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Phytodentistry: A Nature's Gift to Dentist!!!!

Dr. Neeta S Padmawar

Sr. Lecturer, Department of Paediatric & Preventive Dentistry, Rural Dental College, Pravara Institute of Medical Science (Deemed to be University), Loni (BK)-413736, Maharashtra, India.

Corresponding author email: opneeta23@gmail.com

Dr. Minal Patil

Sr. Lecturer, Dept. of Paediatric & Preventive Dentistry, Saraswati Dhanwantari Dental College & Hospital & Post-graduate Research Institute, Dr. Prafulla Patil Educational & Hospital Campus, Pathri Road, National Highway 222 Parbhani – 431401, Maharashtra, India.

Dr. Savita S Thakkannavar

Reader, Department of Oral Pathology & Microbiology, Tatyasaheb Kore Dental College & Research Centre, Maharashtra, India.

Dr. Lingraj Harihar

Sr. Lecturer, Department of Oral Medicine, Radiology & Diagnosis, P.M.N.M. Dental College & Hospital, Bagalkot

Abstract--Oral cavity harbours more than 700 species of micro-organisms. Imbalance in acidogenic and aciduric bacterial causes initiation of Dental caries whereas anaerobic bacteria lead to periodontal disease. Treatment of these diseases use of various chemicals which may have unpleasant taste, allergic reaction or toxicity even can cause financial burden. To overcome this, alternative therapeutical agents which are safer to oral tissues as well as economical. Plants can be better alternative and they are used as Medicine since ages. Ayurveda and Chinese traditional medicine has mentioned the various medicinal properties of these plants. The use of plants / their products can be dated through old eras like use of neem bark or miswak for cleaning the teeth, use of clove oil for dental pain relief. In Ayurveda, methods like Dant Dhavani, Jivha Lekhana, Gandusha and Tissue regeneration therapies are recommended for oral health and involves use of plant or plant extract. Each Plant is the power house of the various chemicals known as phytochemicals which have numerous medicinal actions. Application of these phytochemicals in the dental science is the Phytodentistry. Phytodentistry can be expounded as the use of plants and their extract for the treatment or prevention of various dental diseases.

Medicinal Plants like Tulsi, Amla, ginger, turmeric etc are used and grown in every household in India. Use of these natural, safer herbal products in dentistry will contribute to more safer, cheaper and green dentistry. Present review focuses on application of plant extract in almost all aspects of dentistry - from preventive dentistry till treatment of oral precancerous lesions and conditions.

Keywords---Plants, Extract, Phytodentistry, Treatment, Dental Disease.

Introduction

Among the various streams of health sciences, Ayurveda is the oldest more than 3000 years old and based on the three tatvaa of cough, pitta and vatta. Word Ayurveda is made up of two word - Ayur meaning life and Veda meaning knowledge. Medicine used in Ayurveda are from nature - it mainly uses various parts of plant like seed, leaf, bark, flower, root and fruit. Use of plant extract etc or medicinal purpose is called herbal medicine / therapy routinely but scientifically it is known as phytotherapy or complementary and alternative medicine (CAM).^{1,2}

Almost more than 800 varieties of plants are used for medicinal purpose in India. Almost every household in India has their medicinal box based on spices and herbs used on day to day basis in kitchen. These spices, herbs and plants have various properties like antibacterial, antiviral, antifungal, antioxidant etc. Depending upon the origin, evolution and forms of various usage, WHO has classified herbal medicine into four categories as ³⁻

Category 1: This includes herbs which are native and are used by local community or region and the information about their composition, treatment and dosage is passed from generations to generation.

Category 2: This includes well recorded herbal medicinal system based on over the time tested theories and concepts and well accepted by the respective countries. Example- Ayurveda, Siddha, and Unani.

Category 3: This consists of Modified herbal medicines which required modification to match the national regulatory requirements of food and drug safety and efficacy. These modifications can be done in their shape, dose, administration mode and composition

Category 4: In this category raw herbal products are imported. And the data regarding the safety and efficacy of these products will be maintained by the country which is importing them.

Whereas The National Institutes of Health (NIH) established separate centre for the regularization of various alterative medicinal therapy under the name of the National Centre for Complementary and Alternative Medicine (NCCAM). NCCAM, has grouped complementary and alternative medicine as⁴⁻

Category 1 - This include mainly four alternative medical systems which are well established and practiced in many countries. They are homeopathic medicine and naturopathic medicine originating from Western culture and old non -Western origin are Traditional Chinese medicine (TCM) and Indian Ayurveda.

Category 2 - This consists of healing by mind healing through mind-body interactions. This category consisting of meditation, prayer, mental healing, and music, art or dance therapies.

Category 3 - It includes biologically based medicinal therapy which is based on herbs, foods, vitamins, and dietary supplements.

Category 4 - includes chiropractic and osteopathic manipulation and massage.

Category 5 - Includes energy therapies like Gi Gong, Reiki, and therapeutic touch, as well as bioelectromagnetic based therapies such as pulsed fields, magnetic fields, and alternating or direct current fields.

Gurib Fakim has stated the four ways of use of the herbal medicinal plants which are popular in Tribal areas. These ways are⁵⁻

- 1) Therapeutic agent has directly extracted from the plant.
- 2) A semi-synthetic medicinal compound is developed from these plant.
- 3) A novel synthetic compound is extracted from the plant for medicinal uses.
- 4) Plant extract can be used as taxonomic marker for the newer or recently developed compounds.

Phytodentistry means the application of phytotherapy in various aspects of dentistry. The use of Phytotherapy for Oral health care is age old custom and it is also mentioned in Ayurveda. The methods of oral health care mentioned in Ayurveda are Dant dhavani, Jivha lekhana, Gandoosha or oil pulling and tissue regeneration therapies etc.^{6,7} These recommended Ayurvedic Oral care methods involve –

Dant Dhavani

Ayurveda recommends chewing on fresh plant stick which is of nine inch in length and of thickness as little finger and it should have astringent (kashaya), acrid (katu) and bitter (tikta) taste. This stick should be chewed in morning and after each meal everyday. To brush the teeth with this stick, one should bite and crush one end, chew and eat slowly. Commonly recommended plants for Dant Dhavani process are neem (margosa or *Azadirachta indica*), liquorice (*Glycyrrhiza glabra*), black catechu or the cutch tree (*Acacia Catechu* Linn.), Arjuna tree (*Terminalia arjuna*), fever nut (*Caesalipinia bouduc*) and milkweed plant (*Calotropis procera*).

These biting these plant sticks causes increase in salivation, levelling of occlusal surfaces of teeth and have antibacterial properties. Thus helping in reduction in plaque formation and caries occurrence.^{8,9,10}

Jivha Lekhana (tongue scrapping)

Bacterias are also present on the tongue. Scrapping of tongue with tongue scrapper will help in removing these micro-organisms thus reducing the halitosis (bad odor), improved taste sensation and stimulating the digestive enzyme secretion. The tongue scrapper should be made up of metals like gold, silver, copper & stainless steel. Clinically it is proved that regular scrapping of tongue results in marked reduction in anaerobic micro-organisms.¹¹

Gandusha (Gargling) or Oil Pulling

Oil pulling is an age old Ayurvedic procedure in which oil is swished around the oral cavity. This method is also known as Kavala and is also mentioned in Charaka Samhita. Sesame oil and Sunflower oil is used for gargling. In oral health, Gandusha is useful in prevention of tooth decay, halitosis, gingival health, drying of throat, cracking of lips etc. Oil pulling is also beneficial for patients with migraine to diabetes and asthma.^{12,13,14}

Tissue regeneration therapies

In oral disease like gingivitis and periodontitis, loss of gingival fibers and periodontal fibers is reported. Plants or herbs like Amla (*Phyllanthus emblica*), yellow dock root, alfalfa leaf, cinnamon bark and turmeric root has shown the healing properties through regeneration of tissue. Amla when consumed daily showed regeneration of connective tissues. Recommended dose is 1-2 gms daily. Daily consumption of Bilberry and hawthorn berry has shown improved gingival health. Liquorice root has anti-microbial properties, thus help in plaque and caries reduction.¹⁵ But modern day dentistry is more depend on the various chemicals which have more side effects like unpleasant taste, toxicity and allergic reaction. Phytodentistry provides a better alternative.

The basis of Phytodentistry is the presence of various chemicals present in the plants. These chemicals are called as phytochemicals. These chemicals are produced during various metabolic processes in the plants. These metabolites or chemicals are produced by either primary or secondary metabolism. Most of the metabolites which are recommended for medicinal use are secondary metabolites. Following are the metabolites synthesized by the plants which have medicinal applications¹⁶.

Alkonoids

Alkonoids are the cyclic organic compound which shows presence of nitrogen in negative oxidation state. These are not common in living organisms. Alknoids like morphine, codeine, colchicine, quinine and quinidine are used as remedy for pain, cough, gout, malaria, arrhythmia.

Phenols and Phenolic Glycosides

Phenols are the largest secondary metabolites secreted by plants. They may have simple structure of single aromatic ring or complex polymeric structures like tannins and lignins.

- Capsaicin extracted from *Capsicum* is used as a medicament for pain.
- Eugenol is most commonly used phenol in dentistry. It has antibacterial and anti-inflammatory properties.

Polyphenols

They have single aromatic ring with one or more hydroxyl groups along with other substitutes. They have antioxidation activities. Polyphenols are of three types-

- a. Tannins: They are astringent and are found in bitter plants. They either adhere or break the protein. Tannins have anti-inflammatory action which helps in reduction in signs and symptoms of inflammation. In humans, tannins perform activities like phagocytic cell stimulation, host-mediated tumor activity and comprehensive antibacterial effect. They halt microbial adhesion, cell envelope transport proteins action makes tannins antibacterial.
- b. Flavonoids: They are water soluble and have 15 carbon atoms. They are used as antioxidant, anti-inflammatory, anti-allergic, anti-viral, and anti-carcinogenic.
- c. Carotenoids: They are organic colouring pigments found in the chloroplasts and chromoplasts of plants and photosynthetic organisms like algae, types of fungus and some bacteria. They are anti-oxidants and eliminate free radicals effectively. They also prevent overgrowth of oral microflora. These can be help in overcoming the problem of antibiotic resistant bacteria.
- d. Catechins: They are recently discovered. They are abundantly found in oolong green tea and shown presence of mixture of various catechins. They are have antibacterial action and are effective against Vibrio cholera, Streptococcus Mutans, Shigella etc. in In vitro studies.

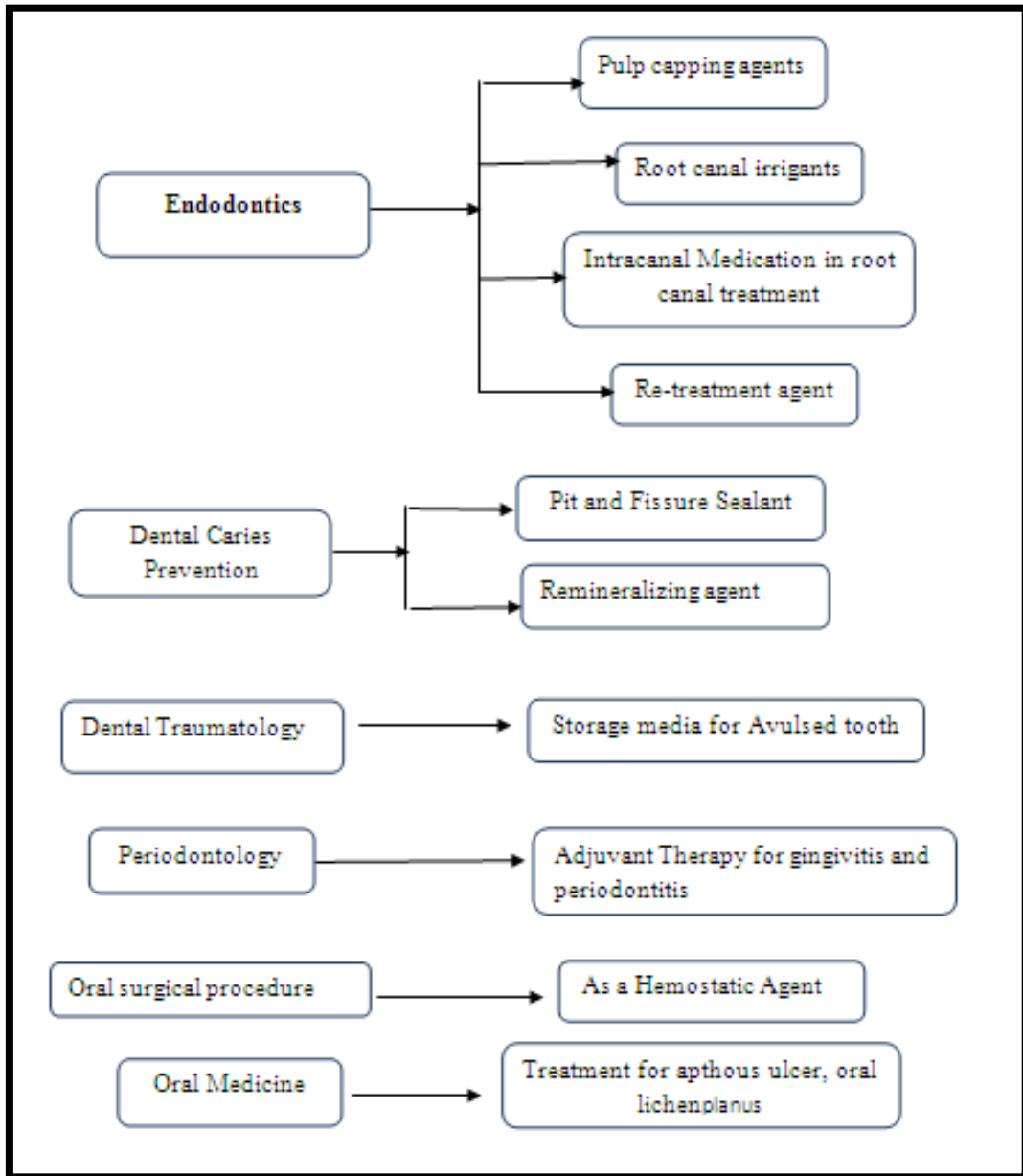
Triterpenoids & Essential oils

Scent present in the plant is due to presence of essential oils. These oils are secondary metabolism products and has rich in isoprene structure containing compounds terpenes. When these compounds contain additional oxygen molecule are called as terpenoids and effective against bacteria, fungi and viruses.

Each plant is a treasure of different phytochemicals which have different biological properties. Mostly these properties are antioxidants, anti-inflammatory, antimicrobial, anticarcinogenic. These actions are due to plant metabolites cause reduction in bacterial replication enzymes, initiation of apoptosis of tumour cells, production of cytokines by stimulating monocytes or phagocytes, stimulation of myeloperoxidase-dependent iodination of neutrophils. However in dentistry, use of medicinal action of these phytochemicals needs to be researched.

Application of Phytomedicine in Dentistry

The aim of any dental treatment not only diagnose and treat the oral disease but prevent the disease. Phytomedicines have promising future in various fields of dentistry like from preventive till treating the oral diseases with minimal side effects, toxicity and most importantly reducing the chemical foot prints on environment. The Phytomedicine have following applications in dentistry¹⁶ -



At present, some of the materials used in dentistry have extract from plants. These are Gutta percha, impression materials, zinc oxide eugenol, citric acid, Camphor Mono Chloro-Phenol (CMCP), Thymol.

Phytomedicine in Dentistry

Clove (*Syzygium Aromaticum*)

It is the oldest herb reported in ancient Indian as well as Chinese Medicine.^{17,18} It has analgesic, antibacterial, antiviral, anti-inflammatory and antioxidant. Eugenol is the main component of clove. Clove is also a rich source of beta carotene which is antioxidant and provitamin.

It is used as restorative material, endodontic, in periodontal diseases, as a cure for halitosis. It is found to be effective against the *Streptococcus Mutans*, responsible for dental caries. It causes the damage to cell membrane leading to cell death thus resulting in reduction in micro-organisms.^{19,20} Analgesic effect of Clove is related to two mechanisms. It causes pain reduction by activation of calcium and chloride channels in ganglion cells. It also inhibits prostaglandin synthesis, cyclooxygenase, and lipoxygenase, which are related to increased pain perception.^{21,22}

Turmeric (*Curcumin*)

Turmeric/*Curcumin* belongs to the ginger family *Zingiberaceae*. It is used since ancient time and its mention is found in Indian and Chinese Medicine since 7th Centaury AD. *Curcumin* (*diferulolymethane*), is the main yellow bioactive component of has wide spectrum of biological action and has antiseptic, antibacterial, anti-inflammatory, analgesic and hepatoprotector properties.^{23,24} It is also antimutagenic, anticarcinogenic, antioxidant, antibacterial.²⁴

It has shown wide variety of uses in dentistry. It used in treatment of dental caries, oral lichen planus, gingivitis, halitosis, pit and fissure sealant, dental plaque detection system.²⁴ Its anti-oxidant property blocks the initiation and progression oral precancerous lesion and conditions as well as oral cancers.²⁵

In Oral Submucous Fibrosis(OSMF), *Curcumin* avert oncotransformation by reducing formation of micronuclei in exfoliated cell. Its antifibrotic property blocks the fibrosis of tissue by inhibiting leukocyte influx and activation of inflammatory cells as well.²⁶ *Curcuma longa*'s anti-inflammatory properties is a result of inhibition of biosynthesis of inflammatory prostaglandins from arachidonic acid as well as neutrophil function during inflammatoryprocess.²⁷

In gingivitis cases, when 0.1 % turmeric mouth wash was used for rinsing; after 21 days significant reduction in inflammation was noticed.²⁸ In periodontitis, subgingival application of 2% whole turmeric gel shown positive results as adjuvant therapy to scaling and root planning.²⁹ Behal Roobal used containing 2% whole turmeric (gel form) as a local drug delivery system as an adjunct to scaling and root planning alone and reported remarkable reduction in plaque and gingival index and reduction in probing pocket depth.³⁰

Vidhyasagar et al in 2018 reported that *curcumin* extract showed superior results in periodontal cell viability as compare to cow's milk.³¹ Rajiv Purohit et al used *curcumin* as a pulpotomy agent in an in vivo study and observed excellent clinical

and radiographic success after 6 months follow-up.³² Curcumin incorporated polymeric fibres were tested for its antimicrobial properties and potential use in root canal disinfection and they showed significant reduction in root canal micro-organisms.³³

Aloe Vera

Aloe vera (*Aloe barbadensis*) is plant of Liliaceae family. It grows in dry parts of Africa, Asia, Europe, and America.³⁴ More than 300 species are found of aloe-vera plant but *Aloe barbadensis* species show medicinal properties. This Plant contains 99.5% water and remaining is active ingredients including essential oils, amino-acids, minerals, enzymes, and glycoproteins. It has anti-inflammatory, antibacterial, anti-fungal, anti-viral, pain relieving properties.

Anti-inflammatory action of aloe vera is through following ways

- a) It blocks mast cells from releasing histamines and leukotrienes and leading to release of nitric oxide and cytokines from macrophages.³⁵
- b) It interfere with the cyclooxygenase pathway, reducing prostaglandin E2 (PGE2) and break down of bradykinin thus leading to reduced pain.³⁵
- c) It also causes limitation in leukocyte adherence and tumour necrosis factor- α (TNF- α), thus blocking the inflammatory process.³⁶

In dentistry, aloe vera is used in almost all the fields of dentistry. It is used in the treatment of recurrent apthous ulcer, dry socket, pulp therapy in primary dentition, gingival and periodontal inflammation, peri-implantitis, endodontics etc. Babae et al reported topical application of 2% Aloe vera gel in apthous ulcer reduces healing time of ulcer as well as pain and discomfort of the patient.³⁷

Ajmera et al. evaluated efficacy of aloe vera mouth wash in plaque induced gingivitis and reported a marked reduction in gingival inflammation after scaling and use of aloe vera mouth rinse.³⁸ Bovik used Aloe vera as a dressing medicament in gingivectomy cases and noticed that healing occurred was better and in least duration.³⁹

Bhat et al evaluated the effectiveness of subgingival application of *A. vera* gel along with mechanical debridement in periodontitis. Use of Aloe vera gel after mechanical debridement showed better results in periodontal healing.⁴⁰ *Athibhan* et al evaluated effectiveness of aloe vera in disinfecting gutta percha and observed promising results.⁴¹

Use of aloe vera was reported in pulp therapy of primary teeth. In primary teeth, when aloe vera was used as a pulpotomy agent; it showed better results as compare to traditional medicament-formacresol.^{42,43} *Khaiwara* et al used mixture of aloe vera and zinc oxide as obturating material in deciduous teeth and observed better clinical and radiographic success.⁴⁴

When aloe vera gel was mixed with denture adhesive, better retention and less incidence of denture related fungal infection was reported.^{45,46} *Sudarshan* et al compared efficacy of aloe vera and antioxidant in treatment of oral submucos

fibrosis. They reported that aloe vera was effective in treatment of OSMF. After three months, it reduced burning sensation and increased the mouth opening.⁴⁷

Though the aloe vera has medicinal properties, adverse effects –local as well as systemic were also reported. Local adverse reactions are redness, burning sensation etc. These reactions are caused by anthraquinones, such as aloin and barbaloin present in aloe vera. Systemic reactions range from mild to severe. These include abdominal cramps, diarrhea, constipation, red urine, hepatitis. Aloe vera has laxative effect which may result in electrolyte imbalance. Prolonged use may increase the possibility of developing colorectal cancer.^{48,49}

Allium Sativum (Garlic Extract)

Garlic (*Allium sativum*), is used in almost every household in the world. It has properties like antifungal, antibacterial & antiviral. Antibacterial property of garlic is due to presence of allicin which is released by enzyme allinase on crushing.⁵⁰ Allicin obstructs the Thiol-containing enzymes - cysteine proteases and alcohol dehydrogenases. Due to presence of elements like diallyl monosulfide, diallyl disulfide, diallyl trisulfide, and diallyl tetrasulfide, antibacterial effect of garlic is against both gram-positive & gram-negative micro-organisms.⁵¹ Thus garlic extract is beneficial in reducing the micro-organisms linked with most common oral diseases- dental caries and periodontal disease like *Streptococcus mutans*, *Streptococcus sobrinus*, *Porphyromonas gingivalis*, and *Prevotella intermedia* respectively.

Kavhad et al reported clinical and radiographic success when Allium sativum extract was used as pulpotomy medicament. Similar observation was reported by Shukry Gamal Mohammad et al.^{52,53} Ahmad Abdel Hamid Elheeny reported used allium sativum as irrigant in pulpectomy procedure of primary teeth and reported 75% success after 12 months follow-up.⁵⁴

Fresh garlic can prevent the onset of oral cancer by apoptosis. It removes free radicals and enhances the enzymes like glutathione S-transferase and catalase, reducing cytochrome p450 2E1 enzyme and restoring DNA structure and its function.⁵⁴ Heon-Jin Lee et al studied the role of garlic extract on the biofilm deposition by *Streptococcus mutans* (*S.mutans*) on orthodontic wire and they observed that though garlic extract showed antimicrobial action against all micro-organisms but it also amplified the attachment of *S. mutans* on orthodontic wire.⁵⁵

Amla (Emblica Officinalis)

It is a member to Euphorbiaceae Family. Amla, *Phyllanthus emblica*, or Indian gooseberry are its other name. This plant is most commonly found in India, and neighbouring countries like Sri Lanka, Pakistan, China, Malaysia and South East Asia. Tannins, alkaloids, phenolic compounds, amino acids, and carbohydrates are main constituents of *Emblica officinalis* (E.O.). Amla juice has the highest presence of Vitamin C (478.56 mg/100 mL). Amla has recommended as immunity booster, antioxidant, for healthy hair and skin; it is also recommended in diabetes, respiratory disease etc. When grinded root of amla is mixed with honey

and applied on oral ulcers, healing period was reduced. Gargling with extract of amla leaves was also effective in oral ulcers.⁵⁵

Bulbule AM et al evaluated the cytotoxic effect of *Emblica officinalis* (amla) on cultured human primary dental pulp fibroblasts and concluded that E.O. preserve the vitality of human primary fibroblast cells.⁵⁶ It also helps in healing of infected tissues. Vitamin-C present in amla acts as a cofactor in the conversion of proline into hydroxyproline, which is one of the essential constituents of connective tissue.⁵⁷

Tewari et al compared role of 10% *Emblica Officinalis* in reduction of periodontal inflammation. They compared it with traditional chlorhexidine mouthwash and saline and concluded that use of 10% *Emblica Officinalis* mouthwash reduced the inflammation effectively.⁵⁸

Tulsi (*Ocimum Sanctum*)

Tulsi is the most ancient plant which has been mentioned in Indian mythological books. It has a mythological as well as medicinal importance in Indian culture. The meaning of Tulsi is “incomparable one”.⁵⁹ It is traditionally used for many diseases like common cold, sore throat, fever, digestive problem, snake bite, asthma etc. In dentistry, many researchers have tried the medicinal application of Tulsi in various field of Dentistry.

Nadar et al evaluated the efficacy of 4% Tulsi extract as a dentifrice in comparison with commercially available dentifrice and placebo. After follow-up of 21 days, efficacy of dentifrice containing 4% Tulsi extract was same as commercially available dentifrice.⁶⁰ Ahirwar P et al compared the efficacy of essential oil extract of Tulsi with triple antibiotic paste as intracanal medicament in primary teeth. Significant antimicrobial action against both aerobic and anaerobic bacteria was observed in Tulsi extract group by author.⁶¹

Aggrawal S et al studied efficacy of Tulsi extract mix with calcium hydroxide in comparison with Metapex as obturating material in primary teeth and concluded that Tulsi extract can be used as obturating material in primary teeth safely.⁶² Hugar S et al evaluated the potential use of Tulsi oil for disinfecting K files and observed that Tulsi oil was effectual in disinfecting the files.⁶³

Triphala

Triphala is combination of words “tri meaning three” and “phala means fruits”. It is obtained by mixing equal parts of dried powder of Amla (*Emblica officinalis*), Harada (*Terminalia chebula*) and Bihara (*Terminalia bellirica*).⁶⁴ According to Ayurveda, our body has three types of Kapha, Pitta, and Vata. This mixture of Triphala is very effective on all three types of dosha.⁶⁵ Triphala interferes with the adherence of *S. mutans* to tooth surface and declines the colony formation of them also. It Hinders the sucrose-induced cohesion and the glucan-induced conglomeration, these processes promote *S. mutans* growth on tooth. Thus interference with these two processes makes it anticariogenic agent.⁶⁶ 0.6%

Triphala mouthwash has shown to reduce caries index in comparison to chlorhexidine mouthwash without discolouring the teeth.⁶⁷

Triphalawhen used as a root canal irrigant it showed remarkable anti-microbial activity against *E. Faecalis*.⁶⁸ Triphala mouthwash was prescribed as an adjuvant with scaling and root planning in periodontitis, marked improvement in periodontal health was observed at recall visits at 7,30 & 45 days as compared with chlorhexidine mouthwash and scaling and root planning group.⁶⁹ When Triphal is used as a mouthwash locally and powder form systemically (Triphalain) for one month, it showed maximum reduction in periodontal inflammation and overall improvement in health of periodontal health when compared with Triphala mouthwash twice a day in combined with metronidazole 400mg three times a day and 0.2% chlorhexidine mouthwash along with metronidazole 400 mg thrice-daily.⁷⁰

Neem (Azadirachta Indica)

Azadirachta indica is universally recognised as Indian Neem, Margosa tree or Indian lilac. Over a period of 2000 years, neem tree and its medicinal advantages are familiar in India and neighbouring countries. Even National Academy of Sciences, United State (US) has acknowledged the medicinal benefits of neem tree and named it as “a tree for solving global problems”.⁷¹ In the field of medicine, Neem has extensive properties like anti-inflammatory, antimalarial, antimicrobial, antiviral, antifungal, antipyretic, antioxidant, analgesic, immune-stimulant, anti-fertility, anti-acne, anti-hypoglycemic, anti-cancer and nematocidal.^{72,72}

In vitro, Neem stick extract efficacy was evaluated against the cariogenic bacterias - *Streptococcus mutans*, *Streptococcus salivarius*, *Streptococcus mitis* and *Streptococcus sanguis*. Reduction in colonies and adhesion of *S. mutans* was observed. It was also observed that neem stick extract was most effective in inhibition of *S. mutans* followed by Extracts from Neem sticks or bark have been shown to inhibit the growth of *Streptococcus mutans* but there was a mark reduction in *Streptococcus salivarius*, *Streptococcus mitis* and *Streptococcus sanguis* numbers also.⁷¹

Neem extract was also effective on *Lactobacillus* but concentration required was higher.⁷⁴ Neem leaf extract was used as root canal irrigant and significant difference was observed in *E. faecalis* colony formation as compared to 2% NaOCl. But no difference was observed on *C. albicans* colony formation.⁷⁵ Hegde et al compared antibacterial property of 2% NaOCl, propolis, neem leaf extract, turmeric and liquorice by agar diffusion method. They noticed that neem extract was most effective against *E. faecalis* and *C. albicans*.⁷⁶

Pomegranate (Punica Granatum)

Pomegranate is well known fruit in the world and its plant and parts of it, is used as a medicine in many countries like Iran. Almost all the parts of this plant are used for various medicinal properties. Flowers of Pomegranate tree are utilized as astringent, hemostatic, antibacterial, antifungal, and antiviral agent.

The rind of the plant is powdered and used as tooth powder and cosmetic industries also.^{77,78} In a clinical trial, when pomegranate was used as mouth rinse in gingival inflammation, marked reduction in inflammation was noted.⁷⁹ In cases of denture stomatitis stimulated by candidiasis- a type of fungal infection, showed marked improvement when Pomegranate extract was used for its treatment.⁸⁰

Caries initiation is inhibited by Tanin present in Pomegranate .This is caused by reduction in human salivary α -amylase which is responsible for the hydrolysis of starch to oligosaccharides and adherence of viridians streptococci and enamel.^{81,82} Consuming pomegranate increases salivary flow and increases the activity of antibacterial and antioxidant agents. Extract of flower of Pomegranate restrain the bacterial sucrose digesting enzyme thus preventing or interfering the initiation of caries and gingivitis.⁸³

Papaine

Papaine is a proteolytic enzyme obtained from the latex of the leaves and fruits of the green full grown papaya. It has an anti-inflammatory, bacteriostatic, bactericidal actions and is effectual against gram positive as well as gram negative organisms. It is deficient of a plasmatic antiprotease called a-1-anti-trypsin which causes partial breakdown of degraded collagen molecules only, contributing to the degradation of fibrin “mantle” formed by carious process, thus acting in infected tissue. This technique is an effective alternative for treatment of dental caries.⁸⁴

Tomato

Tomato and red colored vegetable and fruits like red carrots, watermelons, papayas, and grapes contains Lycopene - an acyclic isomer of β -carotene abundantly. Lycopene is anticarcinogenic and this action occurs by regulation of gap junction communication. It prevents tissue damage by interfering the lipid peroxidation process through inactivation of free radicals. Other mechanism of anticarcinogenic action is repressing carcinogen-induced phosphorylation of p53, Rb antioncogenes and stopping the cell division at the G0-G1 cell cycle phase. It hinders the proliferative action of insulin like growth factor resulting in reduced rate of cell division. It also modulates immune response by regulating intrathymic T-cell differentiation. Lycopene is also found effective in treatment of OSMF and Leukoplakia. In OSMF, it reduces duplication of abnormal fibroblasts. It is also beneficial in increasing the mouth opening and allaying the burning sensation in OSMF. In leukoplakia, lycopene interferes with dysplasia and cell damage.^{85,86}

Eucalyptus Oil (EO)

Eucalyptus oil is secondary metabolite extracted from Eucalyptus plant. It contains terpenic hydrocarbons, especially monoterpenes and sesquiterpenes, and oxygenated derivatives such as aldehydes, ketones, epoxides, alcohols, and esters. The ratio of these phytochemicals depends on geographical conditions where the plant has grown. and maturity of plant. It has antimicrobial and anti-inflammatory action. It causes damage to cell membrane. It is effective against *Lactobacillus acidophilus* and thus a potential anti-cariogenic agent.⁸⁷

Grape Seed Extract (GSE)

GSE has 98% of proanthocyanidins, an antioxidants anti-inflammatory, antibacterial and immune-stimulating actions. It blocks the acid production by streptococcus mutans and also promotes cross linking of collagen fibers. In vitro study, GSE has shown remineralising action on root surface caries.⁸⁸

Liquorice Root

Liquorice root is a fundamental part of Ayurvedic and Chinese medicine. It is sweet, moist, soothing herb which is a part of the glycyrrhiza species found in Mediterranean countries and Asia. Due to its sweet taste, liquorice is often used as artificial sweetener and a flavoring agent in food and medicine and is approved for use in the USA by the Food and Drug Administration (FDA) as Generally Recognized as Safe (GRAS). saponins, flavonoids, isoflavonoids, chalcones, coumarins, auronones, benzofurans, phenols, pterocarpanes, and stilbenes like secondary metabolites are present in Liquorice root which make it pharmacological useful.

It has shown definite reduction Streptococcus Mutan acid production through pterocarpenes - glycyrrhizol A and glycyrrhizol B and isoflavonoids, 5-O-methylglycyrol, isoglycyrol, 6,8-diisoprenyl-5,7,4'-trihydroxyisoflavone and gancaonin G. It has also shown positive results as a therapeutic agent for oral candidiasis, gingivitis and periodontitis and oral cancer. But excess consumption of liquorice root may result in hypokalemia, hypertension, rhabdomyolysis, muscle paralysis, respiratory impairment, hypertensive emergencies, hyperparathyroidism, encephalopathy and acute renal failure.⁸⁹

Ginger

Scientific name of Ginger is *Zingiber officinale* Roscoe and belongs to family of Zingiberaceae. It is used as spice in almost every household of the world. It is also used as a alternative medicine for cough, cold, sore throat, nausea, vomiting, headache asthma in many countries like India, China, Africa and Arab countries. The phytochemical composition of ginger depends upon the geography and climate. It has 115 phytochemicals and among these main phytochemicals are phenol- gingerol and shogaol, sesquiterpene hydrocarbons and oleoresins. It shows anti-inflammatory, antioxidant, anticancer, antimicrobial, antidiabetic properties. Anti-inflammatory action of ginger is due to its action on enzymes like cyclooxygenase-1 and cyclooxygenase-2, which results in prostaglandin - inflammatory mediator. It also reduces synthesis of 5-lipoxygenase enzyme which is required for leukotrienes production.^{90,91}

Ginger promotes apoptosis, up regulation of tumor suppressor genes and suppresses angiogenic factors (vascular endothelial growth factor) thus preventing tumour growth and proliferation.⁹¹ It is recommended for the treatment of xerostomia, aphthous ulcer, dental caries, gingivitis, oral candidiasis, intracanal medicament.

Use of Ginger containing mouthwash has shown improvement in the symptoms of oral candidiasis. Application of ginger extract in aphthous ulcer results in pacifying the symptoms like pain and discomfort. When ginger extract is consumed systemically can improve the salivation rate by acting on parasympathomimetics area on the post-synaptic M3 receptors and also oppressive effect on presynaptic muscarinic autoreceptors. Ginger extract is effective against *S. mutans* and *Lactobacillus acidophilus*. But when ginger is mixed with honey, it is found to be effective against *Staphylococcus aureus*.⁹²

Conclusion

Nature has wide range of herbs. Plants which are the rich source of natural medicinal elements. Our forefathers have knowledge of these phytomedicine and their use in various systematic and dental diseases. Almost 65-80% of World population is still uses or prefer phytomedicine. Ease of availability, biocompatibility and lesser chances of allergic reactions make phytomedicine favorable. . Though this application is not new in dentistry but their utilization in various dental treatments makes dentistry safer, cheaper and environment friendly. This article is brief summarization of phytodentistry. Although more in vitro and in vivo studies with long span follow-ups are required. Phytodentistry is the new beginning of modern, green and future dentistry.

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