

# Herbal Dentistry- A Narrative Review

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## ABSTRACT

The use of medicinal herbs in dentistry continues to expand rapidly across the globe. Herbal dentistry presents an attractive alternative to conventional synthetic materials. With a shift towards evidence-based dental practice, there is a need for dental clinicians to be fully aware of the alternatives and options currently available to them. This review article provides insight into the various herbal products currently available in dentistry. It provides a better understanding of the mechanism of action of the herbal products used to treat various dental problems. This narrative review identifies and summarises the most common medicinal herbs in various preventive and therapeutic spheres of dentistry. High anti-microbial, anti-inflammatory, antioxidant, and immunomodulatory activities along with wound healing ability and sedative-anxiolytic were identified to be the properties favouring use of these medicinal plants in dentistry. Although the natural alternatives discussed in the current narrative review have shown to be either superior or comparable to the synthetically available options, further long-term in-vivo clinical trials are required to substantiate this evidence and justify the replacement of later with herbal alternatives in dentistry.

**Keywords:** Anti-inflammatory, Anti-microbial, Herbal medicine, Traditional medicine

## INTRODUCTION

Oral health is significant in maintaining general health and well-being and relates to an individual's quality of life. Despite this, oral diseases are a significant health problem worldwide. Several chemical and synthetic agents are used to maintain oral hygiene. These have multiple disadvantages, including alteration of the oral microbiota, tooth staining, lack of cost-effectiveness, and increased resistance by pathogenic bacteria to these agents [1]. Thus, there is a need for alternative preventive and therapeutic options for the maintenance of oral hygiene. These should be safe, effective, biocompatible, and economical.

A herb is any plant that lacks the woody character of shrubs or trees, and due to their constituent properties, herbs are used medicinally or for their flavour or scent. Herbs and their extracts are seen to be effective because they interact with specific chemical receptors within the body and pharmacodynamically act as drugs themselves [2]. The earliest reports of phytotherapy can be dated back to 200 B.C. In India, it is known as Ayurveda, a five-thousand-year-old system used in the healthcare system to treat and manage various diseases. Over five lakh plant species are available in India, and traditional healers use approximately two thousand five hundred plant species as medicine sources for various ailments [3].

Herbal dentistry has evolved over the years. *Acacia arabica*, *Salvadora persica*, and *Azadirachta indica* were used as chewing sticks for their anti-microbial property and mechanical cleansing action on teeth. Clove was used to mask foul mouth odour and for its analgesic property to relieve toothaches [Table/Fig-1]. With time, herbs and their extracts have been successfully employed as dentifrices, remineralising agents, mouth rinses for biofilm prevention, treatment of periodontitis, intracanal irrigants, medicaments for vital pulp therapy procedures and treatment of precancerous lesions or conditions to name a few with results demonstrating them to be equally, if not more effective than the commercial options [4-11].

The use of medicinal herbs in dentistry continues to expand rapidly across the globe. Herbal dentistry presents an attractive alternative to conventional synthetic materials in dental practice. With a shift



[Table/Fig-1]: The use of herbal products in dentistry.

towards evidence-based dental practice, there is a need for dental clinicians to be fully aware of the alternatives and options currently available to them. This review article aims to provide insight into the various herbal products currently available in dentistry.

## PHYTOTHERAPEUTIC SUBSTANCES

Phytotherapeutic substances can be classified based on their origin and mechanism of action [Table/Fig-2]. This review focuses on the most used herbal products in dentistry.

Physiotherapeutic agents	Details of classification
General Classification	<ul style="list-style-type: none"> <li>Plant products</li> <li>Animal products</li> <li>Mineral origin</li> </ul>
Based on mechanism of action	<ul style="list-style-type: none"> <li>Anti-microbial</li> <li>Anti-inflammatory</li> <li>Sedative and anxiolytic</li> <li>Miscellaneous</li> </ul>

[Table/Fig-2]: Classifications of Phytotherapeutic substances [2].

### **Aloe barbadensis (Aloe Vera)**

Known to contain around 75 active constituents, aloe vera exhibits a myriad of properties; Wound healing, anti-inflammatory, anti-microbial and immunomodulatory properties are some of its proven benefits. Wound healing property is attributed to glycoproteins such as Acemannan hydrogel which exhibits cell promoting activity and improved angiogenesis at wound site. Aloe vera in the form of gels, mouth rinses and capsules has been recommended in treatment of various oral diseases such as, oral lichen planus, submucosal fibrosis, burning mouth syndrome, radiation induced mucositis and recurrent aphthous ulcers [12]. Active constituents of aloe vera inhibit the cyclooxygenase pathway and release of bradykinase, thereby making it a good anti-inflammatory agent. Mouth rinses containing aloe vera in concentrations of 99-100% are comparable to 0.12 and 0.2% chlorhexidine in reducing gingival inflammation but inferior in reducing plaque levels [13]. Dentifrices containing aloe vera are equally effective against plaque control when compared to fluoride and triclosan containing ones [14,15]. The use of endoflas powder mixed with aloe vera as an obturating material for primary teeth has been advocated in primary teeth presenting with persistent periapical infection [16].

### **Arctium lappa (Greater Burdock)**

Native to Japan, this herb contains sterols, tannins, polysaccharides, and active constituents such as sesquiterpene lactones and carbohydrate inulin. An in-vitro study concluded that *A. lappa* exhibits a high antibacterial activity against *Streptococcus sobrinus* (*S.sobrinus*), *S.mutans*, *Enterococcus faecalis* (*E.faecalis*) and *Candida albicans*, thus making it a potential intracanal medicament to eliminate or reduce the microorganism in the root canal space thereby making it inert and suitable for obturation [17].

### **Acacia nilotica (Babool)**

This plant is a rich source of various organic and inorganic components. In the field of dentistry, *Acacia Nilotica* (*A.nilotica*) has predominantly shown antibacterial (*S.mutans*, *S.aureus* and *S. viridans*) and anti-fungal (*Candida albicans* (*C.albicans*)) activity at a reported Minimal Inhibitory Concentration (MIC) of 35 and 50 mg/mL and a bactericidal activity in the range of 35 and 60 mg/mL [18]. Evidence regarding the use of *A.nilotica* is sparse, in-vitro studies reporting its use as an effective root canal irrigating solution and in the disinfection of gutta percha cones have shown promising results [19,20].

### **Azadirachta indica (Neem)**

It is an evergreen tree which has been used by Indian people since time immemorial for the treatment of various diseases due to its medicinal properties. The bark and twigs have antibacterial properties and have been used for curing gingival problems and mechanical cleansing of teeth. Nimbidin is a main active principle extracted from *Azadirachta Indica* (*A.indica*) seed kernels that has numerous biological activities. Neem is a natural anti-microbial agent with high antiplaque activity. Neem extracts inhibit aggregation, growth and adhesion of plaque forming microorganisms onto hydroxyapatite by hampering the production of insoluble glucans [21]. A 40% water soluble extract and mucoadhesive gel of neem has shown to be as effective as 0.2% chlorhexidine rinse in reducing plaque scores [22]. Toothpaste containing neem has shown to be equally effective as fluoridated toothpaste in reducing the salivary *S.mutans* count [23]. A 10% non resorbable chip of neem significantly reduces *P.gingivalis* strains in chronic periodontitis and maybe used as an adjunct to scaling and root planning procedures [24]. High antioxidant and anti-microbial properties make it a potential agent for root canal irrigation. Neem and 2.5% sodium hypochlorite have shown to be equally effective in reducing endotoxin levels in necrotic canals [25].

### **Thyme vulgaris (Thyme Oil)**

Phenol, thymol and carvacrol are some of the main components of thyme oil, its anti-microbial activity against *S.mutans*, *C.albicans*, *Enterococcus faecalis* (*E.faecalis*) and *Pseudomonas aeruginosa* (*P.aeruginosa*) have made it popular enough to be incorporated into various dental cement powders and varnish to reduce microbial counts significantly [26]. An in-vitro agar diffusion based study, the anti-microbial activity of zinc oxide-thyme oil was significantly higher against root canal pathogens than zinc oxide eugenol [27].

### **Allium sativum (Garlic)**

Alliin is an active ingredient of garlic, which has the potential to destroy the cell wall and membrane of *Actinobacillus actinomycetemcomitans* (*A.actinomycetemcomitans*), *Fusobacterium nucleatum* (*F.nucleatum*) and various root canal pathogens; making it a potential root canal irrigant in permanent and primary teeth [28,29]. Mouthwash with 2.5% garlic extract was effective in decreasing *S.mutans* and *Lactobacillus* count significantly in children however superior effectiveness was reported when combined with chlorhexidine [30]. *Allium sativum* oil showed comparable results to formocresol when used in conjunction with aloe vera as a pulpotomy medicament [31,32].

### **Citrus limonum (Lemon Extract)**

Citrus limonum extracts have an anti-microbial activity due to the presence of many bioactive constituents such as flavonoids, alkaloids, volatile oil, and citric acid reported to be present in it [33]. In-vitro studies have evaluated its anti-microbial property especially against *E.faecalis*, thus making it an alternative root canal irrigating solution [33-35].

### **Psoralea corylifolia (Bakuchi)**

Bakuchiol is an active constituent of this herb which acts by disrupting the cell membrane and Deoxyribose Nucleic Acid (DNA) polymerase enzyme thereby exhibiting bactericidal activity against various cariogenic and periodontopathogens. It has also been recommended to be a potent root canal irrigant due to its activity against *E.faecalis*. Flavonoids form another key constituent which limit the release of reactive oxygen species and cytokines [36]. Thus, the scavenging activity and anti-inflammatory property make widen its use in treating autoimmune lesions of oral cavity.

### **Syzygium aromaticum (Clove)**

Clove oil constitutes 60-90% of eugenol, clove oil, 10% acetyl eugenol and small quantities of gallic acid, sesquiterpenes, furfural and vanillin and flavonoids. It not only has a potent radical scavenging activity but also inhibits germ tube formation by *C.albicans*, due to which clove is widely used in dentistry as an interim therapeutic restoration and obturating material for primary teeth. The presence of eugenol suppresses the inflammatory response mediated by prostaglandin synthesis thereby exhibiting a depressant effect on sensory nerves (obtundent effect) [26].

### **Melaleuca alternifolia (Tea Tree Oil)**

Bactericidal activity is mainly due to the presence of terpen-4-ol (30-40%) which disrupts the cell membrane and permeability. A 0.2% of tea tree oil rinse was shown to be effective against *S.mutans* and *Lactobacilli* when used for two weeks. A 1,8-cineole is responsible for the anti-inflammatory property; it considerably decreases the production of chemical mediators and has been utilised in various concentrations in-vivo to reduce gingivitis and periodontitis only to show results comparable to chlorhexidine mouthwash [26].

### **Curcuma longa (Turmeric)**

Components of turmeric are collectively called as curcuminoids, of these, curcumin, a polyphenol is most active. In dentistry, turmeric has been used for easy identification of dental plaque and pit and fissure sealants [37]. Due to its ability to inhibit *S.mutans*

and *E.faecalis* it be used as an intracanal medicament [38]. Sesquiterpenes are responsible for the anti-inflammatory action, hence *Curcuma longa* (*C.longa*) has been used as a mouthwash, 2% topical gel or a 1% subgingival irrigant [39]. Turmeric chips in treating gingival and periodontal conditions proving to be as effective as chlorhexidine [39]. Analgesic and wound healing properties make it a good alternative to manage dry socket [37].

### **Marticaria Recutitia (German chamomile)**

When utilised as mouth rinse, a reduction in biofilm levels, improvement in gingival and periodontal conditions have been reported and 15% ethanolic extract shows efficacy equal to 0.2% chlorhexidine [40]. Chamomile has also shown effective smear layer removing capacity as opposed tea tree oil and distilled water and more effective than 2.5% sodium hypochlorite, but less effective than Mixture of Tetracycline, Acid, and Detergent (MTAD) mixture [41].

### **Camellia sinensis (Green tea)**

The anticariogenic activity of green tea is due to polyphenols such as Epigallocatechin-3-Gallate (EGCG), tannins, flavan-3ols and fluoride which cause cell membrane disruption, prevent DNA supercoiling, inhibit enolase enzyme thereby inhibiting glucosyltransferase activity, adherence to tooth surface. Catechins inhibit collagenase, protease, and tyrosine phosphatase activity of the periodontopathic pathogens, thereby preventing the disruption and breakdown of collagen of gingival tissues and they also downregulate the pro-inflammatory mediators [42,43]. A 0.5% green tea extract showed highest antiplaque activity when compared to 0.05% sodium fluoride and 0.2% chlorhexidine gluconate mouthwash in children [44]. Evidence has shown that green tea-based mouthwashes can be considered an alternative to chlorhexidine mouthwashes in sustaining oral hygiene as they have an added advantage of being natural preparation [45].

### **Morinda citrifolia (Noni)**

Commonly called as Indian mulberry and is a rich source of phenolic compounds (anthraquinones), alkaloids (xeronine) and organic acids (caproic and caprylic acid). It is commonly employed for cavity disinfection and as an irrigant in deciduous molars due to its action on *E.faecalis* and its ability to dissolve smear layer [46].

### **Propolis**

It is essentially a resinous product obtained from bee hives which is rich in phenolics, and flavonoids which give propolis its strong antioxidant property. It inhibits the glucosyltransferase activity and F-type Adenosine Triphosphatase (F-ATPase) activity, thereby affecting the survival of *S.mutans* [47]. Propolis incorporated in mouth rinses, chewing gums, dental varnish, and cavity disinfectants, and has shown to significantly reduce biofilm levels. It has a bactericidal activity against numerous root canal pathogens and is comparable to conventional irrigants. Owing to its anti-inflammatory and reparative properties, it has been used as a pulp capping material [48].

### **Psidum gujava (Guava)**

Guajaverin is an active component in guava that binds to the cell surface proteins and decreases the hydrophobicity of the pathogens thereby preventing their adhesion onto the tooth surface, hence it has a potential to be used as an antiplaque agent. Other components, mainly the flavonoids and tannins, play an important role in down regulating inflammatory mediators and being a rich source of vitamin C, it helps in wound healing [49]. Use of mouth rinse containing guava leaf extracts leads to a significant reduction in *S.mutans* counts and no altered taste as opposed to that seen with chlorhexidine [50].

### **Salvadora persica (Miswak)**

High sulphur content, abundance of vitamin C and alkaloids makes Miswak a popular choice in treating oral conditions. Miswak sticks may offer similar antiplaque action against gingivitis as an adjunct to traditional toothbrushing [51]. A 40% mouth rinse containing extract of *Salvadora persica* (*S.persica*) has shown to be as effective as a fluoride mouth rinse in reducing *S.mutans* counts. A 5 mL hiora mouthwash containing *S.persica* extract showed similar antiplaque activity as 0.2% chlorhexidine gluconate and had no side-effects [52]. Its various constituents and their actions are mentioned in [Table/Fig-3] [51,52]. Fluoride exposure from various sources, leading to an increased risk of dental fluorosis and systemic toxicity has been the subject of constant debate. Concerns regarding hypermineralisation of the surface of white spot lesion in presence of fluoride, with subsequent decrease in penetration of calcium and phosphate ions into body of the lesion have been documented. Although there is substantial evidence regarding the use of fluoride, natural products such as Miswak, which have proven antiplaque and remineralising action can be considered as alternatives to address concerns regarding fluoride [53].

Component	Role in oral cavity
Alkaloids-salvadorine	Bactericidal
Tannins	Astringent, inhibits glucosyltransferase
Vitamin C	Wound healing, repair, antioxidant action
Sulphur	Bactericidal
Resins	Prevents adhesion of microorganism on tooth surface
Chloride	Inhibit formation of calculus, abrasive
Silica	Abrasive
Essential oils	Stimulate saliva and improves buffering capacity

[Table/Fig-3]: Major constituents of *Salvadora persica* (Miswak) [51,52].

### **Glycyrrhiza glabra (Liquorice)**

Derived from a Greek word "glycos" meaning sweet and "rhiza" meaning root, *Glycyrrhiza glabra* (*G.glabra*) contains licoricidin, licorisoflavan A and glabridin are responsible for its anti-inflammatory activity. In-vitro studies have shown Glycyrrhizic acid impedes proliferation, cell adhesion and acid production of *S.mutans* and periodontopathic pathogens in-vitro when used as a muco-adhesive patch, liquorice has shown to reduce the size and pain of aphthous ulcers thereby hastening the healing [54].

### **Triphala**

Triphala means three (tri) fruits (phala) and consists of *Embllica officinalis*, *Terminalia chebula* and *Terminalia bellerica*. Triphala is rich in vitamin C, carotene, anthraquinones, flavonoids and tannins and is known to possess antioxidant, immunomodulatory, anti-microbial and antiaging properties. Triphala can be prepared in two proportions; Either with equal proportions of all three fruits (1:1:1 ratio) or a 1:2:4 ratio of *T.bellerica*, *T.chebula* and *E.officinalis*, respectively [55]. Twice daily use of mouth rinse containing 6% Triphala for seven days has showed a reduction in oral streptococci counts which are more significant than 0.2% chlorhexidine [56]. Due to its anti-microbial property, it is a potential alternative to conventional root canal irrigant [57].

### **Mentha pipertita (Peppermint oil)**

Obtained from the leaves of peppermint plant *Mentha pipertita*, the oil contains 48-55% of menthol and 14-32% of menthone. It is commonly used in the toothpastes, lozenges, balms, cough drops, etc., for its analgesic property. In-vitro studies have shown that peppermint oil causes allosteric inhibition of *S.mutans* glucosyltransferases hence, it may be used as one of the agents in prevention of biofilm formation [26].



### **Rosmarinus officinalis (Rosemary)**

The presence of numerous bioactive materials is responsible for inhibiting proinflammatory leukotrienes, cyclo-oxygenase pathway thereby can be used in dentistry for its anti-inflammatory action [58]. Both toothpaste and mouth rinse containing Rosemary extracts have reduced gingivitis. An inhibitory effect on *C.albicans* has also been noted through in-vitro studies [59].

### **Sambucus nigra (Elderberry)**

Flavonoids and significant secondary metabolites, such as 1% triterpenes, 1% sterols, 3% phenolic acids and their glycosides, and up to 0.15% essential oils, make up the composition. These components' anti-inflammatory activity has been utilised to treat periodontitis [3].

### **Mangifera indica (Mango)**

Mangiferin is the most active biological ingredient of mango leaves, followed by phenolic acids, benzophenones, and other antioxidants such as flavonoids, carotenoids, quercetin, isoquercetin, ascorbic acid and tocopherol. The essential oil has bacteriostatic characteristics and many antibacterial components that block  $\alpha$ -glucosidase thereby imparting immunosuppressive qualities [60]. A notable decrease in microbial count, improved plaque and gingival scores were seen in children who used a 90% ethanolic extract of 10 mL mango leaf mouthwash once daily for five days [61]. Mango extract has been used as an intracanal irrigant not only because of its anti-microbial property but also because it is less detrimental to root dentin microhardness when compared with conventional irrigants [62].

### **Sesame Oil**

Sesame oil is a rich source of vitamin E due to its high content of polyunsaturated fatty acids. Sesamol, sesamin and sesamolins are the primary antioxidants found in it. Sesame oil can be used for oil pulling and it has exhibited certain advantages over the standard and commercially available mouthwashes as it causes no staining, has no lingering aftertaste, and causes no allergic reactions. It is more reasonably priced and easily accessible. Sesame oil showed a significant antibacterial activity by inhibiting the growth of *S.mutans* and *Lactobacillus acidophilus* (*L.acidophilus*) [63].

### **Cinnamomum zeylanicum (Cinnamon)**

More than 80 compounds have been identified with the main components to be cinnamaldehyde, eugenol, phenol and linalool. Fifteen days of treatment with a mouthwash and spray of *Cinnamomum zeylanicum* (*C.zeylanicum*), showed a reduction of 61% and 33% of *Candida* species in-vivo [64].

### **Salvia officinalis (Sage)**

Sage belongs to the mint family and its essential oil has biologically active components known to possess anti-inflammatory, antibacterial, anti-fungal, and antiviral properties making it useful in dentistry [3]. Its antiplaque function is principally due to the integration of its oil molecules into the lipid bilayer of the cell membrane, which causes it to become more permeable resulting in leaking of essential cell contents and cell death [65]. A 1% sage mouthwash when used by school children was seen to effectively reduce the number of *S.mutans* colony forming units [66].

### **Commiphora molm (Myrrh)**

It is a prominent traditional Arabic herbal compound made up of volatile oil, gum, and resin that has been used for ages to treat a range of inflammatory disorders. Clinical trials using Myrrh oil, tincture and 1% of mouth wash have all demonstrated a significant reduction in plaque levels and gingival inflammation [67]. Myrrh's healing properties can be attributed to the stimulation of maturation and activation of white blood cells, dermal fibroblast proliferation and an increase in the production of collagen III mRNA, making it effective in the treatment of viral disorders such as aphthous ulcers [68].

### **Murraya koenigii spreng (Curry leaves)**

Fresh curry leaves contain 2.6% volatile essential oils (sesquiterpenes and monoterpenes), which have wide antibacterial activity on *S.mutans* and *S.sanguinis*. It also includes chlorophyll, which has been considered as an anticarcinogenic agent and aids in the reduction of halitosis [69]. Mouth rinse containing curry leaf extract has shown to be equally effective as compared to chlorhexidine and more effective than cinnamon extract in maintaining salivary and tongue pH, hence can be considered safe, economical, and effective alternate [69].

### **Hydrastis canadensis L (Goldenseal)**

Goldenseal is a tiny perennial plant that grows in the moist woodlands of the eastern United States and Canada. Its roots are used to cure a variety of diseases. The pharmacological benefits of Goldenseal extract have been linked to the main isoquinoline alkaloids berberine and beta hydrastine, which exhibit antibacterial, anti-fungal and antiprotozoal properties. When used in toothpaste or as a mouth rinse, goldenseal acts as an excellent agent for soothing inflamed gums [2].

### **Radix ginseng**

Also, known as red ginseng, it belongs to Eastern Asia and is known to contain over 12 varieties of bioactive chemical substance known as ginsenosides some of which are triterpene, saponins, oleanolic acid. Anti-inflammatory property of Ginseng can be attributed to its potent effects on Mitogen-activated Protein (MAP) kinase pathway, COX-2, and NF- $\kappa$ B. It inhibits pro inflammatory cytokines like Tumor Necrosis Factor alpha (TNF- $\alpha$ ) and its ability to reduce the expression of Matrix Metalloproteinase (MMP-3) [70]. Due to its antioxidant, anti-inflammatory activity, and ability to stimulate salivary secretion thereby increasing the buffering action of saliva in the oral cavity, Ginseng has proved to be more effective than commercially available mouth rinses in reducing salivary bacterial counts [71].

### **Ocimum sanctum L (Tulsi)**

Known as the "elixir of life" that enhances longevity, tulsi has been utilised for centuries for various treatments. Eugenol is identified as one of the major active constituents and is reported to possess innumerable benefits. Other phytoconstituents isolated from various parts of the plant include palmitic acid, vallinin, gallic acid, vitamin A, vitamin C, ursolic acid and carvacrol [72]. Tulsi has been employed in various concentrations of 2.5%, 4%, 5% and 10% in mouth washes for its antiplaque activity [73]. An in-vitro study evaluated the healing and cytotoxic potential of tulsi crude extract and showed that concentrate of 50  $\mu$ g was effective against microorganisms associated with recurrent aphthous stomatitis and was also non toxic to human gingival fibroblasts [74]. Tulsi extract incorporated into calcium hydroxide has shown to be a beneficial obturating material in primary molar teeth [75].

### **Trifolium pratense (Red clover)**

In dentistry, red clover mouthwash has shown to heal irritated and diseased gums. The ointment prepared from red clover tea from its strained leaves and flowers has antibiotic properties on gingival abscesses and sore, inflamed gums. In a recent animal study, it was seen that Biochanin A present in *Trifolium pratense* alleviates gingival inflammation and alveolar bone loss [76].

### **Cocos nucifera (Coconut)**

Coconut water is a powerhouse of nutrients, sterile and non haemolytic [3]. Coconut water shows the high osmolarity of 372 mOsm/L, enabling it to keep the cells vital from 15-120 minutes without much of cell death. When compared to 50% propolis and oral rehydration solution, coconut water had a considerably larger number of viable periodontal ligament cells [77].

### ***Punica granatum* (Pomegranate)**

Pomegranate extract contains anthocyanins, glucose, ascorbic acid, ellagic acid, gallic acid, catechin, epigallocatechin, quercetin, caffeic acid which contribute to its antioxidant properties [78]. Tannins can cross over the cell walls of *S.mutans* and bind to its inner surface leading to precipitation of proteins and thereby suppressing enzymes such as glucosyltransferases. A 10% topical pomegranate gel has been demonstrated to decrease discomfort from recurring aphthous stomatitis and shorten the time required for ulcer repair [78].

### ***Sanguinaria canadensis* (Bloodroot)**

Bloodroot also known as *Sanguinaria Canadensis* contains quarternary benzophenanthridine alkaloids, chelerythine, chelllutine, chelirubine, sanguilutine with sanguinarine being the main alkaloid in bloodroot. Bloodroot formulations limit the growth of oral microbes they are used to treat gingivitis and periodontal disease, as well as in toothpaste and other oral hygiene products [2].

### ***Withania somnifera* (Ashwagandha)**

It is a plant of the Solanaceae family and is widely used as a remedy to a variety of ailments as well as a general tonic for overall health and longevity in Indian and Nepalese traditional medicine. When used in oral rinses, ashwagandha decreases biofilm development and improves calcium hydroxide diffusion via dentinal tubules, making it a feasible alternative as a vehicle for putting intracanal medicament [79].

### ***Papaya proteinase L* (Papain)**

It is an endoprotein obtained from the leaves of Papaya tree, which has bactericidal, bacteriostatic, and anti-inflammatory actions. When used along with an additional component, chloramine blue, water, salts, and thickeners, it is used in chemo-mechanical removal of dental caries. The principle behind its mechanism is that acts only on affected tissues, which lack the  $\alpha$ 1-antitrypsin plasmatic antiprotease thereby causing preferential dissolution of infected dentin sparing the healthy tissue [80]. Due to its minimally invasive approach, papain gel can be used effectively as an alternative to conventional caries removal techniques, especially in paediatric population, owing to its shorter treatment duration and better outcomes [81].

### ***Eucalyptus globulus***

It is plant of the family Myrtaceae native to Australia and cultivated worldwide. Its oil exhibits antibacterial and anti-inflammatory properties due to the presence of terpenoids, which alter the permeability of the bacterial cell membrane and reduce the ATP synthesis, thereby altering the cell homeostasis [26]. Used to not only disinfect root canal filling materials like gutta percha, but also soften the material to enable its easy removal from the canal in re-treatment cases [82].

### **Cocoa Bean**

The husk contains higher molecular-weight of polyphenolic compounds that has a potent antiglycosyltransferase property. Mouth wash containing a combination of cocoa bean extract with honey has showed comparable activity against biofilm formation in comparison to chlorhexidine [83]. Theobromine, a bitter alkaloid of the cocoa bean plant helps in formation of an apatite structure medium that enhances the remineralisation of the tooth surface.

### ***Vaccinium macrocarpo* (Cranberry)**

Cranberry is a tiny red fruit grown in the cooler climates of North Eastern America, Chile and Canada. In-vitro studies have demonstrated that cranberry components can improve gingival and periodontal health by regulating the host inflammatory response, suppressing bacterial biofilm formation, and decreasing the activity of periopathogenic proteolytic enzymes [84]. The fruit of this plant is a rich source of polyphenols such as flavonoids and non

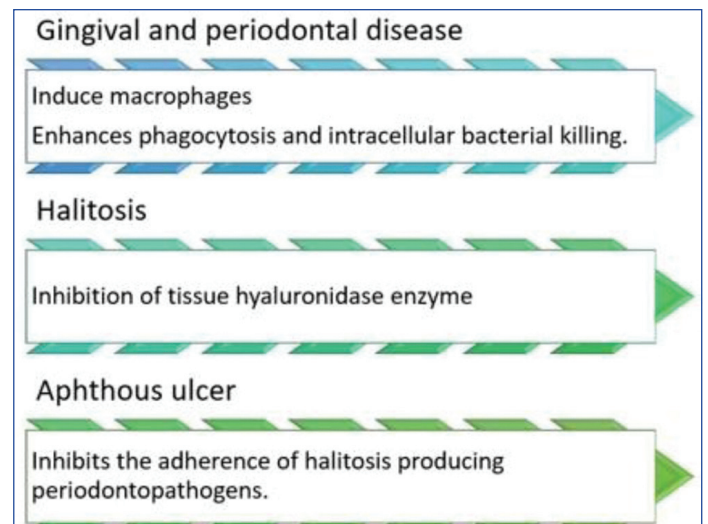
flavonoids such as phenolic acids and stilbens [Table/Fig-4] [84,85]. A 0.6% cranberry extract mouthwash brought a 68% reduction in *S.mutans* count [85]. Dentifrices containing a combination of Casein Phosphopeptide-Amorphous Calcium Phosphate (CPP-ACP) and polyphenol-rich cranberry extracts influenced a significant decrease in *S.mutans*, *Veillonella parvula* (*V.parvula*) and *Neisseria flavescens* (*N.flavescens*) levels [85].

Primary constituents	Subgroup	Mechanism
Flavanols i. Monomeric flavan-3-ols ii. Polymeric flavan-3-ols	Catechin, epicatechin and epigallocatechin A-linked proanthocyanidins	Inhibits the Glucosyl Transferase Activity (GTfs) and F-ATPase; reduces acid production and aciduric properties of <i>S.mutans</i>
Flavonols	Glycosylated forms of quercetin, myricetin, and kaempferol	
Anthocyanins	Cyanidin and peonidin	

**[Table/Fig-4]:** Active constituents of *Vaccinium macrocarpo* (Cranberry) [84,85].

### ***Echinacea purpurea* (Purple coneflower)**

It is an herbaceous flowering plant belonging to Asteracea family, it consists of lipophilic, water-soluble polysaccharides, caffeic acid derivatives, alkaloids and chicoric acid which are known to stimulate the immune system of the human body [86]. Therapeutic uses in dentistry are depicted in [Table/Fig-5].



**[Table/Fig-5]:** Various uses of *Echinacea purpurea* (purple coneflower) in dentistry.

### **Apple Extract**

Apples are a rich source of polyphenols; hence they exhibit both antibacterial and antioxidant effects. Pulp of apple contains catechin, procyanidin, caffeic acid and chlorogenic acid. All the chemicals, as well as flavonoids, such as quercetin glycosides and cyanidin glycosides which are not seen in the pulp of this fruit may be found in apple skin [87]. Study conducted by Shetty V et al., demonstrated the anticariogenic effect of crude apple extract on *S.mutans* which was accredited to its ability to inhibit bacterial adhesion and hence proposed its use as a natural alternative in prevention of dental caries [87].

### ***Vitis vinifera* (Grape)**

Grape seed extracts are a rich source of polyphenols, mainly monomeric catechin and epicatechin, gallic acid and polymeric and oligomeric procyanidins [6]. Grape seed extract is utilised in dentistry for multiple purposes [Table/Fig-6] [6].

### ***Oleum oenothera biennis* (Evening primrose)**

Evening primrose is a species of flowering plant belonging to the family Onagraceae. It is extracted from the seed of the plant and is rich in linolenic acid which is a precursor of prostaglandin E and several other bioactive constituents which are responsible for its therapeutic action. It is a known modulator of inflammation and

Remineralising action	<ul style="list-style-type: none"> <li>➤ Binds to enzymes such as collagenases which are responsible for the breakdown of dentin after enamel has demineralised.</li> <li>➤ Promotes the cross-linking of collagen in dentin thereby strengthening and remineralising the tooth structure.</li> </ul>
Antioxidant action	<ul style="list-style-type: none"> <li>➤ Decreases the formation of reactive oxygen species, nitric oxide, and inducible Nitric Oxide Synthase (iNOS).</li> <li>➤ Suppress lipopolysaccharide-induced Matrix Metalloproteinase (MMP) secretion.</li> </ul>
Anti-microbial action	Polyphenols inhibit hydrolytic enzymes of bacteria such as proteases and carbohydrases they also disable microbial adhesions, cell envelope transport proteins, and non specific interactions with carbohydrates.
Osteogenic action	Animal studies have demonstrated bio-stimulatory role on dental pulp cells when in direct contact.

**[Table/Fig-6]:** Various uses and actions of Grape seed extract in dentistry [6].

has effectively been used to control inflammatory conditions such as arthritis and Sjögren syndrome as patients suffering from such conditions have depressed levels of gamma linolenic acid [88].

### SEDATIVE AND ANXIOLYTIC ACTION OF HERBS

Clinical trials have proved the efficacy of herbs such as *Passiflora incarnata*, *Erythrina mulungu* (E.mulungu) and lavender have been used in dentistry to induce muscle relaxation and inhibit anxiety [89]. *Passiflora* inhibits monoamino oxidase and Gamma-aminobutyric Acid (GABA) receptor activation whereas presence of Erythravine and hydroxyerythravine in *E.mulungu* are responsible for the anxiolytic action of these herbs. Lavender oil may be used via oral or inhalational routes for its effect; it contains linalool which affects the GABA receptors and linalyl acetate which has a narcotic effect [89].

A summary of all the applications of herbal products have been listed in [Table/Fig-7].

Herbal product	Use in dentistry
<i>Aloe barbadensis</i> (Aloe vera)	Wound healing, antiplaque agent, obturating material in primary teeth, root canal irrigating solution, treatment of oral mucosal conditions
<i>Arctium lappa</i> (Greater burdock)	Root canal irrigating solution
<i>Acacia nilotica</i> (Babool)	Root canal irrigating solution, disinfection of gutta percha cones
<i>Azadirachta indica</i> (Neem)	Antiplaque agent, treat gingivitis and periodontitis, root canal irrigating solution
<i>Thyme vulgaris</i> (Thyme oil)	Intracanal medicament and obturating material in primary teeth.
<i>Allium sativum</i> (Garlic)	Antiplaque agent, root canal irrigating solution, pulpotomy medicament
<i>Citrus limonum</i> (Lemon extract)	Root canal irrigating solution
<i>Psoralea corylifolia</i> (Bakuchi)	Root canal irrigating solution, treatment of autoimmune lesions in oral cavity
<i>Syzygium aromaticum</i> (Clove)	Obturating material in primary teeth, interim therapeutic restorations
<i>Melaleuca alternifolia</i> (Tea tree oil)	Treat gingivitis and periodontitis
<i>Curcuma longa</i> (Turmeric)	Identification of plaque, pit and fissure sealants, intracanal medicament, subgingival irrigating solution, treat dry socket, gingivitis and periodontitis
<i>Martcaria recutitia</i> (German chamomile)	Root canal irrigating solution, antiplaque agent, treat gingivitis and periodontitis
<i>Camellia sinensis</i> (Green tea)	Antiplaque and anticariogenic agent
<i>Morinda citrifolia</i> (Noni)	Root canal irrigating solution
Propolis	Antiplaque and anticariogenic agent, remineralizing agent, cavity disinfection, root canal irrigating solution, storage media for avulsed tooth
<i>Psidum gujava</i> (Guava)	Antiplaque agent, wound healing
<i>Salvadora persica</i> (Miswak)	Antiplaque activity

<i>Glycyrrhiza glabra</i> (Liquorice)	Wound healing, anticariogenic
Triphala	Antiplaque agent and root canal irrigating solution
<i>Mentha pipertita</i> (Peppermint oil)	Antiplaque agent
<i>Rosmarinus officinalis</i> (Rosemary)	Treatment of gingival inflammation
<i>Sambucus nigra</i> (Elderberry)	Treatment of periodontitis
<i>Mangifera indica</i> (Mango)	Antiplaque agent, treatment of gingivitis and periodontitis, root canal irrigating solution
Sesame oil	Anticariogenic
<i>C.Zeylanicum</i> (Cinnamon)	Antiplaque agent
<i>Salvia officinalis</i> (Sage)	Antiplaque agent, treatment of gingivitis and periodontitis,
<i>Commiphora molm</i> (Myrrh)	Antiplaque agent and wound healing, treatment of gingivitis and periodontitis,
<i>Murraya koenigii</i> spreng (Curry leaves)	Anticariogenic
<i>Hydrastis canadensis I</i> (Goldenseal)	Treat gingivitis
<i>Radix ginseng</i>	Antiplaque agent
<i>Ocimum sanctum I</i> (Tulsi)	Antiplaque agent, treat recurrent aphthous ulcers, obturating material in primary teeth
<i>Trifolium pratense</i> (Red clover)	Treat periodontitis
<i>Cocos nucifera</i> (Coconut)	Storage media for avulsed teeth
<i>Punica granatum</i> (Pomegranate)	Antiplaque, anticariogenic, wound healing, storage media for avulsed teeth
<i>Sanguinaria canadensis</i> (Bloodroot)	Treat gingivitis and periodontal disease
<i>Withania somnifera</i> (Ashwagandha)	Intracanal medicament
<i>Papain</i> ( <i>Papaya proteinase L</i> )	Chemo-mechanical caries removal
<i>Eucalyptus globulus</i>	Root canal medicament, disinfect and soften gutta percha
Cocoa bean	Remineralisation of enamel
<i>Vaccinium macrocarpo</i> (Cranberry)	Remineralisation of enamel, anticariogenic, plaque control
<i>Echinacea purpurea</i> (Purple coneflower)	Gingival and periodontal disease, aphthous ulcer, halitosis
Apple extract	Anticariogenic
<i>Vitis vinifera</i> (Grape)	Remineralisation of enamel
<i>Oleum oenothera biennis</i> (Evening primrose)	Sjögren syndrome
<i>Passiflora incarnata</i> , <i>Erythrina mulungu</i> and lavender	Sedative and anxiolysis
Septilin	Treat periodontitis
<i>Citrullus lanatus</i> (watermelon)	Anticariogenic

**[Table/Fig-7]:** Summary of the herbal plant extract and their use in dentistry.

### Recent Evidence and Advancements

A recent systematic review and meta-analysis comparing the efficacy of Septilin, an herbal immune modulator, consisting of a mixture of herbal extracts and minerals, has shown to be effective in treating periodontal inflammatory conditions [90]. It acts by inhibiting lipopolysaccharide stimulated macrophage and monocyte cell lines responsible to produce proinflammatory mediators. *Citrullus lanatus* (watermelon) based silver nanoparticle varnish has shown to be effective against various cariogenic microorganisms such as synthesised using *S.mutans*, *C.albicans*, *E.faecalis*, and *Lactobacillus* species when compared to fluoride and chlorhexidine containing varnish [91].



## SAFETY AND SIDE-EFFECTS

There is growing concern over the use of such products in dentistry. However, there are few reports in the literature about the negative effects of these natural products some of these include allergies, gastrointestinal and central nervous system effects [78]. Oil extracts of *Melaleuca alternifolia*, *Allium sativum* and Caraway can be irritating to the skin and mucous membrane resulting in contact dermatitis [1,92]. Bronchial asthma secondary to allergic reactions to Chamomile and E.purpurea have been documented in literature [1,93]. Although topical application of thyme oil is considered safe, however its ingestion can lead to dizziness, nausea and breathing difficulties [3]. Long-term or overdose of bloodroot in dental products has been linked to precancerous conditions such as leukoplakia and is contraindicated in children due to its effects such as increased gastric motility and intraocular pressure [3,94]. Long-term use of small doses of sage may result in elevated heart rate and mental disorientation with seizures at higher doses [3]. At medicinal doses, passion flower ingestion can lead to emesis, while moderate doses might cause antispasmodic or somewhat narcotic effects, and excessive doses have produced spasms and even paralysis in animals. *Passiflora incarnata* (*P. incarnata*) should be taken with caution when used concomitantly with other Central Nervous System (CNS) depressants, stimulants due to the synergistic effect on muscle relaxation [1].

## CONCLUSION(S)

The use of herbal medication is expanding rapidly all over the world. For thousands of years herbal medicine was the traditional treatment till pharmaceutical products took over and became the traditional medicines while herbal medication came to be known as alternative medicine. Soon, with the advent of scientific research in herbs this shift seems to be reverting. These herbal alternatives have advantages over the conventional therapeutic measures since they have minimal side-effects, wide availability, and lower cost, making people more inclined towards their use, especially in preventive and therapeutic dentistry.

There is a wide scope in future for herbal dentistry, however the research is still in infancy and requires an amalgamation of the desired properties of various herbs and formulation of a combination which has maximum efficacy and minimum side-effects. Also, further studies are required to compare the use of conventional antibiotics and other drugs with herbal products.

## REFERENCES

- Buggapati L. Herbs in dentistry. International Journal of Pharmaceutical Science Invention. 2016;5(6):07-12.
- Jain N, Rajwar YC, Batra M, Singh HP, Bhandari R, Agarwal P. Dentistry: Turning towards herbal alternatives: A review. Scholars Journal of Applied Medical Sciences. 2014;2(1C):253-57.
- Taheri JB, Azimi S, Rafeian N, Zanjani HA. Herbs in dentistry. Int Dent J. 2011;61(6):287-96.
- Suresh S, Arumugham IM, Doraikannan S, Rathinavelu PK, Prabakar J, Balasubramanian A. Comparing the effectiveness of herbal and conventional dentifrices in reducing dental plaque and gingivitis: A systematic review. J Int Soc Prev Community Dent. 2021;11(6):601-08.
- Kengadaran S, Anusha D, Baskar K, Muthukrishnan K, Pooraninagalakshmi J, Prabakar J. Comparative effectiveness of herbal and conventional toothpaste on prevention of dental caries: Systematic review and meta-analysis. Indian J Dent Res. 2022;33(3):332-37.
- Priyanka P, Bharathwaj SS, Sindhu PD, Dinesh R. Remineralization potential of grape seed extract-a systematic review. Annals of the Romanian Society for Cell Biology. 2021;18906-17.
- Manipal S, Hussain S, Wadgave U, Duraiswamy P, Ravi K. The mouthwash war-chlorhexidine vs. herbal mouth rinses: A meta-analysis. J Clin Diagn Res. 2016;10(5):ZC81-83.
- Pasupuleti MK, Nagate RR, Alqahtani SM, Penmetsa GS, Gottumukkala SN, Ramesh KS. Role of medicinal herbs in periodontal therapy: A systematic review. Journal of International Society of Preventive and Community Dentistry. 2023;13(1):09-16.
- Agnihotri A, Arora R, Sharma U, Sood P. Herbal irrigants in primary teeth: A step toward green dentistry based on the wisdom of past. Journal of Indian Association of Public Health Dentistry. 2020;18(4):279.
- Subramanyam D, Somasundaram S. Clinical and radiographic outcome of herbal medicine versus standard pulpotomy medicaments in primary molars: A systematic review. Journal of Clinical & Diagnostic Research. 2017;11(10).
- Baharvand M, Jafari S, Mortazavi H. Herbs in oral mucositis. J Clin Diagn Res. 2017;11(3):ZE05-ZE11.
- Nair GR, Naidu GS, Jain S, Nagi R, Makkad RS, Jha A. Clinical effectiveness of aloe vera in the management of oral mucosal diseases- a systematic review. J Clin Diagn Res. 2016;10(8):ZE01-07.
- Al-Maweri SA, Nassani MZ, Alazari N, Kalakonda B, Al-Shamiri HM, Alhaji MN, et al. Efficacy of aloe vera mouthwash versus chlorhexidine on plaque and gingivitis: A systematic review. Int J Dent Hyg. 2020;18(1):44-51.
- Pradeep AR, Agarwal E, Naik SB. Clinical and microbiologic effects of commercially available dentifrice containing aloe vera: A randomized controlled clinical trial. J Periodontol. 2012;83(6):797-804.
- Sayar F, Farahmand AH, Rezaazadeh M. Clinical efficacy of aloe vera toothpaste on periodontal parameters of patients with gingivitis-a randomized, controlled, single-masked clinical trial. J Contemp Dent Pract. 2021;22(3):242-47.
- Priyadarshini P, Gurunathan D. Comparative evaluation of quality of obturation using endoflas and endoflas powder with aloe vera gel as obturating materials in primary mandibular molars: A double blinded randomized controlled trial. Children. 2020;4:5.
- Tonea A, Badea M, Oana L, Sava S, Vodnar D. Antibacterial and antifungal activity of endodontic intracanal medications. Clujul Med. 2017;90(3):344-47.
- Shekar C, Nagarajappa R, Singh R, Thakur R. Antimicrobial efficacy of Acacia nilotica, Murraya koenigii L. Sprengel, Eucalyptus hybrid, and Psidium guajava on primary plaque colonizers: An in-vitro comparison between hot and cold extraction process. J Indian Soc Periodontol. 2015;19(2):174-79.
- Alobaid AS, Fadul AN, Alqahtani RA, Alqahtani NA, Shobeili WA. Antimicrobial Effect of Acacia Nilotica Extracts on Endodontic Microorganisms. JIDA: Journal of Indian Dental Association. 2019;13(10):18-23.
- Jagyasi DR, Chandwani ND, Gunwal MK, Ranka AS. Antimicrobial efficacy of acacia Nilotica (Babul) extract and its effectiveness in disinfecting gutta percha cones-An in-vitro study. Indian J Dent Res. 2021;32(2):221-25.
- Tayal E, Sardana D, InduShekar KR, Saraf BG, Sheoran N. Current perspectives on use of aloe vera in dentistry. European Journal of Medicinal Plants. 2014;4(12):1408.
- Santi SS, Casarin M, Grellmann AP, Chambrone L, Zanatta FB. Effect of herbal mouthrinses on dental plaque formation and gingival inflammation: A systematic review. Oral Dis. 2021;27(2):127-41.
- Abhishek KN, Supreetha S, Sam G, Khan SN, Chaithanya KH, Abdul N. Effect of neem containing toothpaste on plaque and gingivitis--a randomized double blind clinical trial. J Contemp Dent Pract. 2015;16(11):880-83.
- Garg S. Local drug delivery systems as an adjunct to cure periodontitis-The novel dental applicant. Pharm Methods. 2015;6(1):01-08.
- Hosny NS, El Khodary SA, El Boghdadi RM, Shaker OG. Effect of Neem (Azadirachta indica) versus 2.5% sodium hypochlorite as root canal irrigants on the intensity of post-operative pain and the amount of endotoxins in mandibular molars with necrotic pulps: A randomized controlled trial. Int Endod J. 2021;54(9):1434-47.
- Thosar N, Basak S, Bahadure RN, Rajurkar M. Antimicrobial efficacy of five essential oils against oral pathogens: An in-vitro study. Eur J Dent. 2013;7(Suppl 1):S071-77.
- Thosar NR, Chandak M, Bhat M, Basak S. Evaluation of antimicrobial activity of two endodontic sealers: Zinc oxide with thyme oil and zinc oxide eugenol against root canal microorganisms- an in-vitro study. Int J Clin Pediatr Dent. 2018;11(2):79-82.
- Mehta N, Gupta A, Mahesh S, Abraham D, Singh A, Jala S, et al. Comparative evaluation of antibacterial efficacy of Allium sativum extract, aqueous ozone, diode laser, and 3% sodium hypochlorite in root canal disinfection: An in vivo study. J Conserv Dent. 2020;23(6):577-82.
- Elheeny AAH. Allium sativum extract as an irrigant in pulpectomy of primary molars: A 12-month short-term evaluation. Clin Exp Dent Res. 2019;5(4):420-26.
- Houshmand B, Mahjour F, Dianat O. Antibacterial effect of different concentrations of garlic (Allium sativum) extract on dental plaque bacteria. Indian J Dent Res. 2013;24(1):71-75.
- Kahvand M, Mehran M, Haghgoo R, Faghihi T. Clinical and Radiographic Evaluation of Allium sativum Oil (Garlic Oil) in comparison with Formocresol in primary molar pulpotomy. J Int Soc Prev Community Dent. 2019;9(4):390-95.
- Abirami K, Ramkumar H, Senthil D. Clinical and radiographic evaluation of the efficacy of Formocresol, Allium sativum oil, and Aloe barbadensis gel as pulpotomy medicaments in primary molars: A randomized controlled trial. Int J Clin Pediatr Dent. 2020;13(5):518-22.
- Siddique R, Ranjan M, Jose J, Srivastav A, Rajakeerthi R, Kamath A. Clinical quantitative antibacterial potency of garlic-lemon against sodium hypochlorite in infected root canals: A double-blinded, randomized, controlled clinical trial. J Int Soc Prev Community Dent. 2020;10(6):771-78.
- Seker ID, Akca G, Alacam T. In-vitro evaluation of antimicrobial effects of citrus limonum essential oil on some endodontic pathogens. Annals of Medical Research. 2022;29(5):427-33.
- Radwan IN, Randa B, Hend AN, Camilia G. Evaluation of antimicrobial efficacy of four medicinal plants extracts used as root canal irrigant on Enterococcus faecalis: An in-vitro study. International Dental & Medical Journal of Advanced Research. 2015;1(1):01-08.
- Nabi NG, Shrivastava M. Endangered medicinal plant Psoralea corylifolia: Traditional, phytochemical, therapeutic properties and micropropagation. Pharmaceutical and Biosciences Journal. 2017:40-46.

- [37] Nagpal M, Sood S. Role of curcumin in systemic and oral health: An overview. *J Nat Sci Biol Med.* 2013;4(1):03-07.
- [38] Digole VR, Dua P, Shergill SP, Pathak P, Kumar V, Prakash P. Comparative evaluation of antimicrobial efficacy of calcium hydroxide, curcumin and aloe vera as an intracanal medicament: An in-vivo study. *IP Indian Journal of Conservative Endodontics.* 2020;5(3):114-19.
- [39] Singh A, Sridhar R, Shrihatti R, Mandloy A. Evaluation of turmeric chip compared with chlorhexidine chip as a local drug delivery agent in the treatment of chronic periodontitis: A split mouth randomized controlled clinical trial. *J Altern Complement Med.* 2018;24(1):76-84.
- [40] Goes P, Dutra CS, Lisboa MR, Gondim DV, Leitão R, Brito GA, et al. Clinical efficacy of a 1% *Matricaria chamomile* L. mouthwash and 0.12% chlorhexidine for gingivitis control in patients undergoing orthodontic treatment with fixed appliances. *J Oral Sci.* 2016;58(4):569-74.
- [41] Venkataram V, Gokhale ST, Kenchappa M, Nagarajappa R. Effectiveness of chamomile (*Matricaria recutita* L.), MTAD and sodium hypochlorite irrigants on smear layer. *Eur Arch Paediatr Dent.* 2013;14(4):247-52.
- [42] Xu X, Zhou XD, Wu CD. The tea catechin epigallocatechin gallate suppresses cariogenic virulence factors of *Streptococcus mutans*. *Antimicrob Agents Chemother.* 2011;55(3):1229-36.
- [43] Mahmood T, Akhtar N, Khan BA. The morphology, characteristics, and medicinal properties of *Camellia sinensis* tea. *Journal of Medicinal Plants Research.* 2010;4(19):2028-33.
- [44] Hambire CU, Jawade R, Patil A, Wani VR, Kulkarni AA, Nehete PB. Comparing the antiplaque efficacy of 0.5% *Camellia sinensis* extract, 0.05% sodium fluoride, and 0.2% chlorhexidine gluconate mouthwash in children. *Journal of International Society of Preventive & Community Dentistry.* 2015;5(3):218.
- [45] Mathur A, Gopalakrishnan D, Mehta V, Rizwan SA, Shetiya SH, Bagwe S. Efficacy of green tea-based mouthwashes on dental plaque and gingival inflammation: A systematic review and meta-analysis. *Indian J Dent Res.* 2018;29(2):225-32.
- [46] Chandwani M, Mittal R, Chandak S, Pimpale J. Effectiveness of *Morinda citrifolia* juice as an intracanal irrigant in deciduous molars: An in vivo study. *Dent Res J (Isfahan).* 2017;14(4):246-51.
- [47] Khurshid Z, Naseem M, Zafar MS, Najeel S, Zohaib S. Propolis: A natural biomaterial for dental and oral healthcare. *J Dent Res Dent Clin Dent Prospects.* 2017;11(4):265-74.
- [48] Zulhendri F, Felitti R, Fearnley J, Ravalía M. The use of propolis in dentistry, oral health, and medicine: A review. *J Oral Biosci.* 2021;63(1):23-34.
- [49] Shaheena S, Chintagunta AD, Dirisala VR, Sampath Kumar NS. Extraction of bioactive compounds from *Psidium guajava* and their application in dentistry. *AMB Express.* 2019;9(1):208.
- [50] Kassem EM, Khairy MA, Abouauf EA. Antibacterial effect of guava leaves extract mouthwash versus chlorhexidine mouthwash in high caries risk patients: A randomized clinical trial. *Journal of International Oral Health.* 2022;14(2):144.
- [51] Scott J, Marshman Z. Does the use of miswak reduce plaque and gingivitis among adults? *Evid Based Dent.* 2022;23(4):152-53.
- [52] Jassoma E, Baeesa L, Sabbagh H. The antiplaque/anticariogenic efficacy of *Salvadora persica* (Miswak) mouthrinse in comparison to that of chlorhexidine: A systematic review and meta-analysis. *BMC Oral Health.* 2019;19(1):64.
- [53] Attia NM, Hasan MM, Sallam NM. Fluoride alternatives for remineralization of early enamel carious lesions, fact or fiction? A systematic review. *Egyptian Dental Journal.* 2020;66:1971-79.
- [54] Liu G, He YH, Zhang FF, Kong XL, Wen YL, Ma QR, et al. Effects of glycyrrhizic acid on the growth and acid-producing of *Streptococcus mutans* in-vitro. *Sichuan Da Xue Xue Bao Yi Xue Ban.* 2010;41(4):634-37.
- [55] Shanbhag VK. Triphala in prevention of dental caries and as an antimicrobial in oral cavity- a review. *Infect Disord Drug Targets.* 2015;15(2):89-97.
- [56] Naiktari RS, Gaonkar P, Gurav AN, Khiste SV. A randomized clinical trial to evaluate and compare the efficacy of triphala mouthwash with 0.2% chlorhexidine in hospitalized patients with periodontal diseases. *J Periodontal Implant Sci.* 2014;44(3):134-40.
- [57] Shakouie S, Eskandarinezhad M, Gasemi N, Milani AS, Samiei M, Golizadeh S. An in-vitro comparison of the antibacterial efficacy of triphala with different concentrations of sodium hypochlorite. *Iran Endod J.* 2014;9(4):287-89.
- [58] Mandava K, Batchu UR, Kakulavaram S, Repally S, Chennuri I, Bedarakota S, et al. Design and study of anticaries effect of different medicinal plants against *S.mutans* glucosyltransferase. *BMC Complement Altern Med.* 2019;19(1):197.
- [59] Mahyari S, Mahyari B, Emami SA, Malaekheh-Nikouei B, Jahanbakhsh SP, Sahebkar A, et al. Evaluation of the efficacy of a polyherbal mouthwash containing *Zingiber officinale*, *Rosmarinus officinalis* and *Calendula officinalis* extracts in patients with gingivitis: A randomized double-blind placebo-controlled trial. *Complement Ther Clin Pract.* 2016;22:93-98.
- [60] Kumar M, Saurabh V, Tomar M, Hasan M, Changan S, Sasi M, et al. Mango (*Mangifera indica* L.) leaves: Nutritional composition, phytochemical profile, and health-promoting bioactivities. *Antioxidants (Basel).* 2021;10(2):299.
- [61] Bhat SS, Hegde KS, Mathew C, Bhat SV, Shyamjith M. Comparative evaluation of *Mangifera indica* leaf mouthwash with chlorhexidine on plaque accumulation, gingival inflammation, and salivary streptococcal growth. *Indian J Dent Res.* 2017;28(2):151-55. Doi: 10.4103/ijdr.IJDR\_583\_15. PMID: 28611324.
- [62] Philip PM, Sindhu J, Poornima M, Naveen DN, Nirupama DN, Nainan MT. Effects of conventional and herbal irrigants on microhardness and flexural strength of root canal dentin: An in-vitro study. *J Conserv Dent.* 2021;24(1):83-87. Doi: 10.4103/JCD.JCD\_426\_20. Epub 2021 Jul 5. PMID: 34475686; PMCID: PMC8378487.
- [63] Jeevan S, Sindhu R, Manipal S, Prabu D, Mohan R, Bharathwaj VV. Efficacy of oil pulling with sesame oil in comparison with other oils and chlorhexidine for oral health: A systematic review. *Journal of Pharmaceutical Sciences and Research.* 2019;11(11):3573-78.
- [64] Jayaprakasha GK, Rao LJ. Chemistry, biogenesis, and biological activities of *Cinnamomum zeylanicum*. *Crit Rev Food Sci Nutr.* 2011;51(6):547-62.
- [65] Narayanan N, Thangavelu L. *Salvia officinalis* in dentistry. *Dental Hypotheses.* 2015;6(1):27.
- [66] Beheshti-Rouy M, Azarsina M, Rezaie-Soufi L, Alikhani MY, Roshanaie G, Komaki S. The antibacterial effect of sage extract (*Salvia officinalis*) mouthwash against *Streptococcus mutans* in dental plaque: A randomized clinical trial. *Iran J Microbiol.* 2015;7(3):173-77.
- [67] Kariuki HMAH, Wagaiyu EG. Effect of a natural extract toothpaste on the bacteria colonies of initial dental plaque colonizers. *International Organization of Scientific Research Journal of Dental and Medical Sciences.* 2017;16(9):13-21.
- [68] Eid RAA. Efficacy of *Commiphora myrrh* mouthwash on early wound healing after tooth extraction: A randomized controlled trial. *Saudi Dent J.* 2021;33(1):44-54.
- [69] Gupta A, Rawal A. Comparative evaluation of effectiveness of curry-leaf mouthwash, cinnamon mouthwash, and chlorhexidine mouthwash in maintaining salivary and tongue pH. *Journal of Orofacial Research.* 2021;10(1):04-10.
- [70] Kim KR, Chung TY, Shin H, Son SH, Park KK, Choi JH, et al. Red ginseng saponin extract attenuates murine collagen-induced arthritis by reducing pro-inflammatory responses and matrix metalloproteinase-3 expression. *Biol Pharm Bull.* 2010;33(4):604-10.
- [71] Jeddy N, Ravi S, Radhika T, Sai Lakshmi LJ. Comparison of the efficacy of herbal mouth rinse with commercially available mouth rinses: A clinical trial. *J Oral Maxillofac Pathol.* 2018;22(3):332-34.
- [72] Srinivas N, Sali K, Bajoria AA. Therapeutic aspects of Tulsi unraveled: A review. *Journal of Indian Academy of Oral Medicine and Radiology.* 2016;28(1):17-23.
- [73] Gupta D, Bhaskar DJ, Gupta RK, Karim B, Jain A, Singh R, et al. A randomized controlled clinical trial of *Ocimum sanctum* and chlorhexidine mouthwash on dental plaque and gingival inflammation. *J Ayurveda Integr Med.* 2014;5(2):109-16.
- [74] Ahirwar P, Shashikiran ND, Sundarraj RK, Singhla S, Thakur RA, Maran S. A clinical trial comparing antimicrobial efficacy of "essential oil of *Ocimum sanctum*" with triple antibiotic paste as an intracanal medicament in primary molars. *J Indian Soc Pedod Prev Dent.* 2018;36(2):191-97.
- [75] Agarwal S, Gupta S, Tandon S, Mathur R, Rai TS, Kumar M, et al. Comparative evaluation of *Ocimum sanctum* and calcium hydroxide mix as an obturating material in deciduous molars: An in vivo study. *Int J Clin Pediatr Dent.* 2020;13(6):617-21.
- [76] Zhang S, Niu Y, Yang Z, Zhang Y, Guo Q, Yang Y, et al. Biochanin A alleviates gingival inflammation and alveolar bone loss in rats with experimental periodontitis. *Exp Ther Med.* 2020;20(6):251.
- [77] Sanghavi T, Shah N, Parekh V, Singbal K. Evaluation and comparison of efficacy of three different storage media, coconut water, propolis, and oral rehydration solution, in maintaining the viability of periodontal ligament cells. *J Conserv Dent.* 2013;16(1):71-74.
- [78] Prasad D, Kunnaiah R. *Punica granatum*: A review on its potential role in treating periodontal disease. *J Indian Soc Periodontol.* 2014;18(4):428-32.
- [79] Dausage P, Dhirawani RB, Marya J, Dhirawani V, Kumar V. A comparative study of ion diffusion from calcium hydroxide with various herbal pastes through dentin. *Int J Clin Pediatr Dent.* 2017;10(1):41-44.
- [80] Münchow EA, Hamann HJ, Carvajal MT, Pinal R, Bottino MC. Stain removal effect of novel papain- and bromelain-containing gels applied to enamel. *Clin Oral Investig.* 2016;20(8):2315-20.
- [81] Angrish P, Kamboj A, Mitra M, Kaul R, Chengappa DMM, Sharma A, et al. Efficacy of papain gel-a smart alternative to conventional methods of carious dentin removal: An in-vitro study. *Journal of South Asian Association of Pediatric Dentistry.* 2022;5(3):152-56.
- [82] Yadav HK, Yadav RK, Chandra A, Thakkar RR. The effectiveness of eucalyptus oil, orange oil, and xylene in dissolving different endodontic sealers. *J Conserv Dent.* 2016;19(4):332-37.
- [83] Shetty V, Bhandary S, Pereira R. Evaluation of antiplaque and antimicrobial activity of cocoa bean extract: An in vivo study. *World Journal of Dentistry.* 2021;12(2):151.
- [84] Khairan MR, Karibasappa GN, Dodamani AS, Vishwakarma P, Naik RG, Deshmukh MA. Comparative assessment of Cranberry and Chlorhexidine mouthwash on streptococcal colonization among dental students: A randomized parallel clinical trial. *Contemp Clin Dent.* 2015;6(1):35-39.
- [85] Philip N, Leishman SJ, Bandara HMHN, Healey DL, Walsh LJ. Randomized controlled study to evaluate microbial ecological effects of CPP-ACP and cranberry on dental plaque. *JDR Clin Trans Res.* 2020;5(2):118-26.
- [86] Khozeimeh F, Saberi Z, Tavangar A, Badi FF. Effect of herbal Echinacea on recurrent minor oral aphthous ulcer. *Open Dent J.* 2018;12:567-71.
- [87] Shetty V, Aswath NP, Hegde AM. Effect of crude apple extract on the cariogenic factors of *Streptococcus mutans*: An in-vitro study. *J Indian Soc Pedod Prev Dent.* 2018;36(2):135-41.
- [88] Singh D, Jain A, Govila S. Use of herbs-a natural approach in dentistry. *Indian Journal of Contemporary Dentistry.* 2016;4(1):12.
- [89] da Cunha RS, Amorim KS, Gercina AC, de Oliveira ACA, Dos Santos Menezes L, Groppo FC, et al. Herbal medicines as anxiolytics prior to third molar surgical extraction. A randomized controlled clinical trial. *Clin Oral Investig.* 2021;25(3):1579-86.
- [90] Lakshita Sharma SR, Bharathwaj VV, Dinesh Dhamodhar SS, Prabu D, Rajmohan M. Therapeutic effects of "Septilin" (Herbal Immunomodulator) against periodontal manifestations: A systematic review. *Journal of Survey in Fisheries Sciences.* 2023;10(4S):182-89.



- [91] Govindaraj A, Ramakrishnan M, Shanmugam RK, SP SD. Comparative evaluation of the effect of newly formulated citrullus lanatus dental varnish with fluoride and chlorhexidine dental varnish against common oral microflora. *Journal of Survey in Fisheries Sciences*. 2023;10(4S):222-31.
- [92] Seo SM, Kim J, Lee SG, Shin CH, Shin SC, Park IK. Fumigant antitermite activity of plant essential oils and components from Ajowan (*Trachyspermum ammi*), Allspice (*Pimenta dioica*), caraway (*Carum carvi*), dill (*Anethum graveolens*), Geranium (*Pelargonium graveolens*), and Litsea (*Litsea cubeba*) oils against Japanese termite (*Reticulitermes speratus* Kolbe). *J Agric Food Chem*. 2009;57(15):6596-602.
- [93] Reider N, Sepp N, Fritsch P, Weinlich G, Jensen-Jarolim E. Anaphylaxis to camomile: Clinical features and allergen cross-reactivity. *Clin Exp Allergy*. 2000;30(10):1436-43.
- [94] Eversole LR, Eversole GM, Kopicik J. Sanguinaria-associated oral leukoplakia: Comparison with other benign and dysplastic leukoplakic lesions. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod*. 2000;89(4):455-64.

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