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**Review Article**

# A review on four medicinal plants in dentistry

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## ABSTRACT

Dental caries and periodontal problems still remain a global health care burden. In developing and underdeveloped countries, the unmet treatment needs of a large part of population is a challenge to the service providers. WHO believes that oral health is a right to everyone. The use of traditional medicine helps in achieving these goals to a large extent. Medicinal plants are a basis for conventional medicine and a substitute for them. Thus, it becomes a matter of importance to have a greater understanding of the pharmacologically active components of the herbal components and their various uses in dentistry. This article aims to understand the phytotherapeutic uses of four commonly used herbal plants, miswak, moringa, triphala and neem.

**Keywords:** Dental caries, Herbal mouthwash, Miswak, Moringa, Triphala, Neem, Endodontic irrigant

## INTRODUCTION

Medicinal plants have been used in therapeutic and dental practices worldwide. Ancient literatures in different languages and cultures have mentioned the use of various herbs to manage different oral health issues ranging from dental pain ulcers to malodour.[1] With all knowledge and advances in oral health care available dental caries still remains major problem and both it's incidence and prevalence is growing in developing countries. Gum diseases and managing them is challenge for oral health professionals especially in areas where people lack awareness and access to health care. Herbal products due to their ease of availability and cost effectiveness can greatly help in personal preventive care and community level of prevention. Aim was to present 4 widely popular medicinal plants, *Azardirachta indica*, *Morinda citrifolia*, *Salvadora persica* and Triphala as they are used in different ways in maintaining and improving oral health.

## LITERATURE RESEARCH

The Medline, PubMed and Google Scholar databases were electronically investigated for pertinent articles available in English using the key words medicinal plant, Miswak, *Morinda citrifolia*, Noni, neem, *Azadirachta indica*, Triphala, caries prevention, herbal irritants, dentistry and pediatric dentistry.

## MISWAK

Miswak, scientifically known as *Salvadora persica*, is a species of *Salvadora* belonging to family *Salvadoraceae*. In India, it is commonly known as arak tree, miswak, peelu, kharjal/jhank. It also serves natural toothpaste with antibacterial, anti-caries, antiperioptic disinfectant having anti-plaque and antifungal properties. Miswak tree is generally found in Saudi Arabia, Sudan, Southern Egypt, Chad, Pakistan and Eastern parts of India. Miswak is a popular chewing stick. Miswak used by Babylonians 7000 years ago followed by Greek, Romans, Jews, Egyptians and Islamic empires. Miswak sticks are being used by majority of people who cannot afford to buy commercial western toothbrush and toothpaste mainly in rural areas of developing countries.[1]

Many studies carried out to assess the efficiency and potential use of the miswak in dentistry, concluded that

miswak may offer an alternative to a toothbrush for reducing plaque and gingivitis. Studies have demonstrated the antibacterial, anti-caries, anti-periopathic and anti-fungal properties of aqueous extracts of miswak. Miswak contains more than ten different natural chemical compounds considered essential for good oral and dental hygiene. They are fluorides, silica, tannic acid, resins, alkaloids (salvadorine), volatile oils (simgrins), sulfur, vitamin C, sodium bicarbonate, chlorides, calcium, benzylisothoicyanate, salicylic acids, sterols, trimethylamine, saponins and flavonoids.[2]

Silica in miswak acts as an abrasive material to remove stains on teeth.[1]When denture bases were treated with tannic acid it reduces *Candida albicans* counts. Miswak exerts an astringent effect on the mucous membrane and reduces the clinically detectable plaque and gingivitis. Resins are amorphous products which are usually hard, transparent or translucent. The alkaloid present in *S. persica* is salvadorine. It exerts a bactericidal effect and stimulatory action on the gingiva. Essential oils have characteristic aroma, carminative and antiseptic action. The sulfur compounds present in miswak have a bactericidal effect. Calcium saturation of saliva inhibits demineralization and induces the remineralization of tooth enamel.[3] BIT has virucidal activity (at a concentration of 133.3 mg/ml) against herpes simplex virus.[1,2] It has a broad-spectrum bactericidal activity which inhibits the growth and acid production of *Streptococcus mutans*.[4]

### *Antibacterial*

In terms of oral health, *Salvadora persica* has been reported to be antibacterial, antifungal, anticariogenic and antiplaque. Studies have reported that miswak have potential to inhibit plaque formation and antibacterial action against cariogenic bacteria in the oral cavity.[5-9] Al Bagieh et al concluded that aqueous extracts of miswak reduces growth of *C. albicans* at concentrations of 15% or above. They also concluded that alcoholic extract is more effective than aqueous extract for antibacterial activity.[10]

Miswak is used in commercial preparation of a number of toothpastes worldwide. Some commercially available toothpaste produced from *S. persica* plant are as follows: Sarkan toothpaste (UK), QualiMeswak toothpaste (Switzerland) Epident toothpaste (Egypt), Siwak- F toothpaste (Indonesia), Fluoroswak, Miswak (Pakistan), DentacareMiswak Plus (Saudi Arabia), Dabur miswak and Dantkanti (India).

### *Caries prevention*

Mustafa et al compared the DMF scores of school children using miswak and normal tooth brushing at baseline and after 2 years. They concluded that miswak demonstrated better caries prevention.[11] Similar results were obtained in other studies done across different countries.

### *Gingival and periodontal health*

Sote found that regular users of miswak show decreased gingival bleeding on probing compared with non-miswak users.[12] A study on Ethiopian schoolchildren comparing miswak with conventional toothbrush found that miswak is as effective as the toothbrush in removing oral deposits. Al-Obaida et al concluded that 20% Miswak extract is an effective antifungal and antibacterial agent against *C. albicans* and *E*nterococcus *faecalis*.[13] Baeshen and Birkhed recommended to use fresh miswak impregnated in 0.1% NaF or a maximum of 0.5% NaF for a day for the prevention of dental caries.[14] Gupta et al compared the efficacy of miswak-incorporated toothpaste and fluoridated toothpaste. They found that significantly greater plaque reduction was achieved with the miswak-incorporated toothpaste compared to the conventional fluoridated toothpaste.[15]

Miswak-incorporated toothpaste has also been compared with other herbal toothpaste, namely the tea tree oil-incorporated toothpaste. Varma et al observed a significantly greater reduction of plaque with miswak toothpaste compared to the tea tree oil toothpaste.[8]

Wassel and Sherief investigated the efficacy of teeth varnishes incorporated with chitosan, miswak, and propolis in enhancing remineralization of damaged enamel. Chitosan and miswak demonstrated significantly higher remineralization compared to the control varnish, thus, revealing the potential of miswak in remineralization of damaged enamel.[16]

Miswak was superior to tea tree oil in terms of plaque reduction. Miswak used is comparable to tooth brushing for plaque reduction. Fluoridated miswak has greater fluoride release capacity than the fluoridated toothpaste.[17]

Kabil et al incorporated miswak extract with GIC and compared with miswak mixed with chlorhexidne and deionized water. After follow-up of 3, 6 and 9 months they concluded that miswak incorporated GIC has a greater chance of restoration survival after ART.[18]

### *Tooth whitening*

Halib et al studied the whitening potential of miswak extract and concluded that 0.4 and 0.5% miswak paste showed potential as teeth whitening agent.[19] They investigated the tooth whitening potential of miswak with extracted human permanent premolar teeth stained with tea and coffee. Miswak at different concentration, has no significantly different whitening effect compared to the commercial whitening toothpaste used as a positive control in this study. The study with combination of probiotic and miswak spray by Nasry et al reported greater reduction in staining index with

miswak compared to the control. However, the difference was not statistically significant.[20]

Farhadian et al concluded that miswak has similar efficacy as chlorhexidine mouthwash in improving hyperplastic gingiva in orthodontic patient.[21] Chewing gum reinforced with miswak extract can improve gingival health even without teeth scaling.[22]

Omikhoda et al in a study on orthodontic chains found that miswak mouthwash prevents force decay in orthodontic chains.[23] Studies by al Bayatyet al and Dorri et al on treatment of extraction sockets with miswak mouth rinse concluded that Consistent miswak used demonstrated potential to enhance new bone formation following teeth extraction.[24] Miswak mouthwash can also improve deteriorating gingival health resulted from orthodontic treatment.[25]

In developing countries Miswak can be a good alternative to the toothbrush since it is cost effective and readily available in most rural areas. Miswak can be recommended as an important and effective tool for maintenance of good oral and dental health. It also has a great potential to be used as mouthwash and can be incorporated in chewing gums.

## NONI / MORINDA CITRIFOLIA

Noni, has been favored by many physicians because of its excellent healing properties. The botanical name of the commercially available Noni is *Morinda citrifolia* also known as Indian Mulberry.[26,27] Noni has gained popularity in recent times because of its antibacterial, antiviral, antifungal, antitumor, anti-tubercular effect, analgesic activity, immunological activity. Due to these medicinal properties, it also consumed daily as a supplemental health drink.[28,29] Noni has been considered as a vital herb due to its numerous medicinal properties and has been recently included as a plant of interest in the field of dentistry.

Noni was found to be abundant in major essential components such as scopoletin, octoanoic acid, potassium, vitamin C, terpenoids, alkaloids, anthraquinones, β-sitosterol, carotene, vitamin A, flavone glycosides, linoleic acid, amino acids, calcium, and phosphorus.[30,31] Preparations from various parts of the plant namely bark, leaves, fruits etc. were used in many branches of dentistry.[32] Noni juice was identified as first possible alternative to Sodium hypochlorite solution for endodontic irrigation.[33]

### *Antibacterial*

Extracts of *Morinda citrifolia* was found to be effective against oral *Streptococcus* species because of its antibacterial activity. Noni extracts were added to the routine impression materials and then the impressions were recorded. The recorded impressions showed that there was a reduction in the microbial contamination without altering the dimensional stability of the impression.[34]

### *Mouth rinse*

Oral infections like gingivitis and periodontitis affects a majority of the population worldwide. Some of the factors predisposing to gingivitis and periodontitis includes improper oral hygiene, systemic conditions, pregnancy and puberty. Since the ancient times many herbal products were used in the form of tooth brush, toothpaste, mouth rinse, local drug delivery agents and regenerative materials as an adjunct to scaling to improve the condition of the oral cavity. Extracts from ripe noni fruits were used as an effective mouth rinse following mechanical debridement because of their antibacterial, anti-inflammatory properties. Improved gingival status was observed in those who used noni mouth rinse.[35,36.]

Extracts from Noni leaves were used to induce cell proliferation, protein synthesis, and matrix mineralization *in vitro* studies. Hence Noni has the promising osteo-inductive potential bone and periodontal tissue regeneration.[37,38] Noni extract was found to act on human periodontal ligament cells, thus improves initiation of differentiation and proliferation as well as osteoblastic differentiation of the bone marrow derived stem cells.[39,40] Noni extract was effectively used as a bone substitute material in intraosseous defects in a study.[41]

### *Intracanal medicament*

Intracanal medicaments help in reducing the bacteria remaining even after chemo-mechanical instrumentation and can provide an environment conducive to periapical tissue repair. *Morinda citrifolia* gel, along with herbal and CHX gels, was evaluated as an intracanal medicament against *E. faecalis* after their inoculation in extracted teeth by microbiological assessment after a period of 21 days. Results proved that *M. citrifolia* gel had a better antimicrobial activity and showed second best inhibition after CHX gel against E. faecalis.[42] In another study, *M. citrifolia* gel exhibited good inhibition up to the 5th day of application of the gel when colony-forming units (CFUs) were evaluated at days 1, 3, and 5. This proves that *M. citrifolia* gel can be used as an intracanal medicament due to its good antibacterial properties, which can be enhanced with sufficient contact time of the gel with the bacteria.[43] Studies also proved the efficacy of morinda extract as compared to standard irrigants like NaOCl and chlorhexidine.

Studies on irrigation of MCJ in deciduous teeth assessed the administration of NaOCl and MCJ and their effectiveness against the bacterial colonies. It was concluded that there is a significant reduction in CFU in both types of drugs.[44] According to Murray et al 6% *M. citrifolia*, along with EDTA, has shown effective smear removal than 5.25% sodium hypochlorite. When MCJ is

to be used as an endodontic irrigant, a flush of EDTA, followed by a final flush of MCJ, is recommended. The MCJ can be used as an endodontic irrigant and medicament due to its better smear layer removal properties and antimicrobial activity. It also does not have any major side effects as compared with sodium hypochlorite and CHX. It also helps in caries prevention and control.[45]

***Noni pulling***

Noni fruit juice was found to be effective against a lot of grams positive and gram-negative bacteria which are responsible for a numerous oral infection. Extract obtained from noni plant when used as an oral swishing agent was found to be efficacious for periodontal disease.[41]

*Morinda citrifolia* has been used in multiple ways. Its antibacterial property as well as ease of procurement has made it a material of choice in developing countries. From mouthwashes, to incorporated in toothpastes, to a safe endodontic irrigant to disinfecting impressions, dentistry has a lot to look forward to from the humble noni fruit.

## NEEM

Neem (*Azadirachta indica*, A. Juss) is a tree which belongs to the *Meliaceae* family and is considered to be a holy medicinal tree found in India. It is also known as "Indian neem/margosa tree" or "Indian Lilac" and "Persian Lilac". It possesses a wide range of biological activities, such as anti-inflammatory, antimalarial, antimicrobial, antiviral, antifungal, antipyretic, antioxidant, analgesic, immune-stimulant, anti-fertility, anti-acne, anti-hypoglycemic, anti-cancer and nematicidal properties.[46] Neem is a common plant which is cultivated in various parts of India for religious and medicinal reasons. Neem is considered to be a "village dispensary" since every part of the tree including the leaves, bark, and seeds have medicinal properties.

It is effective in several epidermal dysfunctions such as acne, psoriasis, eczema. Neem leaves have been reported to also possess antihyperglycemic, immunomodulatory, anti-inflammatory, antimalarial, antioxidant, antiviral, antimutagenic and anticarcinogenic properties. Neem also exhibits antibacterial, antifungal, hepatoprotective, anti-ulcer, anti-fertility and anti-nociceptive activity.[47]

Neem twigs are used as oral deodorant, toothache reliever and for cleaning of teeth. Neem bark possesses antibacterial and deodorant activity. The phytochemical constituents present in neem are nimbidin, nimbin, nimbolide, Azadirachtin, gallic acid, epicatechin, catechin, and margolone. All these exhibits potent antibacterial activity.[48] The chief active constituent of neem is azadirachtin, which is an effective antimicrobial agent. Nimbidin is extracted from the leaf. Azadiracchtin from seed along with nimbolide from seed oil. Gallic aid and margolin are present in bark.[49] Neem has also been traditionally used as a skin moisturizer.[50] Neem extract contains the concentrated form of active or principal constituents derived from the parts of neem tree. These extracts should be preserved in their original concentrated form which could be used as such for the preparation of final products. These extracts can be divided into three divisions based on their source: 1. neem leaf extract 2. neem seed extract 3. neem bark extract. Neem dental care products contains neem leaf or bark extract. Neem leaf is rich in antioxidants and helps to boost the immune response in gum and tissues of the mouth.[51] Neem offers a good remedy for curing mouth ulcers, tooth decay and acts as a pain reliever in toothache problems.

***Antibacterial activity***

Neem is a natural antibacterial agent. The antimicrobial effects of Neem have been reported against S. mutans and *S. faecalis*.[51] Ethanolic extract of Neem leaves and sticks and bark exhibited significant antibacterial activity.[52] Dried chewing sticks of neem showed maximum antibacterial activity against *S. mutans* compared to other dental caries-causing organisms, *S. salivarius*, *S. mitis*, and *S. sanguis*.[53]

***Anti-candidial activity***

Ethanolic and aqueous extract of Neem leaf showed significant anti-candidial effect against *C. albicans*.[52] A clinical study demonstrated the effects of the leaf aqueous extract from *Azadirachta indica* (Neem) on adhesion, cell surface hydrophobicity and biofilm formation, which may affect the colonization by *Candida albicans*.

***Anti-cariogenic activity***

Mango and neem extract showed antimicrobial activity against *S. mutans*, *S. salivarius*, *S. sanguis* and *S. mitis*. chloroform extract of neem leaf inhibited *Streptococcus mutans* and *Streptococcus salivarius* and provides an aid for treating dental caries.[54] Antimicrobial activity of commercially available Himalaya herbal dental cream containing neem and fluoride-containing cheerio gel toothpaste has been assessed in school children. The study reported both the toothpastes showed a good antimicrobial effect on caries producing salivary *Streptococcus mutans*.[55] The toothpaste containing neem as well as fluoridated toothpaste were equally efficacious against caries-producing bacteria. Acetone extract from the bark of neem is bactericidal against *S. sobrinus* hence indicates its anti-cariogenic activity.[56]

***Anti-plaque activity***

Aqueous extract of neem stick and the gallotannin-enriched extract from Melaphis chinensis inhibited

insoluble glucan synthesis and results in bacterial aggregation. It reduces the ability of *Streptococci* to colonize tooth surfaces.[57] Neem oil shows significant antibacterial activity and has been suggested for use in treating dental plaque.[58] Mucoadhesive dental gel containing *Azadirachta indica* is found to be beneficial in reducing the plaque index and salivary bacterial count comparatively better than chlorhexidine gluconate mouthwash.[59] Studies indicate that leaf extract of A. indica-based mouth rinse is highly efficacious and that it may be used as an alternative therapy in the treatment of periodontal disease.[60] Studies indicate that leaf extract of *A. indica*-based mouth rinse is highly efficacious and that it may be used as an alternative therapy in the treatment of periodontal disease. Gingivitis has been prevented or even reversed with regular use of neem toothpaste and mouthwash.[61]

***Endodontic irrigant***

Aim of endodontic treatment is to eliminate intracanal tissue and pathogens, aided by antimicrobial substances and optimized root canal obturation.[57,58]The isoprenoid group (nimbin, nimbinin, nimbidinin, nimbolide and nimbidic acid) of constituents of neem has a broad range of therapeutic and antimicrobial effects suggesting its potential as an endodontic irrigant.[49,62] The use of neem as an endodontic irrigant may be advantageous because neem is an excellent antioxidant with a very high biocompatibility, and thus there is no risk of tissue toxicity with its use.[63] Biocompatibility of neem to the human periodontal ligament fibroblasts has already been proved, and this is an important factor favoring its clinical application in endodontics.[61]

Bohora et al compared the antibacterial efficacy of the neem leaf extract and 2% sodium hypochlorite against *E. faecalis* and *C. albicans*. They found that there was a significant difference between the zone of inhibition of neem leaf extract and the 2% NaOCl against *E. faecalis* and a mixed culture.[64]

Hegde et al compared the antibacterial efficacy of 2% sodium hypochlorite, propolis, neem leaf extract, turmeric and liquorice against *E. faecalis* and *C. albicans*, using the agar diffusion method. They concluded in their study that the neem leaf extract showed the highest zone of inhibition against *E. faecalis* and *C. albicans*.[65]

Dutta et al in evaluated the *in vivo* antimicrobial efficacy of 2.5% sodium hypochlorite and 0.2% chlorhexidine gluconate, and an experimental irrigant formulated from the neem tree. It was concluded that neem had good anti-microbial efficacy and could be considered for endodontic use.[66] In another study by Arora et al. compared the antimicrobial potential of herbal extracts, namely neem (*Azadirachta indica*), tulsi (*Ocimum sanctum*), bitter gourd (*Momordia charantia*), and arka (*Calotropis procera*) were used as endodontic irrigants against *E. faecalis* and *C. albicans*. It was observed that bitter gourd demonstrated the maximum zones of inhibition, followed by neem, tulsi, and calotropis for both *E. faecalis* and *C. albicans*.[67]

Babaji et al in their *in vitro* analysis, concluded that herbal medicines such as neem, *M. citrifolia*, and *A. vera* showed inhibitory zones against *E. faecalis*. Therefore, these can be used as root canal irrigating solutions.[68]

Sundaram et al also tested the herbal irrigants including neem for their antibacterial efficacy and had suggested its potential role in the future of endodontics.[69]

In a study conducted to evaluate the efficacy of neem gel formulation in gingivitis patients it was found that both the mouth gels (neem and chlorhexidine) used in study were effective in the reduction of plaque and gingival inflammation in gingivitis patients. This study demonstrated the use of neem in treating the oral infections by inhibiting the plaque growth and anti-inflammatory activity. Thus, it can be used as an adjunct to mechanical therapy for treating plaque induced gingivitis.[70]

Regular brushing with Neem-containing toothpaste will reduce the deposition of plaque, prevents caries, and enhances the immune response for overall oral health. Frequent usage of mouthwash containing Neem extract will lessen gingival problems, and also treats halitosis. Incorporation of neem extracts in root canal medicaments and caries preventive gels and varnishes needs to be explored more.

## TRIPHALA

Triphala has been utilized in Ayurvedic (Indian) medicine for about 2,000 years. It's formed from the dehydrated and preserved powder of three distinctive fruits, thus bearing the names tri meaning three and phala which means fruit.[71,72] Triphala is a vedic compound made up of balanced portions of three dried astringent fruits: Amalaki (*Emblica officinalis*), Bibhitaki (*Terminalia bellirica*), and Haritaki (*Terminalia bellirica*) eaten without seed (*Terminalia chebula*). Triphala is a mixture made up of equal portions of three tropical fruits mentioned above, all of which have the efficiency to reduce pain, inflammation and reverse aging.

Active ingredients in triphala are tannins, quinolones, flavanols, gallic acid, vit *C. Tanins* mode of anti-microbial action may be related to their ability to inactivate microbial adhesins, enzymes, and cell envelope transport proteins.[73] In addition to providing a source of stable free radicals, quinones are known to complex irreversibly with nucleophilic amino acids in proteins, often leading to inactivation of the protein and loss of function. For that reason, the potential range of quinone anti-microbial effects is great. Flavanols activity is probably due to their ability to complex with extracellular

and soluble proteins and to complex with bacterial cell walls. More lipophilic flavonoids may also disrupt microbial membranes. These compounds have been shown to inhibit *Vibrio cholera, Shigella, Streptococcus mutans in vitro*. Inhibition of isolated bacterial glucosyltransferases in S. mutans, and reduction of fissure caries by about 40% has also been demonstrated.[74,75] Gallic acid is a common phyto-constituent present in all three herbs used in Triphala. It is reported to possess hepatoprotective and antioxidant activity. It also suppresses growth of cancer cells.[74] Fruit juice of Emblica officinalis (EO) contains the highest vitamin C (478.56 mg/100 mL) content.

***Antibacterial***

Triphala has exhibited anti-bacterial activity against a number of gram-positive and gram-negative human pathogenic bacterial species. It also exhibits anti-fungal and anti-viral properties. It has also shown anti-mutagenic/anti-carcinogenic activity, antioxidant activity, adaptogenic and anti-anaphylactic activities, immunomodulatory activity, cytoprotective and radioprotective activity. It is also effective in hypolipidemia/hypercholesterolemia, improving gastro-intestinal motility with anti-spasmodic activity, diabetes, retinopathy, and wound healing.[73]

*Terminalia chebula* is valuable in the prevention and treatment of several diseases of the mouth such as dental caries, spongy and bleeding gums, gingivitis, and stomatitis. Extract of *T. chebula* may be an effective agent in the treatment of carious teeth, owing to its ability to inhibit the growth and accumulation of *S. mutans* on the surface of the tooth. This would prevent the accumulation of acids on the surface of the tooth, and thus the further demineralization and the breakdown of the tooth enamel.[76]

***Triphala as a mouth rinse***

According to the Sushruta Samhita, Triphala can be used as a gargling agent in dental diseases.

The 0.6% triphala mouthwash has shown to have significant anti-caries activity, which is comparable to that of chlorhexidine without possessing disadvantages as staining of teeth and at much less cost although there was no evidence of re-mineralization of tooth structure.[77] Triphala mouth rinse along with scaling and root planing showed considerable reduction in the plaque, gingival, and oral hygiene indices of teeth at 7, 30, and 45 days when compared to chlorhexidine mouth wash.[78]

Triphala mouth rinse when combined with scaling and root planing showed significant reduction in the plaque, gingival, and oral hygiene indices which was comparable to reduction obtained by chlorhexidine mouth rinse in combination with scaling and root planing.[79]

Triphala mouthwash twice-daily combined with metronidazole 400 mg thrice-daily when compared with 0.2% chlorhexidine with metronidazole 400 mg thrice-daily and triphala mouthwash with oral powder of triphala in a one month study showed improvement in clinical indices in terms of reduction in tooth mobility, pocket depth, bleeding gums, sensitivity to hot and cold, and calculus formation with minimal recurrence in all the clinical parameters.[80] Triphala showed better results than Chlorhexidine. [81] 6% triphala when used twice a day brought down the oral *Streptococci* count by 17% and 44% compared to 0.2% chlorhexidine group which showed 16% and 45% reduction at the end of 48 h and 7 days respectively suggestive of an anti-oral-*Streptococci* efficacy of triphala comparable to that of chlorhexidine.[82]

***Anti-oxidant effect of triphala***

Oxidative stress has been accounted as a predisposing factor in various oral diseases. Disruption of balance between the production of oxygen free radical species and inactivation of the same results in diseases. Phenolic compounds present in triphala extracts attributed to its antioxidant property. *Emblica officinalis* exhibits remarkable lipid peroxidation properties whereas *Terminalia chebula* has excellent radical scavenging property. This synergistic effect makes triphala a better antioxidant.[83]

***Antimicrobial anti caries effect***

Triphala has notable antimicrobial action against gram positive and gram-negative bacteria namely *Staphylococcus aureus, Staphylococcus epidermidis, Bacillus subtilis, Escherichia coli* and *Pseudomonas aeruginosa*. About 5% solution of triphala inhibits 83.7% *Streptococcus mutans.* It is due to the tannic acid in Triphala which gets adsorbed onto the surface of the bacterial cell leading to protein denaturation and ultimately to cell death. Triphala also helps in controlling dental plaque, microbial growth and gingival inflammation caused by the *Lactobacillus* and *Streptococcus mutans.* [84]

In addition, one of the constituents of Triphala, *Terminalia chebula* has shown significant inhibitory effect on *Candida* and is probably due to the gallic acid components. Triphala is also noted to possess antiviral action against herpes simplex virus 1 (HSV-1) and cytomegalovirus and HIV. [85]

Studies have shown that *Terminalia chebula* prevents plaque formation on the surface of the tooth by inhibiting sucrose induced adherence and glucan induced aggregation. It inhibits the growth and accumulation of *Streptococcus mutans* on the surface of the tooth.[86] This in turn prevents the build-up of acids on the tooth surface and thus prevents further demineralization. Rinsing of mouth with aqueous extracts of triphala has shown to reduce total bacterial load and total *Streptococcal* count

in saliva samples for up to 3 hours. Triphala mouthwash (0.6%) has shown to have significant anticaries activity, which is comparable to that of chlorhexidine without causing staining of teeth.[87,88]

***Triphala as an analgesic and antipyretic agent***

Triphala has both analgesic and antipyretic action by blocking release of the endogenous substances that produce pain by stimulating nerve endings which is similar to non-steroidal anti-inflammatory drugs.[89]

***Root canal irrigant***

Triphala has been demonstrated to have antibacterial activity against biofilms after three and six weeks. Herbal alternatives to sodium hypochlorite as root canal irrigants prevailed over sodium hypochlorite's numerous negative qualities.[72] Triphala is a safe choice to frequently used root canal irrigants because it is made up of chemicals that have correct physiologic effects as well as anti-oxidant and anti-inflammatory qualities. Triphala was determined to be the most potent antibacterial agent among the nine herbal agents studied in the evidence-Based complementary and alternative medicine study, followed by green tea polyphenol and *Morinda citrifolia*.[90]

Triphala is an efficient chelating agent and has shown promise in removing the smear layer.[91] Tannic acid, the main component of Triphala, has been shown in various research to have properties like controlling the growth of bacteria and killing the bacteria mainly against gram-positive and gram-negative bacteria.[92] The antibacterial action of triphala as an irrigant was shown to be comparable to that of NaOCl, according to Divia et al.[93] In another study triphala performed equally well as NaOCl. Triphala was found to be more effective against endodontic bacteria. This is owing to its formulation, which contains equal amounts of three different ayurvedic botanicals. Furthermore, diverse compounds may aid in boosting the efficacy of active chemicals and assisting in an additive impact.[94.] When compared to 0.5 and 1 percent NaOCl, triphala was more effective on E. faecalis cultures, indicating stronger antibacterial activity.[95] In studies where triphala efficacy was compared with other herbal products and NaOCl and chlorhexdine, triphala extract proved more effective in eliminating the bacteria.[96,97]

Triphala is a gift from ancient ayurveda, in addition to its enormous clinical benefits it also possesses antimicrobial and antiplaque properties that are highly useful in dentistry.

## CONCLUSION

There has been a change in global awareness with a growing tendency to go natural in all aspects of our everyday life. This is seen also in healthcare. Patients show growing concern with artificial products and side effects of conventional therapies being used. Herbal products are gaining importance as a safer and more effective caries preventive or mouthwash or a medicament. There needs to be a better understanding of the nature, variety and mechanism of action of the products we use and may be recommending to our patients in time.

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