Herbendodontics – Phytotherapy In Endodontics: A Review

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Plants have been used for health disorders and to prevent diseases including epidemics since times immemorial. Many plants are used as Phytomedicines in dentistry because they possess varying degree of biological and antibacterial effects. In endodontics, plants and their extract can be used as irrigant and intracanal medicament to prevent the potential side effects caused by conventional chemical agents. Such herbal preparations are derived from the roots, leaves, seeds, stems and flowers of medicinal plants. This paper emphasize on the advantages of different herbal plants and their products when used as phytotherapy in endodontics.

Keywords: Endodontics, Root canal system, Microorganisms, Herbs, Phytotherapy, irrigants, intracanal medicaments, E. faecalis.

The potential role of microorganisms in the initiation and progression of endodontic infections has long been established. So, the main objective of endodontic treatment is either prevention or repair of periapical pathosis caused by these microorganisms. In order to achieve complete elimination of infection and to promote healing, “chemo-mechanical preparation” of the tooth is carried out by mechanical instrumentation of the root canal space with simultaneous use of chemical agents.

Nowadays there has been an increasing trend to seek herbal alternatives for endodontic treatment. This way of use of herbas for curing various diseases is known as “Phyotherapy or Phytomedicine or Ethnopharmacology”. In recent years, there has been an extreme growth in the field of herbal medicine due to their beneficial properties, ease of availability and less side effects.

The root canal anatomy is complex and the challenging part of endodontic treatment is to disinfect this complex system most effectively. For this purpose, irrigants and intracanal medicaments are used in endodontics which primarily reduces the microorganisms inside the root canal system. The most commonly used irrigants in endodontics are sodium hypochlorite (NaOCl), ethylenediamine-tetra-acetic acid (EDTA) solution and chlorhexidine (CHX) which can cause harmful side effects. Intracanal medicaments such as calcium hydroxide causes collagen breakdown and leads to weakening of radicular dentin. Triple antibiotic paste containing minocycline, metronidazole and ciprofloxacin have potential side effects of tooth discoloration and also cause demineralisation of dentin.

In the search for novel irrigants and intracanal medicaments with good biocompatibility...
and antimicrobial activity, researchers have explored a number of potential agents of natural origin. India has rich source of medicinal plants that are widely distributed throughout the country. In ancient times, they believed that right herb in the right combination keeps the body system in harmony. Herbs contain different components such as essential oils, flavonoids, tannins and alcohols through which it attains varying degree of medicinal values.

Plants, animals & minerals are all sources of phytotherapeutic agents. Many herbs have potential use in endodontics which can be used with minimal incidences of complications.

**Herbal Alternatives used as Irrigants in Endodontics**

**Azadirachta indica – Neem**

It is also called as “Indian neem / Margosa tree / Indian lilac”. This medicinal tree common in India, is considered holy. US National Academy of Sciences entitled neem as “a tree for solving global problems” as it produces numerous biological activities.

Tetranor triterpenes extracted from neem are nimbin, nimbidinin, nimbolide and nimbidinic acid. The crude extracts from their leaves, bark, flowers, roots and seeds have various pharmacologic actions. It possess a significant antibacterial action against many gram positive and gram negative microorganisms such as Streptococcus mutans, M.tuberculosis, Streptomyacin resistant strains, M.pyogenes, Vibrio cholera & Klebsiella pneumonia.

From the studies done by Bohra et al, it reveals us that the aqueous and ethanolic extract of neem leaf has potential action against E. faecalis. It is as effective as NaOCl. So, neem can be used as a potential alternative to sodium hypochlorite against endodontic microflora.

**Melaleuca alternifolia – Tea tree oil**

This tree is native to wet lowland locations of Australia. Its height is usually 10-25 feet and has a papery white bark, dark green needle-like leaves and colourful blossoms. It possess great antibacterial and antifungal properties due to the presence of its major active component terpinen-4-ol (30%-40%). It has also mild tissue solvent action which can be used for dissolving necrotic pulp tissue.

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.

**Curcuma longa – Turmeric**

Turmeric belongs to Zingiberaceae family which is a perennial plant with small stem, large oblong leaves and bears ovate brownish yellow rhizomes. This popular Indian herb is used since ancient times as food preservatives, colouring material and in traditional medicine for treating sprains and swelling caused by injury. Turmeric contains polyphenols like curcuminoids [curcumin (diferuloylmethane), dimethoxycurcumin & bisdemethoxycurcumin] and various volatile oils like tumerone, atlantone & zingiberone. In this curcumin is the main yellow pigment which is responsible for antimicrobial, anti-inflammatory, antioxidant, anticarcinogenic, anti mutagenic, antifungal and anti –coagulant activities.

The antimicrobial action of turmeric is due to the reason that curcumin destroys the assembly of a protein-filamenting temperature-sensitive mutant Z (FTSZ) profilaments and enhances the GTPase activity of FTSZ which are all detrimental to bacteria. As an irriganting solution, turmeric prevents the formation of biofilms. This is because it eliminates the extracellular polymeric substance matrix which serves as the source of nutrient or substrate for further cell growth of bacteria.

Many in vitro studies have proved the beneficial effects of curcumin when used as aqueous solutions against gram positive bacteria like E. faecalis, Streptococcus intermedius and other gram negative bacteria like E. coli. Prasanna Neelakantan et al done an in vitro study to compare the antimicrobial activity of curcumin and NaOCl against E. faecalis which showed that curcumin has similar antimicrobial action as NaOCl. In 2013, Hemanshi Kumar et al designed an in vitro study in which they found that curcumin extract showed larger zones of microbial inhibition against the E.faecalis anaerobes. Hence, it can be used as an endodontic irrigant especially in retreatment cases.

**Morinda citrifolia – Noni fruit**

Noni also known as Indian Mulberry, nono or nonu, BaiiTian, cheese fruit and Nhau in various countries across the world. They are indigenous in tropical countries. It is discovered by Polynesians and it has been used as one of the traditional folk medicinal plants over 2000 years.
A variety of compounds have been identified from Noni fruit such as Acubin, L-asperuloside, atizarin and also some anthraquinone compounds which are responsible for its antimicrobial activity against infectious bacterial strains like *Pseudomonas aeruginosa, Proteus morgaii* and *Shigella*. Besides this, it also exhibits anti tumor, anti-inflammatory, analgesic, anthelmintic and immune-enhancing properties.

In 2008, Murray et al conducted a study to evaluate the efficacy of *Morinda citrifolia* juice (MCJ) as an irrigating solution. The results of the study showed that MCJ was same as NaOCl in conjunction with EDTA, in removing smear layer from the instrumented root canal walls. It was the first juice to be indicated as a possible alternative to NaOCl as an endodontic irrigant as it is biocompatible & antioxidant in nature.

**Triphala**

It is an ayurvedic combination of dried and powdered fruits of three herbal plants namely *Terminalia bellerica* (Bibhitaki), *Terminalia chebula* (Haltuki) and *Emblica officinalis* (Amalaki). Triphala consists of tannins, quinones, flavonoids, gallic acid and vitamin C. Bacteriostatic and bactericidal properties of triphala are mainly because of tannic acid. It can be used as a chelating agent due to the presence of citric acid in its fruits. Dimethyl sulfoxide was used as a solvent for triphala.

![Emblica officinalis](image)

*Emblica officinalis* has got antimicrobial and cytotoxic effects whereas ethanolic extract of *Terminalia chebula* has broad spectrum activity against different bacteria like *Salmonella typhi, Staphylococcus epidermidis* & *Bacillus subtilis*. *Terminalia bellerrica* was found to be highly potential when compared to other two fruits. It also has more potency against *E. faecalis*. In a study conducted by Prabakar et al in 2010, revealed that triphala was effective against root canal biofilms and are similar to NaOCl & doxycycline based irrigating agents. This is because its free radical scavenging action makes it an efficient tool to prevent formation of biofilm.

**Syzygium aromaticum** – Clove

Essential oils of clove are eugenol, isoeugenol and vanillin which exhibits antioxidant, antibacterial and anodyne effects. Clove oil has sedative action on pulpal inflammation.

Gupta et al made an SEM study to evaluate the effectiveness of three different plant extracts namely *Syzygium aromaticum* (clove), *Ocimum sanctum* (tulsi) and *Cinnamum zeylanicum* (cinnamon) when used as an endodontic irrigant. The study results revealed that among the experimental groups tested, *Syzygium aromaticum* along with EDTA was the most effective in removing smear layer.

**Acacia nilotica** – Babool

Babool also called as Gum Arabic tree

### S.no Phytomedicines Used In Endodontics Active Ingredients

<table>
<thead>
<tr>
<th>No.</th>
<th>Phytomedicines Used In Endodontics</th>
<th>Active Ingredients</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td><em>Azadirachta indica</em> – Neem</td>
<td>Nimbin, nimbidinin, nimbolide and nimbidinic acid</td>
</tr>
<tr>
<td>2.</td>
<td><em>Melaleuca alternifolia</em> – Tea tree oil</td>
<td>Terpinen-4-ol</td>
</tr>
<tr>
<td>3.</td>
<td><em>Curcuma longa</em> – Turmeric</td>
<td>Curcuminooids, tumerone, atlantone &amp; zingiberone</td>
</tr>
<tr>
<td>5.</td>
<td>Triphala</td>
<td>Tannins, quinones, flavonoids, gallic acid and vitamin C.</td>
</tr>
<tr>
<td>6.</td>
<td><em>Syzygium aromaticum</em> - Clove</td>
<td>Eugenol, isoeugenol and vanillin.</td>
</tr>
<tr>
<td>7.</td>
<td><em>Acacia nilotica</em> - Babool</td>
<td>Tannins, phenolic compounds, essential oils &amp; flavonoids</td>
</tr>
<tr>
<td>8.</td>
<td><em>Allium sativa</em> - Garlic</td>
<td>Alicant</td>
</tr>
<tr>
<td>9.</td>
<td><em>Zingiber officinale</em> – Ginger</td>
<td>Zingerone, gingerol &amp; 6-shagoal</td>
</tr>
<tr>
<td>10.</td>
<td><em>Propolis</em> – Honey bee wax</td>
<td>Flavonoids and cinnamic acid derivatives</td>
</tr>
<tr>
<td>11.</td>
<td><em>Aloe barbadensis</em> – Aloe vera</td>
<td>Aloidin and aloe-emodin</td>
</tr>
<tr>
<td>12.</td>
<td><em>Agaricus bisporus</em> - Mushroom</td>
<td>Plectasin, confuentin, grifolin and neogriofilin</td>
</tr>
<tr>
<td>13.</td>
<td><em>Arctium lappa</em></td>
<td>Sesquiterpene lactones and inulin</td>
</tr>
<tr>
<td>14.</td>
<td><em>Glycyrrhiza glabra</em> - Liquorice</td>
<td>Triterpenoid compound - Glycyrrhizin</td>
</tr>
<tr>
<td>15.</td>
<td><em>Rhus plants</em></td>
<td>Tannins &amp; gallic acids</td>
</tr>
<tr>
<td>16.</td>
<td><em>Vaccinium macrocarpon</em> - Cranberry</td>
<td>Flavonoids, phenolic acids, anthocyanins and condensed tannins</td>
</tr>
<tr>
<td>17.</td>
<td><em>Psidium guajava</em> - Guava</td>
<td>Guajaverin</td>
</tr>
<tr>
<td>18.</td>
<td><em>Ricinus communis</em> - Castor</td>
<td>Ricinoleic acid</td>
</tr>
</tbody>
</table>
is common species found in 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.

Rosina Khan et al revealed that this tree possess effective antimicrobial action against Streptococcus mutans and E. faecalis26 Dhanya Kumar et al in 2011 investigated the antibacterial activity of four plant extracts namely clove, cinnamon, liquorice and babool and stated that babool is most effective in erradicating E. faecalis organisms when used at 50% concentration27

Allium sativa – Garlic

The bulbs of garlic or Amaryllidaceae has been used medicinally as antimicrobial & antihyperlipidemic agent since ancient times. It has also numerous other effects such as detoxification, antioxidant, anticarcinogenic, anticoagulant, anti hypertensive, antibacterial, antifungal, antiviral and anti-inflammatory28

The active ingredient of garlic is allicin which makes garlic a popular antimicrobial agent and produces immunological functions. Allin has detrimental action on the cell wall and cell membrane of the bacteria. It was found that the ethanolic extract of garlic are effective against Staphylococcus aureus and it exhibits both bacteriostatic & bactericidal activity29 Also it was shown that the aqueous solution of garlic has antibacterial activity against 17-multidrug-resistant bacterial isolates. So this can be utilised as an herbal alternative to NaOCl30

In 2014, a study was done by Basma A. Alrazhi et al to evaluate the antibacterial activity of garlic and ginger as irrigant. In that garlic extract reported to inhibit the formation of biofilms by Streptococcus epidermidis and exhibited antibacterial efficacy against E. faecalis31 From the reported literature, ginger produced markable antimicrobial effect against gram negative bacteria like Porphyromonas gingivalis, Porphyromonas endodontalis and Prevotella intermedia. This is because that gingerol present in ginger inhibited the growth of these organisms35

Jeeryin

This is a Chinese herbal plant which were popular for its antimicrobial properties. It is effective against anerobes when used as irrigating solution along with ultrasonic activation. The 30% jeeryin solution has similar effect as that of NaOCl in root canal irrigation36

Hybanthus enneaspermus

It is popularly called as Ratanpurus that belongs to Violaceae family, is herb or under shrub seen in tropical and sub-tropical areas. It has anti-inflammatory and anti-oxidant properties37-41

In a study done by Kalepu Vamsi et al in 2014, to evaluate the antibacterial activity of Hybanthus enneaspermus & CHX against E. faecalis, the study results showed that 50% aqueous form of Hybanthus enneaspermus inhibits the most resistant anaerobe E. faecalis and its effect is as comparable with that of CHX42

Herbal Alternatives used as Intracanal Medicaments in Endodontics

Propolis – Honey bee wax

Propolis is a natural antibiotic resinous material obtained by honey bees (Apis mellifera L.) from different plant species like trees of poplars & conifers and mix with wax and other substances. It exhibits varying degree of antioxidant, antiviral, anti-inflammatory, antibacterial, antifungal, antitumor, immunomodulating, pharmacological properties such as healing, cytostatic & are cariostatic. The main biologically active components present in this antitoxic natural substance are flavonoids and cinnamic acid derivatives43, 44

In a study done with propolis, it inhibited the activity of hyaluronidase and has significant anti-inflammatory action as they contain caffeic acid and phenethylester (CAPE)45 Ethanolic
preparation of propolis enhances bone regeneration and induces hard tissue bridge formation in vital pulp therapy procedures. It also contains viscidone which further makes it used as an irrigating solution. It can also be used as a transport medium for avulsed teeth as it maintains the viability of periodontal ligament cells. Propolis can be effectively used along with calcium hydroxide as dressing for elimination endodontic pathogens especially against *E. faecalis*.

**Aloe barbadensis – Aloe vera**

Aloe vera contains clear gel surrounded by the green part of leaf. The two active components of aloe vera are aloin and aloe-emodin. Its antibacterial action is due to protein synthesis in the bacterial cells and it is rich in vitamins, minerals, enzymes, sugars, lignin, saponins, salicyclic acids and aminoacids.

It is effective against *S. pyogenes* and *E. faecalis* due to the presence of anthrax quinine which inhibits the formation of these two organisms. In an in vitro study done by Kurian B *et al* in 2016 showed MIC (Minimal Inhibitory Concentration) of Aloe vera was superior to calcium hydroxide in eliminating *E. faecalis* and its antibacterial activity increased with time period. Compared to other natural extracts, Aloe vera has broad spectrum antibacterial activity against various oral pathogens.

**Agaricus bisporus – Mushroom**

It has both low and high molecular weight (LMW, HMW) active compounds. Because of these compounds, it possess medicinal properties like immune modulatory, anti-inflammatory, antiviral, anti-oxidant and antimicrobial properties. The low molecular weight components present in mushroom are plectasin, confuentin, grifolin and neogrifolin which imparts capacity to penetrate deep into dentinal tubules.

The gel form of mushroom is used as intracanal medicament. This is prepared by sun drying, grinding and boiling it with distilled water which then followed by adding hydroxyl ethyl cellulose as thickening agent in 2:1 ratio and injected into the canal with a syringe. Also it has been revealed that the gel form of the extract increases the contact time which enhances its performance. It has highest efficacy against gram negative bacteria.

**Arctium lappa - Burdock**

This plant has been obtained from Japan and grown mostly in Brazil. They has many therapeutic applications. It possess antibacterial, antifungal, antiplatelet, antioxidant, diuretic, anxiolytic and HIV inhibitory effect. *Arctium lappa* contains sterols, tannins, sulphur containing polyacetylene, volatile fatty oils & polysaccharides. The active constituent of Burdock are sesquiterpene lactones and carbohydrate inulin.

The antimicrobial properties of *Arctium lappa* was studied. From that it was concluded that the constituents of *Arctium lappa* showed a great effect against the most organisms such as *E. faecalis, Staphylococcus aureus, Pseudomonas aeruginosa, Bacillus subtilis & Candida albicans*. This antimicrobial potential of the *Arctium lappa* makes it use as root canal medicament.

**Glycyrrhiza glabra – Liquorice**

They are frequently used Kampo medicines. It exhibits anti-inflammatory, anti-viral & anti-carcinogenic effects. It consists of a triterpenoid compound namely Glycyrrhizin that that imparts sweet taste to the liquorice root. Because of this Glycyrrhizin, it possess antimicrobial effect especially against *E. faecalis*.

Liquorice also inhibits most of the cariogenic bacteria like *Streptococcus mutans* its biocompatibility is compared to that of calcium hydroxide due to the presence of pentacyclic triterpenoid structure. But it has slightly acidic pH whereas calcium hydroxide having strong alkaline pH of 12.

**Rhus plants**

Rhus plants are enriched with tannins & gallic acids. Tannins exhibited antibacterial & antifungal properties. Gallic acid aids in healing periradicular inflammation. It also helps in opening up of obliterated dentinal tubules.

**Nissin**

It’s a naturally occurring antimicrobial peptide obtained from *Streptococcus lactis* sub species. It exerts antimicrobial activity against a huge range of bacterial spores. It was also shown that it is potential in eradication of *E. faecalis* and superior to calcium hydroxide.

Mahendra M *et al* in 2016 done a study to assess the efficacy of Nissin, neem, propolis,
calcium hydroxide & PRP when used as intracanal medicament against *E. faecalis*. The results showed that Nissin produced better results than other tested agents.

**Citrus limonum - Lemon solution**

Lemon solution has pH of 2.21 with lower acidity. It is effective in clearing the smear layer thereby acting as a chelating agent. Fresh lemon solution has antibacterial property making it an ideal root canal medicament without any side effects.

Abuziad & Eissa *et al* done a study, in which fresh lemon solution was shown to have wide antibacterial efficiency against *E. faecalis* and hence can be used as an intracanal medicament.

**Vaccinium macrocarpon – Cranberry**

In ancient times, cranberry was used to treat stomach aches, scurvey and other liver diseases. They has numerous biologically active ingredients such as flavonoids, phenols, anthocyanins and condensed tannins.

They have antibacterial, antimicrobial and antiadhesive properties, thereby prevents inhibition of many pathogens and biofilms. 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.

Papaine

Papaine is a proteolytic cysteine enzyme that comes from the latex of the leaves & fruits of the green adult papaya. It exhibits significant bacteriostatic and bactericidal effects.

In the study by Anug Bhardwaj *et al*, antimicrobial efficacy of natural extracts of *M.citrifolia*, papine, *A. vera* gel, 2% CHX and calcium hydroxide against *E. faecalis* were compared. In that Papaine produced significant results as compared to that of CHX than other tested agents.

**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 *Pseudomonas aeruginosa* and *Escherichia coli*. Considering the antimicrobial potential of eucalyptus essential oil against resistant microorganisms, it is expected that its association with calcium hydroxide contributes to the control of endodontic infections.

**Psidium guajava - Guava**

The leaves of guava are rich in guajaverin that inhibits *S.mutans* & *Staphylococcus aureus* formation that lead to plaque. They also contain phenolic compounds, vitamins, sesquiterpene alcohols, lineol, tannins, tripentenes & flavonoids. These all ingredients make them to exert anti-inflammatory, antimicrobial, antioxidant & antimutagenic properties. The ethanolic extract of it has higher antimicrobial activity.

**Riccinus communis - Castor**

It is rich in castor acid or ricinoleic acid. It can be used as intracanal medicament as well as an irrigant too. In an in vitro study conducted by Marcio Carneiro Valera *et al* it was found that castor was able to destroy *Candida albicans* and also significantly reduces the amount of *E. faecalis*. In other study done by Lucas da Fonseca Roberti Garcia *et al*, it was observed that calcium hydroxide and Castor oil paste had better activity than calcium hydroxide and propylene glycol paste against microorganisms commonly found in endodontic infections.

**Carvacol**

Carvacrol is extracted from Origanum vulgare. The prime use of carvacrol is inhibition of *E. coli* & *Pseudomonas aeruginosa*. The main action of Carvacrol is disruption of bacterial cell membrane. It also aids in healing of periapical tissues as they stimulates the fibres of the pulp.

It is commercially marketed by various companies like Sigma Aldrich, Biocore, MP Biochemicals, Life chemicals & Glentham Life Sciences Ltd.

**CONCLUSION**

Herbal formulations are advantageous in many ways. They are safe, easily available, increased shelf life, economic and mainly there is lack of microbial resistance so far. They are most effective if used with proper knowledge. Many studies have concluded that herbal extracts produced promising results when used as endodontic irrigant and intracanal medicament.
REFERENCES


26. Rosina Khan, Barira Islam, Mohd Akram, Shazi Shakil, Anis Ahmad, S.Manazir Ali. Antimicrobial activity of five herbal extracts against multi drug resistant (MDR) strains of...


50. Alves MJ, Ferreira IC, Dias J, Teixeira V, Martins A, Pintado M. A review on antimicrobial activity of mushroom (*Basidiomycetes*) extracts and


