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Exquisite Herbal Bullets in Dentifrices - A Scientific Review

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ABSTRACT

Ayurveda, known to be the science of life focuses on prevention of diseases rather than treatment. One's daily health and hygiene regimen referred to as *Dinacharya* in Ayurveda is essential to keep our mind and body in optimum health. Oral hygiene is vital to an individual's overall health and well being. Natural phytochemicals isolated from plants used in traditional medicine are considered to be good alternatives to synthetic chemicals. Herbs with medicinal properties are useful and effective source for treatment of oral diseases and can be used for cleansing and maintaining oral hygiene. They have been proven to be safe, effective, easily adjustable and acceptable with body physiology. The present review focuses on herbs incorporated in dentifrices and their effects in oral cavity.

Key words: Ayurveda, Dentistry, Dentifrices, Herbs, Phytochemicals, Dinacharya

INTRODUCTION

Dental plaque can be defined as the soft deposits that form the biofilm adhering to the tooth surface or other hard surfaces in the oral cavity, including removable and fixed restorations.^[1] Early plaque consists predominantly of gram-positive organisms and if left undisturbed it matures resulting in a more complex and predominantly gram-negative flora.^[2]

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These organisms colonise and eventually lead to oral infections.^[3] Control of plaque is mainly done by mechanical plaque control methods such as scaling and root planing and at home by tooth brushing.^[4] The use of chemotherapeutic agents are accepted adjunctive mode for reducing plaque build-up, and incorporation of anti-plaque and anti-gingivitis agents to the oral hygiene regimen has been found to be beneficial. These antimicrobial agents can be chemicals or herbal preparations.^[5]

Ayurveda has mentioned various procedures for maintaining oral hygiene. These include procedures like *Gandusha*, *Kavala*, *Dantadhavana*, and *Jivha Nirlekhana*. In *Gandusha*, water processed with various medicinal herbs is held in mouth for certain duration. In *Kavala*, water is moved in mouth. However, *Danta Dhavana* is cleaning of teeth. *Danta Dhavana* is to be done with stem of certain plants (called as *Dantakasha*)^[4]

Dentifrices are agents used along with a toothbrush to clean natural teeth, supplied in paste, gel, or powder

form. An ideal dentifrice should significantly reduce plaque and gingivitis, prevent growth of pathogenic bacteria, prevent development of resistant bacteria, biocompatible with oral tissues, should not stain teeth or alter taste and should be inexpensive and easy to use.^[5] Herbal dentifrices are effective in removing food debris and dental plaque.^[6] This review article focuses on dental application of common herbs used in Ayurveda as dentifrices.

1. Neem



Figure 1: Neem

Scientific aspects of Neem^[7]

- Botanical name - *Azadirachta indica*
- Family - Meliaceae
- Other Names - Holy tree, Indian lilac tree, Neem, Nimba
- Chemical constituents - Azadirachtin, Steroids, Triterpenoids, Alkaloids, Carotenoids, Ketones, Flavonoids and phenolic compounds.

Therapeutic Uses of Neem

- Antibacterial activity

The antibacterial effects of Neem seed oil, bark oil and leaf oil has been reported against Gram-positive and Gram-negative microorganisms that include streptomycin, Mycobacterium tuberculosis resistant strains, *S. mutans* and *S. faecalis*.^[7,8] Study done by Jerobin et al concluded that Neem nanoemulsion formulated using *Neem* oil treated cells showed disruption and disintegration of the bacterial cell wall

and a significant alteration in the morphological structure leading to bacterial cell death.^[9]

- Anti viral activity

The aqueous leaf extract of Neem offers antiviral activity against Measles virus, Vaccinia virus, Chikungunya and Group-B coxsackie viruses. Oral administration of acetone water neem leaf extract is recommended as part of an HIV/AIDS drug treatment program.^[7]

- Antifungal activity

Ethanol and aqueous extract of Neem leaf showed significant anti-candidal effect against *C. albicans*. Human fungi, including *Epidermophyton*, *Geotrichum*, *Trichosporon*, *Trichophyton*, and *Microsporum*, are effectively inhibited by extracts of neem oil, seed kernels, and neem leaf.^[7,8]

- Anticarcinogenic activity

Oral squamous cell carcinoma induced by 7, 12-dimethylbenz[a] anthracene is suppressed by aqueous neem leaf extracts. This is exerted by modulation of glutathione and its metabolizing enzymes.^[7] Neem extracts boosts the lymphocytic and cell mediated immunity, including the natural killer cells, which are able to destroy viruses, bacteria and cancer cells.^[10]

- Anti-inflammatory and analgesic activities

Bark extract of Neem is effective against inflammatory stomatitis in children. Analgesic activity mediated through opioid receptors in laboratory animals are also reported in the plant.^[7]

Dental Implications of Neem

- Anti-cariogenic activity

Chewing sticks made of Neem extract showed antimicrobial activity against *S. mutans*, *S. salivarius*, *S. sanguis* and *S. mitis*. Which is found to be beneficial in eradicating the dental caries.^[7] Study done by Packia Lekshmi et al. evaluated the antimicrobial properties of neem extract against three bacterial strains causing dental caries such as *Streptococcus mutans*, *Streptococcus salivarius* and *Fusobacterium nucleatum* using disc diffusion method and concluded

that chloroform extracts of neem has a strong antimicrobial activity and can be useful in the treatment of dental caries.^[11]

- Anti-plaque activity

Neem oil shows significant antibacterial activity and can be used as an antiplaque agent. Aqueous extract of Neem stick inhibits insoluble glucan synthesis and results in bacterial aggregation. It reduces the ability of streptococci to colonize tooth surfaces. 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[8]. Anirban Chatterjee et al evaluated the antigingivitis and antiplaque effect of an *Azadirachta indica* (neem) mouthrinse on plaque induced gingivitis and concluded that they are equally efficacious with fewer side effects as compared to chlorhexidine and may be used as an adjunct therapy in treating plaque induced gingivitis.^[12,13]

2. Triphala

Triphala is a dried powder of three assorted fruits hence it is named as *Tri* (Three) *Phala* (Fruit).



Figure 2: Triphala

Scientific aspects of *Triphala*^[14]

Indian gooseberry / Amla / Amalaki

Botanical Name - *Embilca officinalis*

Family - Phyllanthaceae

Chemical constituents - Ascorbic acid , Gallic Acid, Flavones

Black myrobalan / haritaki / harada

Botanical Name - *Terminalia chebula*

Family - Combretaceae

Chemical constituents - Ascorbic acid , Gallic Acid and tannic acid

Belliric myrobalan / bibhitaki / bahera

Botanical Name - *Terminalia bellirica*

Family - Combretaceae

Chemical constituents - Ascorbic acid, Gallic Acid and tannic acid, Syringic acid and epicatechin.

Therapeutic Uses of *Triphala*

- Anti-microbial 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*. This is due to presence of various chemical constituents like flavonoids, terpenes and alkaloids. Tannic acid in *Triphala* which gets adsorbed onto the surface of the bacterial cell leading to protein denaturation and ultimately to cell death.^[15]

- Antioxidant activity

Polyphenolic contents in *Triphala* are responsible for the antioxidant and radioprotective ability and reduce the oxidative stress by converting reactive oxygen free radicals to non-reactive products.^[16]

Dental Implications of *Triphala*

- Anticaries activity

Extracts of *T. chebula* are 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.^[15]

- *Triphala* as a mouth rinse:

Neeti Bajaj et al (2011) evaluated clinically the efficacy of *Triphala* mouthwash on the dental plaque, gingival

inflammation, and microbial counts (Streptococcus and lactobacilli counts) and concluded that 0.6% of *Triphala* mouth have an inhibitory effect on plaque, gingivitis, and growth of Streptococcus mutans and Lactobacillus and is as effective as CHX [17]

Bhuvaneswari et al assessed the effectiveness of *Triphala* against gingivitis and periodontitis and concluded that *Triphala* can be a promising therapeutic agent in treatment of gingivitis and periodontitis with no side effects on long term use.[18]

▪ Anticollagenase activity of *Triphala*

Matrix metalloproteinases play a key role in periodontal destruction, and this knowledge leads to a new concept involving the chemotherapeutic inhibition of these enzymes. *Triphala* has strong inhibitory activity against PMN-type collagenase, especially matrix metalloproteinase 9 at a 1500 µg/ml concentration, which is well within the safety profile of toxicological studies.[15]

3. Nutmeg



Figure 3: Nutmeg

Scientific aspects of nutmeg^[19]

Botanical name - *Myristica fragrans*

Family - Myristicaceae

Other Names - Nutmeg

Chemical constituents - Myristicin, Elemicin, Safrole And Sabinene, A-Pinene, B-Pinene, Sabinene, Limonene, Γ -Terpinene, Terpinolene, Terpinene-4-Ol, Methyl Eugenol.

Therapeutic uses of Nutmeg

▪ Antimicrobial activity

The antibacterial activity of the volatile oil obtained from the seeds of *Myristica fragrans* is effective against the majority of gram positive and gram negative microbes. Essential oil obtained from *Myristica fragrans* seeds has growth inhibition capability of bacterial spores and can be used as food preservatives. The dried seed cover of *Myristica fragrans* exhibit strong antifungal and antibacterial activities.^[20]

▪ Anti-inflammatory activity

The essential oil of nutmeg contains limonene, β -pinene, α -pinene and sabinene which lipoxygenase inhibitors. Limonene is a COX-2 selective inhibitor having significant inhibitory effects on PGE2 production. Terpene-4-ol suppresses the production of TNF- α and IL-1 β , IL-8, IL-10 and PGE2.[19] Ethanolic extract of nutmeg seed showed high anti-inflammatory activity by inhibiting the inflammatory cytokines and Nitric oxide production. Quercetin was found to be the active compound responsible for the anti-inflammatory activity.^[20]

▪ Anti-oxidant activity

Methanolic extract of Nutmeg seed showed good antioxidant activity by methods of 1,1-diphenyl-2-picrylhydrazyl (DPPH) and ferric reducing antioxidant power (FRAP) due to high content of tannin, flavonoid and terpenoids. Acetone extract showed good antioxidant activity by the DPPH radical scavenging assay due to the presence of several terpenoids like sabinene, myristicin and eugenol.^[20]

Dental Implications of Nutmeg

▪ Periodontal infections

An arginine specific cysteine protease Arg-gingipain is one of the major proteases produced by *P. Gingivalis*.^[12,13] Chikara Shinohara et al determined that malabaricone C isolated from nutmeg irreversibly inhibited Arg-gingipain by 50% at a concentration of 0.7 µg/ml and selectively suppressed Porphyromonas gingivalis growth.^[23]

Zaleha Shafiei et al showed a significant decrease in the bacterial concentration of Aggregatobacter

actinimycetemcomitans and Porphyromonas gingivalis with the ethyl acetate and ethanol extracts of Myristica fragrans and concluded that Myristica fragrans can be incorporated in oral care products.[21]

4. Clove



Figure 4: clove

Scientific aspects of clove

Botanical name - Syzygium Aromaticum

Family - Myrtaceae

Other names - Laung, Lavanga, Grambu, Karambu

Chemical constituents - Volatile oil, Flavanoids, Ethanol, Hexane, Methylene chloride, Thymol, Eugenol and Benzene

Therapeutic Uses of Clove

Antimicrobial activity

Clove is a potent anti-viral, anti-fungal and anti-bacterial agent. Clove oil is found to be effective against Staphylococcus species. Amongst fungi, Aspergillus Niger was found to be highly sensitive to clove oil. Essential oil of clove, showed germicidal effect against various bacteria (S. Aureus, Klebsiella Pneumoniae, Pseudomonas Aeruginosa, Clostridium perfringens, E.coli) and Candida albicans. Essential oil which is the major constituent of clove interacts with the cell wall and membrane thereby causing destruction leading to the loss of vital intracellular materials, which finally result in the bacterial death.[24]

Antioxidant Activity

Clove and Eugenol possess strong antioxidant activity, which is comparable to the activities of the synthetic antioxidant. Clove has the highest capacity to give off hydrogen and reduce lipid peroxidation. It also showed a significant inhibitory effect against hydroxyl radicals and act as an iron chelator.[24]

Anti-inflammatory

The volatile oil, Eugenol, composed of flavonoids, including kaempferol, rhamnetin and β -caryophyllene contributes to clove's anti-inflammatory properties.[24]

Dental Implications of Clove

- Clove oil has been used for pain relief. The mechanism of action for pain relief is by the activation of calcium and chloride channels in ganglion cells. It also inhibits the prostaglandin synthesis, cyclooxygenase, and lipoxygenase, which are all known to increase pain perception.[24] Hot water extract of clove plant inhibits the growth of S. mutans.[25]
- Clove oil in the form of clove paste in Aphthous Ulcer treatment acts as a biocide being active against invasive bacteria, fungi and even invading larvae.[25]
- Clove oil helps in the reduction of amount of plaque deposition on oral hard tissues.[25]
- Clove extracts helps reduce root canal microflora (S. mutans and Enterococcus faecalis)
- Clove oil can be short term remedy for halitosis since it is antimicrobial agent (An Insight into Halitosis Hunny Sharma).[26]
- Yanti et al. conducted an invitro study to determine antihalitosis efficacy of clove bud on preventing and eradicating S. sanguinis oral biofilms, inhibiting Volatile Sulphur Compounds and acid production and concluded that clove exerted potential anti-halitosis effect by preventing S. sanguinis biofilm formation, eradicating the existed S. sanguinis biofilms, inhibiting S. sanguinis VSCs production, and reducing S. sanguinis acid production.[27]

5. Tulsi



Figure 5: Tulsi

Scientific aspects of Tulsi^[28]

Botanical name - *Ocimum sanctum*

Family - Lamiaceae

Other names - Tulsi, Basil, Manjari, Krishna Tulsi, Trittavu, Tulshi

Active components - Phenolic compounds (antioxidants) such as cirsilineol, circimaritin, isothymusin, apigenin and rosameric acid, eugenol, carvacrol and sesquiterpine hydrocarbon caryophyllene. Flavonoids- orientin and andvicenin.

Therapeutic uses of Tulsi

- Anti-inflammatory effects

Compounds present in *O. sanctum* such as Civsilineol, Civsimavatine, Isothymonin, Apigenin, Rosavinic acid, linoleic acid, and eugenol. Linoleic acid has the capacity to block both the cyclooxygenase and lipoxygenase pathways of arachidonate metabolism.^[29]

- Antimicrobial effect

Tulsi contains volatile substances such as estragol, eugenol, linalool, methyl chavicol, methyl cinnamate, cineole, and other terpenes which is considered to be effective against *Candida albicans*, *Staphylococcus aureus*, and enteric pathogens. *Ocimum basilicum* act as a strong antiviral agent against DNA viruses such as herpes virus, adenovirus, and Hepatitis B virus, and RNA viruses.^[28,29]

Dental Implications of Tulsi

- *O. sanctum* has got antimicrobial effect against periodontal pathogens. In a study conducted by

Sajjan Shetty, different concentrations of tulsi, namely 0.5%, 1%, 2%, and 5% were prepared and subjected to the microbiological investigation against *A. actinomycetemcomitans*, *P. gingivalis*, and *P. intermedia*. Results showed *Ocimum* extracts demonstrated effective antimicrobial potential against *A. actinomycetemcomitans*.^[30] Hence, holy basil mouthwash may have potential as an antiplaque mouthwash with prophylactic benefits.

- Oral ulcers: Tulsi effectively cures mouth ulcers, lesions, and other related disorders and is useful for sensitive teeth and gums.^[28]
- For Halitosis: Oil of *O. sanctum* has shown the presence of five fatty acids (palmitic, stearic, linoleic oleic, and linolenic acids). It is also a good source of calcium, beta carotene, vitamin C, camphor, flavonoids and tannins. Chewing tulsi leaves helps clear infections and ulcers of the mouth. As mouthwash, it is useful for maintaining healthy gums and reducing against bad breath.^[26] Study done by Kriti Sharma evaluated the efficacy of tulsi extract mouthrinse in reducing halitosis as compared to chlorhexidine and hydrogen peroxide mouthrinses using spectrophotometric analysis for Volatile Sulphide Compounds (VSCs) from saliva samples, Löe & Silness gingival index and Silness & Löe plaque index and concluded that tulsi is effective in reducing halitosis, plaque and gingivitis and with its lack of side effects & cost effectiveness, can be an effective & economic tool to deal with halitosis.^[31]

6. Akarkara



Figure 6: Akarkara

Scientific aspects of Akarkara^[32]

Botanical name - *Spilanthes acmella*

Family - Asteraceae

Other names - Tooth ache plant, Paracress, Sichuan buttons, Buzz buttons, Mandal Poo Chedi

Chemical Constituents - Spilanthol, Triterpenoids, β -Caryophyllene, β -Sitosterol, Stigmasterol, Flavanoids

Therapeutic Uses of Akarkara

- Anti inflammatory agent

The activity was attributed to the presence of flavonoids which are potent inhibitors of prostaglandins at later stages of acute inflammation.^[32]

- Antifungal activity

Spilanthes acmella flower head extract are effective against *Aspergillus niger*, *Aspergillus parasiticus*, *Fusarium oxysporum*, and *Fusarium moniliformi*.^[32]

- Antioxident Activity

Spilanthes acmella was found to be a potent antioxidant activity in the crude ethanol extract of the leaves of the plant was attributed to the presence of tannins, flavonoids and phenolic compound^[32].

Dental Implications of Akarkara**1. Toothache**

Traditionally, *Spilanthes acmella* is called as antitoothache plant. The pungent flower heads of the plants were chewed by people as they deaden or numb the tooth pain, throat problems or paralysis of the tongue. The component responsible for this is Spilanthol.^[33]

2. Dentifrice

Spilanthol has been incorporated in tooth pastes and mouth rinses. The objective is to provide a lasting fresh minty flavor; the spilanthol present also has a mild anesthetic effect thus enabling people with toothache to brush comfortably.^[34]

3. Anti bacterial

ethanolic extract of *Spilanthes acmella* showed antimicrobial activity against *Staphylococcus aureus*, *Staphylococcus epidermidis*, *Streptococcus pyogenes*,

Enterococcus faecalis, *Escherichia coli*, *Klebsiella pneumoniae*, *Pseudomonas aeruginosa*, *Proteus mirabilis*, *Salmonella typhi*, *Shigella dysenteriae* ^[33] Study done by Ismail et al concluded that *S. acmella* has beneficial effects against *S. mutans* and can be a potential option for preventive measures against dental caries, although more studies are needed for its validation.^[34]

Oral Hygiene Practices in Ayurveda**▪ Chewing Sticks**

Herbal chewing sticks can be obtained from fresh stems of specific plant and has medicinal and anticariogenic properties. The method of use is to crush one end, chew it, and eat it slowly. It can be used in morning and in evening, before going to sleep and after every meal. According to *Acharya Sushruta*, it should be fresh and straight. Its length should be 12 angul (9 inches), while thickness should be equal to *Kanshtika Anguli* (little finger). These herb sticks should be either '*Kashaya*' (astringent), '*Katu* (acid), or '*Tikta*' (bitter) or *Madhura Rasa*.^[35]

Malik et al compared the effectiveness of two oral hygiene aids: Chewing stick and manual toothbrush, for plaque removal and gingival health after one month of a randomized clinical trial and concluded that Chewing stick has revealed parallel and at times greater mechanical and chemical cleansing of oral tissues as compared to a toothbrush.^[36]

▪ Jihwa Nirlekhana

It is used for cleaning tongue with the help of tongue scraper. Tongue scrapers on a regular basis eliminates anaerobic bacteria, stimulates the reflex points, eliminates bad odour (halitosis), Improves the sense of taste, stimulate the secretion of digestive enzymes. It should be made up of either metal or branches of the tree. Its length should be twelve fingers. Its margin should be blunt so that it will not damage the tongue and should be curved so can be use easily.^[35]

▪ Oil Pulling Therapy

Oil pulling is performed preferably in the morning on an empty stomach. One tablespoon (approximately 10 ml), of sesame oil, being the recommended dose for adults is sipped, and swished between the teeth for a

duration of approximately 15-20 min and spat out. This changes the viscosity of the oil, which turns milky white with a thin consistency. This should be followed by rinsing, conventional tooth brushing and flossing. The practice should preferably be performed 3 times daily for acute diseases. While there are no suggested contraindications, it is not advisable for children below the age of 5 years to perform oil pulling.^[37]

Mechanism of Action

There are numerous theories and the exact mechanism of action is unclear. One theory speculates a mechanism involving alkali hydrolysis of fat, resulting in saponification. Since the oils used for oil pulling contain fat, the alkali hydrolysis process emulsifies the fat into bicarbonate ions, normally found in the saliva. Soaps which are effective cleaning agents blend in the oil, hence increasing the surface area of the oil, and in turn increasing the cleansing action.

Another theory suggests that the viscous nature of the oil inhibits plaque accumulation and adhesion of bacteria.

The third theory hypothesizes that the antioxidants present in the oil cause detoxification by preventing lipid peroxidation, resulting in an antibiotic-like effect. Thus, helping in the destruction of microorganisms.^[37]

CONCLUSION

Phytochemicals have the potential to be developed into agents that can be used as preventive and curative agents for dental diseases. The use of herbal extracts in dentistry in the form of chewing sticks, tooth paste and mouth rinse is expanding. This is probably because of its antimicrobial, antiplaque and anti-inflammatory actions. Further studies are warranted to establish the pharmacokinetics of these herbs in various dental ailments.

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