dentinal tubules. It was reported that Enterococcus faecalis present in the dentinal tubules was resistant to Ca (OH)₂ over 10 days.

In endodontics because of the cytotoxic reactions of the most of the commercial intracanal medicaments used and their inability to eliminate bacteria from dentinal tubules, trend of recent medicine is to use biologic medication extracted from natural plants. The herbal products are also being increasingly used as sedatives, or plaque reduction and healthy gums.

a. Phytotherapeutic substances are generally classified into three groups:
- Plant products
- Animal products
- Mineral origin.

b. In dentistry, they are used as:
- Antimicrobial agents
- Anti-inflammatory agents
- Sedative and anxiolytics.

c. Miscellaneous endodontic irrigants, medicaments and endodontic retreatment.

Materials and Methods

A PubMed search was made with the keywords; herbal, dentistry, phytomedicines and from the relevant articles medicaments found closest to these three keywords were selected for this review.
**Acacia nilotica Linn. (Babool - Indian gun Arabic)**

It has long been used for the treatment of skin, sexual, stomach, and tooth problems. It has been proved as an effective medicine in the treatment of malaria, sore throat (aerial part) and toothache (bark). Babool has shown to possess antibacterial activity against *Streptococcus mutans* and *E. faecalis*. Antimicrobial function is believed to be due to tannins, phenolic compounds, essential oil, and flavonoids.

Aloe barbadensis Miller (Kumari - Aloe)

*Aloe* leaves contain a clear gel and green part of the leaf that surrounds the gel is used to produce juice or dried substance. It contains aloins and barbadoin as main chemical constituents. In dentistry, *A. vera* is used in cases of apthous ulcers, lichen planus, alveolar osteitis. *A. vera* gel has inhibitory effects on *Streptococcus pyogenes* and *E. faecalis* because of arthroquinone. Its bactericidal activity is found to be less than Ca (OH)₂.

**Arctium lappa Linn.**

It has antibacterial and antifungal activity, diuretic, anti-oxidant and anxiolytic action, platelet anti-aggregating effect, and HIV inhibitory action. In dentistry, *A. lappa* has been investigated due to its antimicrobial potential against oral microorganisms, specifically those associated with endodontic infections. An *in vitro* evaluation of antimicrobial activity of *A. lappa* against microorganisms specifically found in endodontic infections showed a great microbial inhibition of *A. lappa* against the tested endodontic pathogens. The microbial inhibition potential of *A. lappa* observed in this study opens the perspective for its use as an intracanal medication.

**Azadirachta indica A. Juss (Nimba - Nimbtree)**

Each part of the *Neem* tree has some medicinal property and is thus commercially exploitable. This product has been proved to be effective against *E. faecalis* and *Candida albicans*. A study was conducted to evaluate the efficacy of *Neem* extract dental gel with commercially available CHX gluconate mouthwash as a positive control. Microbial evaluation of *S. mutans* and *Lactobacilli* species was carried out to determine the total decrease in the salivary bacterial count over a period of treatment. The results of the study suggested that the dental gel containing *Neem* extract had significantly reduced the plaque index and bacterial count than that of the control group.

**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 not only inhibits microbial colonization, but also makes microbes more sensitive to antibacterial agents. It has an antibacterial effect against *Enterobacteriaceae* family including *Escherichia coli*, *Salmonella enteritidis* and *Salmonella essen*. Antibacterial effect of carvacrol and its isomer thymol against six ATCC standard bacterial strains including *E. faecalis* has been proved. Carvacrol also has anti-inflammatory effects. It can restrain neutrophilic elastase enzyme and suppress prostaglandin production. Carvacrol has inhibitory action on *E. coli* and *Pseudomonas aeruginosa*. The cause of antimicrobial property is attributed to action on several targets in bacterial cell and disruption of bacterial cell membrane. 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 hornesis.

**Casearia sylvestris Sw. (Galkhair - Wild coffee)**

Alcoholic extract of *C. sylvestris* constitutes a rich source of phospholipase A2 inhibitors, which reduce the acute phase of the inflammatory process and prolongs the regenerative phase. It offers a wide range of uses: Healing, anti-oxidant, anti-inflammatory, diuretic, tonic, stimulant, and antimicrobial. It is shown as an alternative intracanal medicament.

**Allium sativum Linn. (Rason - Garlic)**

Garlic contains sulfur containing compound allicin which is converted to active ingredient “allicin” when the garlic bulb is crushed. This compound has an inhibitory effect upon the key enzymes involved in cholesterol biosynthesis, such as 3-hydroxy-3-methyl-glutaryl-CoA reductase. Hypocholesterolemic effect of garlic is exerted by a decrease in hepatic cholesterologenesis, whereas the triacylglycerol lowering effect appears to be due to inhibition of fatty acid synthesis, by malic enzymes, fatty acid synthetase and glucose-6-phosphate dehydrogenase. Garlic helps to prevent lipid implantation on the arterial wall. Allicin destroys cell wall and cell membrane of root canal bacteria. This is used as irritant alternative to NaOCl.

**Marticaria recutita Linn. (German chamomile)**

The German chamomile has been used for centuries as a medicinal plant mostly for its anti-inflammatory, analgesic, antimicrobial, antispasmic, and sedative properties. Chamomile was also found to be effective when used as a mouthwash to treat irritations and minor infections of the mouth and gingivae and is also used in some toothpaste.

**Camelia sinensis (Chai - Tea)**

The antioxidative properties of unfermented tea can be attributed to the ability of the polyphenols contained in the leaves of *Thea chinensis*, especially the galloycatechins, to inactive free radicals. Green and black teas both contain flavonoids that inhibit the growth and activity of the bacteria associated with tooth decay. Tea also contains natural fluoride, which may be helpful in preventing dental caries. An *in vitro* study conducted to evaluate the antimicrobial efficacy of *Triphala* (one of the well-known Indian Ayurvedic herbal formulation consisting of dried and powdered fruits of three medicinal plants namely *Terminalia bellierica, Terminalia chebula* and *Emblica officinalis*), green tea polyphenols (GTPs), MTAD and 5% NaOCl against *E. faecalis* biofilm formed on tooth substrate showed maximum antibacterial activity with NaOCl and statistically significant antibacterial activity with *Triphala*, GTPs and MTAD.

**Citrus limonum Risso. (Nimbuka - Lemon)**

Fresh lemon juice 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.

**Morinda citrifolia Linn. (Ashyuka - Indian mulberry)**

A number of major components have been identified in the Nomi plant such as scopoletin, octanoic acid, potassium,
vitamin C, terpenoids, alkaloids, anthraquinones (such as nordamcanthal, nomidone, rubidain, and rubidiain-1-methyl ether, anthraquinone glycoside), β-sitosterol, carotene, vitamin A, flavone glycosides, limoleic acid, Alizarin, amino acids, acubin, L-asperuloside, caproic acid, caprylic acid, uroseolic acid, rutin, and a putative proxerone. These compounds have been shown to fight against infectious bacteria strains such as \( P. \) aeruginosa, Proteus morgianii, Staphylococcus aureus, Bacillus subtilis, E. coli, Salmonella, and Shigella.\(^{[50]} \) Its juice has a broad range of therapeutic effects including antibacterial, antiinflammatory, antiviral, antitumor, antihelmenthic, analgesic, hypotensive, and immune enhancing effects.

The antimicrobial activity of 2% CHX gel, propolis, Morinda citrifolia juice and Ca (OH)\(_2\), has been compared on \( E. \) faecalis infected root canal dentin at two different depths and three intervals. It was concluded that propolis and \( M. \) citrifolia were effective against \( E. \) faecalis in dentin on extracted teeth.\(^{[31]} \)

**Orange Oil (Narahang)**

This is composed mostly of d-limonene. It also has a long chain aliphatic hydrocarbon alcohols, aldehydes like octanal. It is suggested as an alternative to chloform or xylene for gutta-percha softening and also in dissolving endodontic sealers.\(^{[12]} \)

**Propolis (Propolis resin)**

Pharmacologically active constituents in propolis are flavonoids, phenolics, and aromatics. It exhibits various biologic activities, including antimicrobial, anti-inflammatory, antioxidant, anesthetic and cytotoxic properties.\(^{[15]} \) The anti-inflammatory property of propolis is due to the presence of caffeic acid and phenethyl ester in propolis. In dental practice it is used as a pulp capping agent, intracanal irrigant, mouth rinse, cariostatic agent, treatment of periodontitis and denture stomatitis, etc.\(^{[14]} \) The antimicrobial activity of propolis with Ca (OH)\(_2\) as intracanal medicament against \( E. \) faecalis found that propolis was effective in eliminating the microorganisms.\(^{[15]} \)

Study showed less pain, less incidence of postoperative complications and less swelling in the honey treated wounds after surgical removal of impacted third molars than in the untreated control group.\(^{[56]} \) It has been reported in another study\(^{[77]} \) that natural honey showed antibacterial action against anaerobic bacteroides present in dental abscess and ostcomylitis.\(^{[58]} \) It has also been proposed that antioxidants be used to protect the periodontal tissues from the damaging free radicals formed in the inflammatory response. Honey contains a substantial level of antioxidants.\(^{[19-41]} \) In a study, eight honeys and three types of propolis were tested and the result proved them effective as an anticalculus agent in toothpastes and mouthwashes.\(^{[85]} \) Recent studies indicated that honey possessed moderate antitumor and pronounced anti-metastatic effects in five different strains of rat and mouse tumors. Furthermore, honey potentiated the antitumor activity of chemotherapeutic drugs such as 5-flourouracil and cyclophosphamide.\(^{[83]} \) Studies suggested that chewing “honey leather” can reduce inflammation of the gingiva.\(^{[46-66]} \) Candy made with honey may be useful for prevention of halitosis.\(^{[47]} \) It was found that the minimum inhibitory concentrations of honey for Streptococcus mitis, Streptococcus sobrinus and Lactobacillus casei were 7%, 7.5-8.5%, and 8-12%, respectively. The production of acid by these bacteria was also inhibited.\(^{[48-60]} \) Direct pulp capping with propolis in rats may delay dental pulp inflammation and stimulate reparative dentin.\(^{[60]} \) Another study conducted on premolars for direct pulp capping also showed that propolis is equally efficacious as calcium hydroxide.\(^{[11-12]} \)

**Psidium guajava Linn. (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.\(^{[15]} \) The leaf extracts of \( P. \) guajava have some pharmacological activities, such as anti-inflammatory, anti-diarrheal besides antimicrobial activities. It has also been used extensively as a hypoglycaemic agent. The active flavonoid compound guajerin isolated from the methanol leaf extract of \( P. \) guajava has been demonstrated by one of the researcher to be a potential antiplaque agent by inhibiting the growth of \( S. \) mutans.\(^{[14]} \)

**Psoralea corylifolia Linn. (Bakuchi - Psoralea seeds)**

\( P. \) corylifolia extract contains a number of bioactive compounds including flavonoids, coumarins, meroterpenes and benzoferan glycosides that are the molecular basis of its action. Neobavaisoflavone is isolated from fruits and seeds of \( P. \) corylifolia.\(^{[55]} \) This is found to be effective against \( E. \) faecalis. It acts by causing injury to the cell membrane and inhibiting DNA polymerase.\(^{[23]} \)

**Rhus lancia (L.f.) F.A. Barkley (African Sumac)**

It contains gallic tannins and gallic acid. Tannins exhibit antibacterial and antifungal properties. Gallic acid is antioxidant and bactericidal. Gallic acid has been found to reduce periapical inflammation. Water extract of Rhus plants help in the opening of blocked dentinal tubules.\(^{[24]} \)

**Salavadora persica Linn. (Peelu – Mustard tree)**

Many studies have demonstrated that extracts of \( S. \) persica possess various antiplaque, antiperiopathic, anticasries, anti-inflammatory and antimycotic effects. Its chewing sticks contain trimethyl amine, salvadorime chloride and fluoride in large amounts.\(^{[56]} \) Tests have shown that these sticks contain natural antibiotics, fluoride, and other anti-cavity components. 15% alcoholic extracts of it has maximum antimicrobial action. It can be used as a substitute for NaOCl and chlorhexidine as root canal irrigant.\(^{[17,58]} \)

**Syzygium aromaticum (L.) Merrill and Perry (Lavanga - Clove)**

Essential oil shows antioxidant, antibacterial, and anodyne effects.\(^{[92-94]} \)

**Melaleuca alternifolia (Maiden and Betche)**

**Cheel (TeaTree Oil)**

Tea tree oil’s major active component is terpinen-4-ol (typically 30-40%).\(^{[24,25]} \) In order to avoid the undesirable effects of NaOCl, a scanning electron microscopy study was conducted using two medicinal plants that is German chamomile extract and tea tree oil which might disinfect the root canal system with less toxicity when used as irrigants. It was concluded that the efficacy of chamomile to remove the smear layer was...
superior to NaOCl alone, but less than NaOCl combined with ethylene di-amine tetra acetic acid.[69]

**Tripaha (Haritaki, Bibhitaki and Amalaki)**

Tripaha is one of the well-known Indian Ayurvedic herbal formulation consisting of dried and powdered fruits of three medicinal plants namely Terminalia Bellerica (Gaertn.) Roxb., Terminalia chebula Retz. and Embellica officinalis Gaertn.[41] It can be used as an effective antiplaque agent due to its antioxidant properties and it can effectively inhibit the biofilm formation.[69] Its fruit is rich in citric acid, which may aid in removal of smear layer thereby acting as chelating agent and also found to be alternative to NaOCl for root canal irrigation.[1]

**Curcuma longa Linn. (Haridra - Turmeric)**

The active constituents of turmeric are the flavonoid curcumin (diferuloylmethane) and various volatile oils, including tumerone, atlantone, and zingiberone. It possess good antioxidant, hepatoprotective, antimicrobial, and anticancer activity.[61]

A researcher conducted an in vitro study to evaluate the antimicrobial efficacy of curcumin against *E. faecalis* considering NaOCl (3%) as reference for comparison. The result of his study revealed that curcumin had significant antibacterial activity against *E. faecalis* and thus can be used in endodontics for root canal failures.[63,62] Curcumin in surfactant preparations showed its potential as a photosensitizer in antibacterial photodynamic therapy in vitro.[61]

**Glycyrrhiza glabra Linn. (Yashtimadhu - Liquorice)**

A number of pharmaceutical effects of liquorice are known anti-inflammatory, antiviral and anticarcinogenic.[64,65] It has been evaluated for the management of oral lichen planus. The study reported that liquorice extract was as effective as triamcinolone acetonide, but safer and may be used as an alternative treatment for lichen planus.[64] Glycyrrhizin, a triterpenoid compound, accounts for the sweet taste of liquorice root. The antibacterial activity of liquorice and glycyrrhizin on different strains of *S. mutans* was also studied and their effects on the adherence of *S. mutans* to glass. Liquorice extract exhibited a more profound activity in both adherence and anti-bacterial assays than that of glycyrrhizin.[65] Liquorice has also shown greater biocompatibility with fibroblasts cells compared to calcium hydroxide, which was severely toxic to the cells. A mixture of liquorice and calcium hydroxide showed moderate cytotoxicity.[66]

**Discussion**

Over the past decade, interest in drugs derived from medicinal plants has markedly increased. Literature has addressed many plants with a potential source for new therapies in endodontics. In dentistry, phytotherapy has been used as anti-inflammatory, antibiotic, analgesic, sedative, and also as endodontic irrigant [Table 1].

The major drawbacks of the many antimicrobial and pulp therapeutic agents used in dentistry since long have been immune suppression, hypersensitivity, allergic reactions and resistance of microorganisms to these drugs; also some are mutagenic and cytotoxic. Therefore, there is a need to conduct extensive researches to find plant based alternatives for the conventional drugs.[69] Studies have found herbal agents such as *A. nilotica, A. barbadensis, A. lappa, A. indica, carvacrol, C. sylvestris, A. sativum, M. recutitia L, C. sinensis, C. limonum, M. citrifolia, propolis, P. guajava, P. corylifolia, R. lancia, S. persica, S. aromaticum, M. alternifolia, C. longa, G. glabra* can be used as an alternative intracanal medicament and can be used as potential root canal irrigants because of their anti-inflammatory, antimicrobial and immune-modulating activity. Propolis and *M. citrifolia* were found to be effective against *E. faecalis* (most common bacteria isolated from recurrent and failed root canal cases) in dentin on extracted teeth.[61] In our study too, the results indicated that propolis had an effective antifungal action on *C. albicans* (which is the most common fungus seen in root canals) similar to that of NaOCl.[70]

Herbal agents like propolis, *A. vera* have healing potential thus making them good pulp therapeutic agents.[69,69] Propolis, GTPs have shown to preserve periodontal cell viability and thus used as storage media for avulsed tooth.[70-72,69]

**Tripaha** has free radical scavenging property thus aiding in the protection of gum cells effectively from free radicals produced by the microorganisms.[71] Some essential oils like orange have endodontic filling material dissolving capacity thus making them readily useful in endodontic retreatments.[72-74] Herbal agents like German chamomile is used in mouthwashes to reduce gingival inflammation and plaque formation.[24]

**Conclusion**

The major advantages of using natural alternatives are easy availability, cost-effectiveness, increased shelf life, low toxicity

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**Table 1: Classification of herbal drugs used in dentistry based on their actions**

<table>
<thead>
<tr>
<th>Uses in dentistry</th>
<th>Names of the herbal agents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Antimicrobial action</td>
<td><em>Acacia nilotica, Aloe barbadensis, Arctium lappa, Azadirachta indica, Carvacrol, Casearia sylvestris, Allium sativum, Maticaria recutitia, Camellia sinensis, Citrus limonum, Morinda citrifolia, Propolis, Psidium guajava, Psoralea corylifolia, Rhus lancia, Salavadora persica, Syzigium aromaticum, Melaleuca alternifolia, Curcuma longa, Glycyrrhiza glabra</em></td>
</tr>
<tr>
<td>Anti-inflammatory action</td>
<td><em>Casearia sylvestris, Maticaria recutitia, Camellia sinensis, Morinda citrifolia, Propolis, Psidium guajava, Rhus lancia, Salavadora persica, Glycyrrhiza glabra</em></td>
</tr>
<tr>
<td>Sedative and anxiolytics</td>
<td><em>Arctium lappa, Maticaria recutitia</em></td>
</tr>
<tr>
<td>Miscellaneous action (endodontic irrigants, medications and endodontic retreatment)</td>
<td>*Arctium lappa, Azadirachta indica, Casearia sylvestris, Allium sativum, Morinda citrifolia, Camellia sinensis, Citrus limonum, Orange Oil, Propolis, Salavadora persica, Melaleuca alternifolia, <em>Tripaha, Curcuma longa</em></td>
</tr>
</tbody>
</table>
and lack of microbial resistance reported so far. Herbal agents have been used in dentistry for reducing inflammation, as antimicrobial plaque agents, antiinfectives, antioxidants, antimicrobials, antifungals, antibacterials, antivirals, and analogics. They also aid in healing and are effective in controlling microbial plaque in gingivitis and periodontitis and thereby improving immunity. Though the in vitro results appear promising, many clinical trials are warranted to evaluate biocompatibility and safety factor before they can be recommended for clinical use conclusively.

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