	Flavonoids and cinnamic acid derivatives	Intracanal medicament, pulp capping agent and storage media for avulsed tooth
11	Aloe barbadensis	Aloe vera	Aloin and aloe-emodin	Irrigant and intracanal medicament
12	Agaricus bisporus	Mushroom	Plectasin, confuentin, grifolin and neogrifolin	Intracanal medicament
13	Arctium lappa	Burdock	Sesquiterpene lactones and inulin	Intracanal medicament
14	Glycyrrhiza glabra	Liquorice	Triterpenoid compound - Glycyrrhizin	Irrigant, intracanal medicament
15	Rhus plants	Rhus plants	Tannins & gallic acids	Intracanal medicament
16	Vaccinium macrocarpon	Cranberry	Flavonoids, phenolic acids, anthocyanins and condensed tannins	Intracanal medicament
17	Psidium guajava	Guava	Guajaverin	Intracanal medicament
18	Ricinus communis	Castor	Ricinoleic acid	Intracanal medicament
19	Vitisvinifera	Grapeseeds	Proantho-cyanidin (PA)	Irrigant
20	Camellia sinensis	Green tea	Catechins and Proanthocyanidins	GTP: Irrigant GTE: storage media for avulsed tooth
21	Citrus sinensis	Orange	Polymethoxylated flavonoids, terpenoids, limonene, linalool, aliphatic hydrocarbon alcohols, octanal	Irrigant and retreatment agents
22	Myristica fragrans	Nutmeg	Myristic acid	Irrigant
23	Ocimum sanctum	Tulsi	Tannins, Aerosol acid, Oleanolic acid, â	Irrigant and intracanal medicament



34	Morus rubra	Red mulberry	Anthocyanosides	Storage media for avulsed tooth	
35	Salvia officinalis	Garden sage	Essential oil constituents	Storage media for avulsed tooth	
36	Cocos nucifera	Coconut plant	Flavonoids, alkaloids, steroids, saponin	Storage media for avulsed tooth	
37	Casearia sylvestris	Gulkhair - Wild coffee	rich source of phospholipase A2 inhibitors	Intracanal medicament	
				caryophyllene and germacrene	
24	Nigella sativa	Black cumin	<u>thymoquinone (TQ), dithymoquinone, thymol, and thymohydroquinone</u>	Pulp capping agent	
25	Clitoria ternatea	Telang flower, butterfly pea plant	active peptide compound, clotide	Antibiofilm activity	
26	Salvadora persica	Mustard tree (miswaak/tooth brush tree)	Volatile oils, flavonoids, alkaloids, terpenoids, tannin	Intracanal medicament	
27	Matricaria chamomilla	German chamomile	Terpenoids, flavonoids	Irrigant	
28	Hybanthus enneaspermus	Ratnapurus	aurantiamide acetate, isoarborinol, b-sitosterol and triterpene	Intracanal medicament	
29	Citrus limonum	Lemon	Citric acid, vitamin C	Chelating agent , intracanal medicament	
30	Papaine	Papaya	proteolytic cysteine enzyme	Intracanal medicament	
31	Carvacol	essential oil of Origanum vulgare	works by inhibiting ATPase	Intracanal medicament	
32	Eucalyptus globulus	Eucalyptus, blue gum tree	Flavonoids	Retreatment agents	
33	Psoralea corylifolia Linn.	Bakuchi - Psoralea seeds	flavonoids, coumarins, meroterpenes and benzofuran glycosides	Intracanal medicament	

Conclusion:



We are living in an era of evidence-based medicine. Any material with potential clinical application must go through a series of tests to demonstrate biocompatibility to the tissues of the oral cavity as well as marked advantages in terms of efficacy in endodontics when compared to contemporary materials. Herbal formulations are safe, easily available, economical and mainly there is a lack of microbial resistance so far. This article provides information that can help clinicians to use safer alternatives to chemical irrigants in dental patients and also a baseline to conduct further trials using similar or a combination of herbal irrigants in a larger sample size and with long-term follow-ups. Many studies have concluded that herbal extracts produced promising results when used as endodontic irrigant and intracanal medicament.

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