

Review Article

Role of herbal leaf extracts in caries prevention

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ABSTRACT

Dental caries is one of the most prevalent diseases in humans. Endogenous oral bacterial species play a major role in the initiation and progression of the dental caries. Effective prevention of dental caries can be achieved by mechanical plaque removal or chemical agents. These chemical agents used in the form of either dentifrices or oral rinses may have undesirable side effects like staining of teeth, altered taste sensation, toxic effects on connective tissues, dryness and soreness of oral cavity and particularly in children it would cause oral desquamation. Recently with the constant increase in antibiotic resistant strains and side effects caused by chemical agents, new horizons in the field of alternative medicine have opened. Natural products have been tried to prevent oral maladies, since antiquity. Herb is any plant that lacks the woody tissue characteristic of shrubs or trees. Herbs are plants with medicinal properties, which are used as an effective source in the treatment of various disease processes. Herbal leaf extracts are composed of structurally different substances displaying a wide range of biological activities. Recently, herbal extracts are gaining importance in various fields of dentistry, as irrigants, mouthrinses and to treat gingival and periodontal problems. Studies have proven their antibacterial efficacy against caries pathogens, especially *Streptococcus mutans*. Thus, this update focuses on the use of herbal leaf extracts in the prevention of oral diseases such as dental caries. It highlights the efficacy of tulsi, neem, guava, aloe vera, pudina and tea leaf extracts against caries pathogens.

Key-words: Caries, Herbal leaf extracts, Prevention, mouthrinses, Tulsi, Neem, Pudina, Tea, Aloe Vera,

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INTRODUCTION

Dental caries is one of the widespread devastating diseases affecting manhood. Oral microorganisms play a vital role in their initiation and progression. It can be prevented by mechanical plaque removal or by the use of chemical agents (dentifrices or mouth rinses).¹ Although chemical plaque control methods are effective, they cause side effects like staining of teeth, altered taste sensation, toxic effect on connective tissues, dryness and soreness of oral cavity and oral desquamation, especially observed in children.^{2,3} To overcome these problems, recently alternative dentistry using natural products are being evaluated. Literature review has demonstrated the efficacy of various herbal leaf extracts such as Tulsi, Neem, Guava, Aloe vera, Pudina, Green and Oolong tea, over the chemical agents such as chlorhexidine and sodium fluoride. Their phytochemical constituents play a major role in the inhibition of oral bacteria (**Table 1**). This update is an attempt to outline the role of herbal leaves in dentistry.

TULSI (*Ocimum sanctum*)

Tulsi is the traditional herb, known as “Queen of Herbs or the Mother Medicine of Nature as its rich antimicrobial substances have been used to treat a variety of illnesses. Its sun dried and powdered leaves have been used for brushing

teeth and tulsi leaves with mustard oil is used as toothpaste.⁴

Tulsi leaves contain 0.7% volatile oil comprising about 71% eugenol and 20% methyl eugenol, carvacrol, sesquiterpine hydrocarbon, caryophyllene, linolenic acid, ursolic acid, cirsilineol, circimaritin, isothymusin, apigenin, rosameric acid, luteolin, molludistin, monoterpenes. Flavonoids like orientin and vicenin are also present. Their components

Herbal Leaves and its Phytochemical constituents

1. ***Ocimum sanctum* (Tulsi):** 0.7% volatile oil (71% eugenol and 20% methyl eugenol), carvacrol, sesquiterpine hydrocarbon, caryophyllene and ursolic acid.

2. ***Azadirachta indica* (Neem):** Nimbidin, nimbin, nimbinin, nimbolide, nimbidic acid, alkaloid margosine, resins, calcium, fluoride, silica, tannins.

3. ***Psidium guajava* (Guava):** Tannins, phenols, triterpenes, flavonoids, essential and fixed oils, saponins, carotenoids, lectins, vitamins, alkaloids, reducing sugars and glycosides.

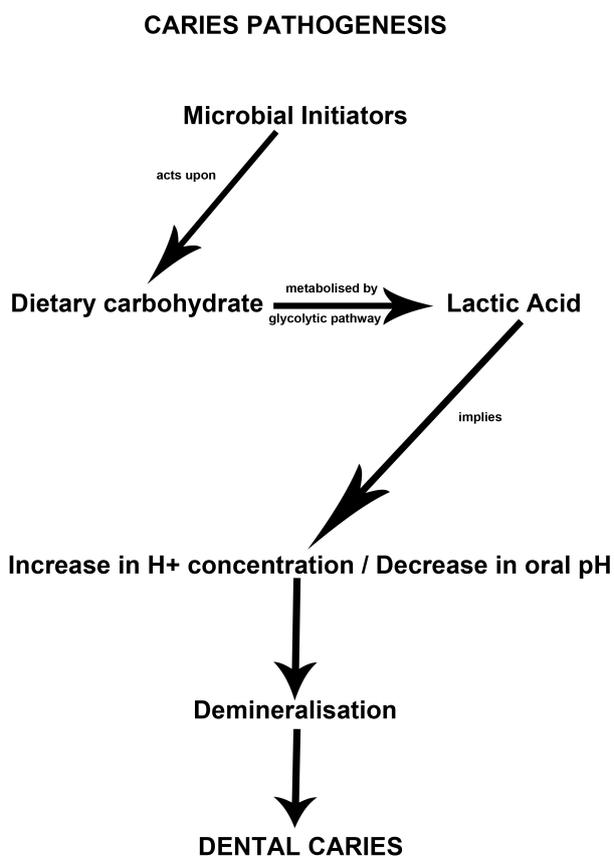
4. ***Aloe Barbadosis* (Aloe vera):** Water (98-99%), active compounds (1-2%) - aloesin, aloin, aloe emodin, aloemannan, acemannan, aloeride, naftoquinones, methylchromones, flavonoids, saponin, sterols, amino acids and vitamins.

5. ***Camellia sinensis* (Green tea):** Polyphenols, Epigallocatechin -3 gallate (EGCG), alkaloids, flavonoids, terpenoids, vitamins, proteins, minerals, lipid, fiber, carbohydrates, amino acids, pigments, phenolic compounds, catechins, tannins and gallic acid

6. ***Camellia sinensis* (Oolong tea):** Alkaloids, tannins, saponins, flavanoids

7. ***Mentha Piperita* (Pudina):** Terpinene, piperitenone oxide, menthol, piperitone, pinene, menthone, menthyl acetate.

Table 1: Phytochemical constituents of herbal leaves



ursolic acid and carvacrol are known to be responsible for the anti-microbial activity of tulsi.⁵

In the year 2010, the botanical, phytochemical, ethnochemical, pharmacological and toxicological information about Tulsi was reviewed by Pandey G. They stated that the fixed oil obtained from Tulsi showed good antibacterial activity which was thought to be due to its higher linolenic acid content.⁶ A literature review by Mahantesh P et al elaborated the role of tulsi in the medicinal field, in addition stated that it has an effective antibacterial potential to conflict with the oral pathogens.⁷

A systematic review by Nagappan et al evaluated the antimicrobial efficacy of herbal and chlorhexidine mouth rinses against Streptococcus mutans and stated that herbs like tulsi, triphala, pudina, neem, clove oil and ajwain used as single herb or in combination have been experimentally proven to be safe and effective medicine against various oral health problems like preventing tooth

decay, bleeding gums, mouth ulcers and halitosis.⁸

NEEM (*Azadirachta indica*)

Azadirachta indica, ("Indian neem/ Margosa tree" or "Indian lilac") is considered as a holy medicinal tree in India. It is the resourceful medicinal plant having a wide spectrum of biological activity.⁹

Its components are Nimbidin, nimbin, nimbinin, nimbolide, nimbidic acid, alkaloid margosine, resins, gum, chloride, fluoride, silica, sulfur, tannins, oils, saponins, flavonoids, sterols, and calcium.^[8,9] Its fluoride content is known to exhibit maximum antimicrobial activity against *Streptococcus mutans* (S mutans).¹⁰

Silica, an abrasive prevents accumulation of plaque, while alkaloids exert an analgesic action. Tannins exert an astringent effect and form a coat over the enamel, thus protecting against tooth decay.^{10,11} It inhibits water-insoluble glucan synthesis, induces bacterial aggregation of various oral streptococci. Due to its anti-adhesion activity it alters bacterial adhesion and ability of microorganisms to colonize. In addition it reduces plaque formation and salivary S mutans counts.³

Packia Leskshmi NCJ et al evaluated the antimicrobial properties of neem extract against three bacterial strains causing dental caries and suggested that it could be used in the treatment of dental caries.¹²

Aarti Bohora et al compared the antimicrobial activity of 2% sodium hypochlorite and Neem leaf extract against *E. faecalis*, *C. albicans* and mixed culture and assessed the antimicrobial property of neem leaf extract against endodontic pathogens and concluded that neem leaf extract has a significant antimicrobial effect against *E. faecalis* and *C. albicans* and mixed state and suggested it as a potential endodontic irrigant.¹³

Macro Antonio Botelho et al in 2008 compared the short-term efficacy and safety of Neem mouth rinse on gingival inflammation and microbial plaque, compared to 0.12% chlorhexidine and demonstrated that Neem mouth wash was highly efficacious in reducing S.Mutans count.¹⁴

GUAVA (*Psidium guajava*)

This shrubby ever green plant, leaves are chewed for bleeding gums, while leaf decoction is used for treating mouth sores and bleeding.⁴

Phytochemicals studies of *Psidium guajava* indicated the presence of bioactive substances like tannins, phenols, triterpenes, flavonoids, essential and fixed oils, saponins, carotenoids, lectins, vitamins, alkaloids, reducing sugars and glycosides.¹⁵ Guava aqueous extract is used as a mouth wash because some of its active ingredients possess anti-oxidant properties which is attributed to its polyphenol content found in the leaves. These compounds are capable of neutralizing volatile sulfur compounds. Since volatile sulfur compounds are the malodorous substances that actually cause halitosis. Anti oxidant constituents of guava extract – based mouth wash could decrease the concentrations of these compounds in a person's breathe thereby reducing mouth odor.¹⁵

Chewing sticks when used without toothpaste are very efficient, effective, and reliable for cleaning teeth. The teeth of chewing sticks users are usually strong, clean, fresh, and devoid of dental plaque and caries. The tender leaves are chewed for bleeding gums and bad breath. Indians throughout the Amazon gargle a leaf decoction for mouth sores, bleeding gums.⁴

Charles O esimone et al carried out a study to assess the antimicrobial potency of aqueous extract of *Psidium guajava* leaves and found it to be effective. Thus, it could be explored further for commercialization and used as a mouth wash.¹⁵

ALOE VERA (*Aloe barbadensis*)

Aloe vera also called "The Elixir of Youth" by the Russians and the "Harmonious Remedy" by the Chinese. It has antibacterial, anti-inflammatory, antiviral, antifungal and antioxidant activities. The gel consists of 98-99% water and the remaining 1-2% contains the active compounds aloesin, aloin, aloe-emodin, aloemannan, acemannan, aloeride, naftoquinones, methylchromones, flavonoids, saponin, sterols, amino acids and vitamins.^{2,16} While Barandozi FN in 2013 identified individual phytochemicals

from Aloe vera leaves such as phenolic acids/polyphenols, phytosterols, fatty acids, indoles, alkanes, pyrimidines, alkaloids, organic acids, aldehydes, dicarboxylic acids, ketones, and alcohols.¹⁷

Aloin, aloe-emodin possessed strong antibacterial and antiviral activities. They have polyphenolic structures, which inhibit protein synthesis by bacterial cells. Saponins contain glycoside which have both cleansing and antiseptic properties.^{2,16}

Mohammadmehdi Fani et al in their study proved the inhibitory activity of aloe vera gel on some clinically isolated cariogenic and periodontopathic bacteria.²

GREEN TEA (*Camellia sinensis*)

Green tea has positive impact on bone density, caries, periodontal disease and diabetes.¹⁸ It can be used as a gargle or mouthwash to treat dental decay, halitosis, laryngitis, mouth sores, plaque formation, sore throat, thrush, and tonsillitis. In a study, the formulation and evaluation of green tea mouthwash as a new, safe and nontoxic product for children and pregnant women was evaluated. Green tea mouthwash has been shown to effectively reduce plaque accumulation, and is free from side effects compared to chemical mouthwashes.⁴

Green tea polyphenols have demonstrated significant antimicrobial, anti-inflammatory, thermogenic, probiotic and antioxidant activities. The chemical composition of tea includes polyphenols, alkaloids, flavonoids, Vitamins, proteins, minerals, lipid, fiber, carbohydrates, amino acids, pigments, phenolic compounds, catechins and gallic acid.^{3,18,19} Catechins are found to be inhibitory against *Streptococcus mutans* at minimum inhibitory concentration. Epigallocatechin -3 gallate (EGCG) the predominant component of green tea polyphenols inhibits both eukaryotic and prokaryotic cell derived collagenase activity. EGCG completely inhibits the growth of *Porphyromonas gingivalis*.¹⁸ The alkaloids are said to interfere with microbial cell division, whereas flavonoids possess anti – glucosyltransferase activity and inhibit bacterial adherence. Tannins, on the other hand, inhibit bacterial growth with their strong iron – binding capacity and also inhibit

glucosyltransferase activity and bacterial adhesion.¹⁸ Biological activity includes antimicrobial activity against planktonic cells of *S.mutans*, inhibitory effects of GTF activity and *S.mutans* adherence, inhibitory effects on acid production in plaque and reduces halitosis by deodorizing menthylmercaptin.³

OOLONG TEA (*Camellia sinensis*)

Oolong tea extracts exhibit antimicrobial activity against planktonic cells of *S mutans*, inhibitory action on GTF activity and *S mutans* adherence.^{3,19} In addition, it reduces cellular hydrophobicity, induces aggregation of *S mutans* and consecutively reduces plaque accumulation.¹⁹

Oolong tea leaves contain 16.0% polyphenols, including 9.7% monomeric polyphenols and 6.4% unknown polymeric polyphenols. Oolong tea extracts also exhibit the most prominent inhibitory action among various tea extracts. It was found that the GTFase inhibition was caused by polymeric polyphenols free of low-molecular weight catechins. Nakahara K et al found that Oolong tea extracts (OTE) to inhibit the water-insoluble glucan-synthesizing enzyme, glucosyltransferase I (GTase-I) of *Mutans Streptococci*.²⁰

PUDINA (*Mentha piperita*)

Pudina is a perennial aromatic herb with immense medicinal use, cultivated in North America, Africa, Australia and Asia mainly for its pharmaceutical, medicinal and culinary uses. Its phytochemical constituents are Menthol, Terpinene, Piperitenoneoxide, Piperitone, Pinene, Menthone, Menthyl acetate and Ketones. Menthyl acetate and Ketones are responsible for the antimicrobial activity of Pudina. Its menthol component is the biologically active antioxidant.²¹ Pudina leaf extract displays antimicrobial activity against planktonic cells of *S mutans* and plaque inhibition.²¹

DISCUSSION

Herbal medicine is both promotive and preventive in its approach. Plaque accumulation and oral microorganisms are the main

predisposing factors to various orodental infections. An effective way of combating these diseases might be by targeting their predisposing factors. Herbal extracts have been of particular interest these days owing to various side effects associated with conventional modes of treatment.³

Literature search through Pubmed and Google revealed few studies assessing the effectiveness of herbal leaf extracts on caries pathogens. Aggarwal et al^{22,23} conducted an in vitro and clinical study using tulsi leaf extracts. Their in vitro study confirmed the antimicrobial activity of ethanolic tulsi extract against *S. mutans*, while its 4% concentration showed the widest zone of inhibition from the 15 concentrations tested. They conducted the clinical trial to assess and compare the effect of chlorhexidine, listerine and 4% Tulsi mouthrinse on salivary *S. mutans* level in 45 children aged 14-16 years and substantiated that tulsi was as effective as chlorhexidine and Listerine in reducing the *S. mutans* count.²³

Siswomihardjo et al proved ethanolic extracts of both neem leaves and stick to be effective against *S. mutans*, but their neem leaf extract had lesser inhibition value compared to neem stick extract on all concentrations tested.²⁴ Chatterjee A et al confirmed the antigingivitis and antiplaque effect of *Azadirachta indica* in Forty four subjects with plaque induced gingivitis, as it reduced gingival bleeding and plaque indices, in addition to inhibiting the growth of bacteria.²⁵

Anitha Rani A investigated the antibacterial activity of two varieties of *Psidium guajava* (*P. guajava* berry, *P. guajava* variegata) by disc diffusion method against clinically isolated human cariogenic pathogen (*Streptococcus mutans*). Among the two varieties, *P. guajava* berry showed potential inhibitory action than *P. guajava* variegata against *S. mutans*. The study showed that the active compounds present in these two varieties could serve as a lead compound in the formulation of a new antibacterial herbal drug to cure dental caries.²⁶ In an in vitro study the ethanolic and water extract of guava leaves at various concentrations against *Lactobacillus acidophilus* was evaluated and found that Ethanolic and water extracts of guava leaves possessed antibacterial activity against *L. acidophilus* with 20% ethanolic extract

being as efficacious as 0.2% chlorhexidine. In another study the antibacterial activity of guava leaves extracts were evaluated against *S. Mutans* which showed better results.²⁷

The inhibitory activities of Aloe vera gel on *Streptococcus mutans* were investigated by Fani et al using the disc diffusion and microdilution methods. They found *S. mutans* species to be most sensitive to Aloe vera gel at optimum concentration (MIC of 12.5 µg/ml).² Barandozi FN in 2013 identified that among the three solvents of Aloe vera leaves extract, maximum antibacterial activity was observed with acetone extracts.¹⁷ Besides methanolic extracts of *Aloe barbadensis* miller inner leaf gel had the broadest antibacterial activity, being capable of inhibiting growth of both gram-positive and gram-negative bacteria.²⁸

A study determined the in vitro inhibitory activity of aqueous green tea extract on some clinically isolated cariogenic bacteria. Standard techniques of agar disc diffusion and broth microdilution assays were applied for qualitative and quantitative determination of its antibacterial activity. It was sensitive to all clinical isolates of *Streptococcus mutans* with minimal inhibitory concentration of 3.28 ± 0.7 mg/ml.²⁹ Tehrani et al compared the effect of sodium fluoride and green tea mouth rinses on the level of *Streptococcus mutans* and *Lactobacillus* in 60 children aged 8-12 year old. Subjects were instructed to rinse their mouth with 0.05% sodium fluoride mouth rinse or 0.5% green tea mouth rinse, twice a day for 2 weeks. Before intervention and after 2 weeks, salivary levels of bacteria were measured. No significant differences in the average number of bacterial colonies before and after intervention in both groups. But significant difference between the mean number of bacterial colonies, before and after intervention, in each group were seen. Green tea mouth rinse resulted in significant reduction in colony number of salivary *S. mutans* and *Lactobacillus* comparable to sodium fluoride mouth rinse. It was concluded that due to fewer side effects, it seems that green tea could be tried with less concern.³⁰ The effect of aqueous and organic extracts of three types of tea (green, oolong, and black tea), on the growth of *S. mutans* were determined by Subramanian et al. They found the phytochemical content to be

higher in oolong tea. Both aqueous and organic extracts of oolong tea showed greatest zones of inhibition, followed by green tea and black tea. In addition, aqueous extracts of oolong and green tea showed greater zone of inhibition than chlorhexidine. Thus all the three types of tea inhibited growth of *S. mutans*.¹⁹

In a study, the efficacy of alcoholic extracts of Pudina (Mint) on *Streptococcus mutans* was evaluated. At 50% concentration of Pudina methanolic extract, a zone of inhibition of 10 mm was obtained. This was widest zone of inhibition observed among all three different concentrations of Pudina that were investigated, thus confirming its antimicrobial property against *Streptococcus mutans*.²⁰ In other study, the salivary and tongue coating pH on chewing 5-6 fresh leaves of Pudina, Tulsi, and Curry leaf twice daily for 7 days was estimated. It was found that chewing the herbal leaves in all groups increased the pH immediately and 30 min after their use.³¹

Combination of leaf extracts

Natural herbs like triphala, tulsi patra, jyestiamadh, neem, clove oil, pudina, ajwain and many more used either as a whole single herb or in combination have proven to be safe and effective against various oral health problems. Mehta S et al compared the efficacy of a commercially available homeopathic mouthwash Freshol (staphysagria, chamomilla, Echinacea, plantago, ocimum, and cistus) with chlorhexidine on plaque status, gingival status, and salivary *S. mutans* count in 55 children, aged 8-14 years. Freshol was found to be better than chlorhexidine in reducing the salivary mutans streptococci count. It has been postulated that the superior antistreptococcal effect seen in the test mouthwash could be due to the presence of Echinacea and ocimum which accelerates granulation and regeneration of the tissue due to the presence of methyl ester of salicylic acid.³² In another study, Herboral (triphala, khadir chaal, bakul chaal, tulsi patra, jyestiamadh, maypal, neem paan, clove oil, pudina and ajwain ke phool) in comparison with chlorhexidine proved to be an effective anti-plaque agent. Herboral was preferred by the study subjects for its taste, convenience of use, taste duration (after taste) in

their mouth after rinsing, which might be attributed to the presence of natural herbs like tulsi and pudina.³³

CONCLUSION

There has been a change in global awareness, with a growing tendency to 'go natural' and due to the side effects of conventional mouthwashes towards caries prevention. Herbal products have been gaining much importance. Thus we had made an attempt to outline commonly available herbal leaves which can be used effectively as dental therapeutic agents. With further research in this field, we would get much safer alternatives for caries prevention in children.

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