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Review article

Antimicrobial activity of medicinal plant for oral health and hygiene

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ABSTRACT

A mouth rinse is a chemotherapeutic agent used as an effective home care remedy to enhance oral hygiene and prevent dental caries by targeting the cariogenic bacteria. The usage of antimicrobial herbal products in dentistry has been well documented in prevention of dental infection. In spite of various commercially available antimicrobial agents, the search for an effective herbal antimicrobial mouth wash still continues. Chemical drugs have unpleasant side effects and causing drug resistant microorganisms. On the other hand, herbal mouthwashes have fewer side effects and are more economic than similar chemical drugs. Researchers are trying to pay more attention to herbal drugs. The use of mouthwash has increased because of attention to oral hygiene. In the last decades a plenty of research has been done to evaluate antimicrobial effect of herbs and medicinal plant for maintaining oral hygiene. The review is addressed to accumulate data on plants having in vitro and in vivo antimicrobial effects against pathogens associated with oral diseases. The review will help clinician and researcher to search and select the plant for developing effective medication for maintaining cost effective oral care.

Key words: Antimicrobial activity, medicinal plants, oral microbes

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INTRODUCTION

Oral health is integral to general well-being and relates to the quality of life that extends beyond the functions of the craniofacial complex. The link between oral diseases and the activities of microbial species that form part of the microbiota of the oral cavity is well established (Jenkinson and Lamont, 2005). Over 750 species of bacteria inhabit the oral cavity (50% of which are yet to be identified) and a number of these are implicated in oral diseases (Jenkinson and Lamont, 2005). The global need for alternative prevention and treatment options and products for oral diseases that are safe, effective and economical comes from the rise in disease incidence (particularly in developing countries), increased resistance by pathogenic bacteria to currently used antibiotics and chemotherapeutics, opportunistic infections in immune-compromised individuals and financial considerations in developing countries (Tichy and Novak, 1998; Badria and Zidan, 2005).

In spite of the tremendous progress in the development of medical science, plants continue to be an important source of drugs in many countries around the world. During past two decades reliability and usage of herbal product has become of increasing importance, due to the side effects and complications of many chemical and synthetic medicines. Though chlorhexidine was found to be more effective on aerobic and anaerobic micro-organisms, well documented side effects of chlorhexidine like tooth staining, taste alteration, and development of resistant micro-organisms, limits its use especially in children (Malhotra et

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al., 2011). Therefore, herbal mouth rinse can be considered as a potential plaque inhibitor and can serve as an alternative in patients with special health care needs (Subramaniam and Gupta, 2013).

About 25 % of drugs are derived from plants and many other are formed from prototype compounds isolated from plant species (Kala et al., 2006). Kanwar et al. (2006) reported that about two million traditional health practitioners use over 7500 medicinal plant species. Herbal medicine is both promotive and preventive in its approach. It is a comprehensive system, which uses various remedies derived from plants and their extracts to treat disorders and to maintain good health. The major strength of these natural herbs is that their use has not been reported with any side-effects till date (Malhotra et al., 2011). A number of herbs and medicinal plants have been found to be evaluated against oral microbes in vitro. Some of the plant extracts showed promising antimicrobial effects both in vitro and in vivo. The aims of the review are to accumulate the data of plant and plant product having antimicrobial effect against oral flora. The review will help the interested researcher to find and select the effective medicinal plants for development of cost effective, reliable and efficient drugs for maintaining oral health and hygiene.

ANTIMICROBIAL EFFECTS OF PLANTS AGAINST ORAL MICROBES

Azadirachta indica

Azadirachta indica commonly known as Neem is an evergreen tree, cultivated in several parts of the Indian subcontinent. Pre-treatment of *Streptococcus sanguis* with Neem extract resulted in the significant inhibition of bacterial adhesion to saliva-conditioned hydroxyapatite, a composite of bone and enamel. Neem extract also inhibited insoluble glucan synthesis, suggesting that Neem has the ability to reduce the adherence of streptococci to tooth surfaces (Wolinsky et al., 1996). Neem extract produced the maximum zone of inhibition on *Streptococcus mutans* at 50% concentration (Prashanth et al., 2007).

In an in vivo study the neem mouthwash against salivary levels of *Streptococcus mutans* and *Lactobacillus acidophilus* has been tested over a period of 2 months. It is observed that *Streptococcus mutans* was inhibited by Neem mouthwashes, with or without alcohol. Neem has been proved to be effective against *Enterococcus faecalis and Candida albicans*. Its antioxidant and antimicrobial properties makes it a potential agent for root canal irrigation as an alternative to sodium hypochlorite (Vanka et al., 2001).

Allium sativum

Allium sativum, commonly known as garlic, is a species in the onion genus, Allium. Aqueous extracts of garlic has antibacterial effects against a wide range of Gram-positive organisms, Gram-negative organisms, fungi (Amin et al., 2012) including multidrug-resistant enterotoxic genetic strains of *Escherichia coli* (Ankri and Mirelman, 1999) hence used for management of dental infections like periodontitis (Bakri and Dowglas, 2005). Garlic juice has shown impressive inhibition of *Streptococcus mutans* (Xavier and Vijayalakshmi, 2007) isolated from human carious teeth (Fani et al. 2007) considering that this microorganism is resistant to antibacterial agents such as penicillin, amoxicillin, tetracycline and erythromycin. Sasaki et al. (1999) detected the antibacterial activity of garlic and showed that the usage of fresh garlic powder was more effective than old garlic powder.

Despite the antibacterial effects of garlic extract, side effects such as unpleasant taste, halitosis and nausea were reported (Groppo et al., 2007). However, the efficacy of garlic juice was higher than chlorhexidine against target bacteria and could be used as an effective mouthwash. A mouth wash containing 10% garlic in quarter Ringer solution produced a drastic reduction in the number of oral bacteria (Elnima et al., 1983).

Piper betle

The betel (*Piper betle*) is the leaf of a vine belonging to the Piperaceae family. Crude aqueous extract of *Piper betle* exhibited reduced effect towards the growth, adhering ability, glucosyltransferase activity against *Streptococcus*

mutans (Nalina and Rahim, 2007). In another study following exposure of the bacteria to *Piper betle* extracts showed profound ultra-structural changes to their morphology. With respect to the dental plaque, the suppression of bacterial growth may slow down the process of plaque formation and minimize the accumulation of plaque on the tooth surface. Thus, the incorporation of either *P. betle* extract in a mouth rinse formulation may be considered for use in oral plaque control.

Rosemary and Cinnamon

Rosmarinus officinalis, commonly known as rosemary, is a woody, perennial herb with fragrant, native to the Mediterranean region. Rosemary had antimicrobial activity against *Streptococcus mutans* (Nalina and Rahim, 2007). Its antimicrobial potentiality was higher than chlorhexidine mouthrinse (Dalirsani et al., 2011). More studies are suggested for production of herbal mouthwashes. In Bozin et al. (2007) study the essential oils of rosemary and sage showed antimicrobial activity against some bacteria. According to Vanka et al. (2001) study cinnamon, barberry, chamomile, sage and rosemary extracts had strong antimicrobial activity toward the *Arcobacter butzleri* strains tested. Cinnamon water possesses profound activity against *Pseudomonas aeruginos* (Ibrahim and Ogunmodede, 1991). In another study, mixed extracts were prepared from Chinese chive, cinnamon, and *Corni fructus*, which exhibited antimicrobial activity against *Escherichia coli*. These extracts had excellent stability to heat, pH, and storage (Mau et al., 2001). Weseler et al. (2005) found that chamomile inhibited *Helicobacter pylori* growth. Another study demonstrated that chamomile has moderate antimicrobial activities (McKay and Blumberg, 2006).

Syzygium aromaticum

Syzygium aromaticum commonly known as clove, are native to Indonesia and used as a spice in cuisines all over the world. Clove oil is commonly used for the relief of toothache. In dentistry, clove oil is applied in an undiluted form using a plug of cotton wool soaked in the oil and applied to the cavity of the tooth. Cai and Wu (1996) reported preferential activity of crude methanolic extract of clove against Gram-negative anaerobic oral pathogens which cause periodontal diseases. The authors reported kaempferol and myricetin to have significant growth inhibitory effect against periodontal pathogens. The clove and clove bud oil have a potent antimicrobial activity against five dental caries causing microorganisms namely *Streptococcus mutans*, *Staphylococcus aureus*, *Lactobacillus acidophilus* (bacteria), *Candida albicans* and *Saccharomyces cerevisiae* (yeast). The authors suggest that clove and clove oil can be used as an antimicrobial agent to cure dental caries.

Juglans regia

Juglans regia, the Persian walnut, English walnut, is native to the mountain ranges of central Asia, Europe and America. The efficacy of the plant extracts (acetone and aqueous) has been assessed by testing on salivary samples of patients suffering from dental carries (Deshpande et al., 2011). Antimicrobial assay was carried out using disc diffusion method. Acetone extract was found to be more effective as anti-cariogenic medicine.

Myristica fragrans

Myristica fragrans is an evergreen tree indigenous to the Moluccas (or Spice Islands) of Indonesia. Ethanol extracts in *Myristica fragrans* exhibited good antibacterial property against both gram-positive *Streptococcus mutans*, *Streptococcus salivarius* and Gram-negative periodontopathic bacteria *Aggregatibacter actinomycetemcomitans*, *Porphyromonas gingivalis* and *Fusobacterium nucleatum* (Jaiswal et al., 2009).

Mimusops elengi

Mimusops elengi is a medium-sized evergreen tree found in tropical forests in south Asia, Southeast Asia and northern Australia. English common names include Spanish cherry, maulsari in Hindi, bakul in Sanskrit, Marathi, Bengali, Bokul in Assamese. The bark extract of *Mimusops elengi* was screened for antimicrobial activity against salivary micro flora collected from children of 6-12 years of age. The results confirmed the antimicrobial potential of the plant and indicated that the acetone extract can be used in the

treatment of infectious diseases caused by salivary micro flora (Deshpande et al, 2010).

Punica granatum

Punica granatum Linn. is a shrub or small tree native to Asia. The antibiotic activity of the extract of *Punica granatum* is associated to tannin phyto constituents and alkaloids found in leaves, roots, stem and fruits (Silva et al., 2008); there is a growing interest in using tannins as antimicrobial agents in caries prevention (Scalbert, 1991). The antimicrobial activity of *Punica granatum* has been widely investigated (Menezes et al., 2006; Pereira et al., 2006; Vasconcelos et al., 2003). Ethanolic, water, methanolic and acetone extract of *Punica granatum* showed strong antimicrobial activity in different investigations done on both gram-positive and gram-negative non-oral bacteria (Haghighati et al., 2003; Machado Thelma et al., 2002; Silva et al., 2008; Reddy et al., 2007). Kakiuchi et al. (1986) and Pereira et al. (2006) examined a gel derived from *Punica granatum*, the glucan synthesis and its antimicrobial action gave this gel an effective control of the already formed biofilm. Hydro alcoholic extract from *Punica granatum* fruits showed very effective activity against dental plaque microorganisms in an in vivo study done by Menezes et al. (2006).

Emblica officinalis

Emblica officinalis is commonly called by several names such as amalaka, oval, amla, amlaki and Indian gooseberry. It consists of the following constituents such as phenols, tannins, polyphenols, flavonoids, kaempferol, ellagic acid and gallic acid (Nair and Chanda, 2006). They have the potential to prevent dental caries by inhibiting the virulence factors of *Streptococcus mutans* and *Lactobacillus* (Hasan et al., 2012). The antibacterial efficiency of amla was found higher than the chlorhexidine and more effective mouthwash.

Terminalia chebula

Terminalia chebula is a medicinal plant known as *Kadukka* in Tamil. The chief constituents are hydrolysable tannins (13%) such as gallic acid, chebulic acid, chebulagic acid and corilagin (Han et al., 2006). These acids are found to have antibacterial activity against cariogenic bacteria (Aneja and Joshi, 2009). It is proved that *Terminalia chebula* as an effective anticaries mouthwash (Carounanidy et al., 2007). The aqueous extract of *Terminalia.chebula* strongly inhibits the growth, sucrose induced adherence and glucan induced aggregation of *Streptococcus mutans* (Jagtap and Karkera, 1999; Nayak et al., 2010). The aqueous extract *Terminalia chebula* was more effective as a mouth rinse, but with less time of action than chlorhexidine.

Triphala

This is an ayurvedic rasayana consisting of Amulaki (*Emblica officinalis*), Bibhitaki (*Terminalia bellirica*) and Halituki (*Terminalia chebula*) is rich in citric acid, which may aid in removal of smear layer thereby acting as chelating agent and also found to be alternative to sodium hypochlorite for root canal irrigation (Prabhakar et al., 2010). The 0.6% Triphala (*Terminalia chebula* and *Emblica officinalis* combination) and 0.1% chlorhexidine had been shown to have an inhibitory effect on plaque, gingivitis and growth of *Streptococcus mutans* and *Lactobacillus* (Srinagesh and Pushpanjali, 2011; Bajaj and Tandon, 2011). Similar results observed by Hegde et al. (2011) with 67.8% and 71.7% reduction of *Streptococcus mutans* and *Lactobacillus* respectively, at the same time, chlorhexidine was less effective against Lactobacilli than *Emblica officinalis* and *Terminalia chebula*. Thus, Triphala can be suggested for management of dentinal caries as their action on *Lactobacillus* is more than chlorhexidine. However, Triphala can be used as a mouthwash for a longer period of time, without any side effects (Hegde et al., 2011).

Baccharis dracunculifolia

Baccharis dracunculifolia DC (Asteraceae), popularly known as "alecrim-do-campo," is largely distributed in South America, possess biological activities, such as antimicrobial and antivirus activities. *Baccharis dracunculifolia* had the same efficiency of the materials used to oral hygiene in reduction of dental plaque and, consequently, prevention of dental caries. Thus, it can be considered *Baccharis dracunculifolia* as a

good candidate for new material to be implemented in dental care (Pedrazzi et al., 2014).

Salvadora persica

The *Salvadora persica* tree drives its Persian name, Darakht-e-Miswak or tooth brush tree. South of Iran, next to Persian Gulf, is the main growing area of this plant. *Salvadora persica* is a medical plant whose roots, twigs or stems have been used over centuries as oral hygiene tools in many parts of the world (Al-Sabawi et al., 2007) and has been reported to have many pharmaceutical effects such as anti plaque, anti caries, anti-inflammatory and antiviral properties (Darout et al., 2000), even more, low dental caries among miswak users has been reported in epidemiological studies (Almas and Al-Zeid, 2004). It was shown in different in vitro and in vivo studies that alcoholic and aqueous extracts of *Salvadora persica* against different aerobic and anaerobic bacteria like *Streptococcus mutans* and *Emblica corrodens* had showed strong antimicrobial activity (Abdeirahman et al., 2002; Poureslami et al., 2007; Al-Bayati et al., 2008; Darout et al., 2008). The in vivo studies showed that using miswak, miswak extract and persica mouth wash reduced salivary bacteria count and resulted in improved gingival health and lower carriage rate (Almas and Al-Zeid, 2004; Khalessi et al., 2004). Results of some studies reported low to moderate antimicrobial activity for *Salvadora persica* ethanolic and water extracts (1999; Al-Latif and Ababneh, 1995; Sofrata et al., 2008) and showed the miswak pieces embedded in agar or suspended in the air above the agar plate clearly demonstrated much stronger inhibitory effects than the aqueous miswak extract (Sofrata et al., 2008), in addition, Al-Sabawi et al. (2007) showed that inhibitory effect of ethanolic extract of *Salvadora persica* is not significantly less than 0.2% chlorhexidine.

Clinical trials have shown that regular use of chewing stick of *Salvadora persica* reduces plaque. The Arabian researchers concluded from a comprehensive survey of several thousands of Saudi school children that the low incidence of gingival inflammation was attributable to the practice of using miswak for teeth cleaning (Gazi et al 1992). In vitro studies indicate that, of a variety of common oral bacteria, members of the genus *Streptococcus* (including the mutans streptococci) are especially sensitive to the antimicrobial activities of *Salvadora persica* (Al-Lafi and Ababneh 1995). A study showed that the risk of dental caries for each tooth in the control group was 9.35 times more than the case group (Aldini and Ardakani 2007). The use of persica mouthwash improves gingival health and lower carriage rate of cariogenic bacteria when compared with the pretreatment values (Khalessi et al 2004). Scientific evaluation of use of miswak revealed that it is at least as effective as tooth brushing for reducing plaque and gingivitis and that the antimicrobial effect of *Salvadora persica* is beneficial for prevention/treatment of periodontal diseases (Al- Otaibi 2004).

The miswak has an immediate antimicrobial effect and *Streptococcus mutans* were more susceptible to miswak antimicrobial activity than lactobacilli (Almas and Al-Zeid 2004). It seems persica mouthwash doesn`t have any side effects. Results of a study have shown the mouthwash significantly lowers the gingival index, plaque index, and bleeding index in case group without any reported side effects (Kaur et al 2004). Miswak extract can be used in mouth rinses and toothpastes for control dental plaque and caries (Poureslami, 2007).

Sanguinaria canadensis

Sanguinaria canadensis or bloodroot is a perennial, herbaceous flowering plant native to eastern North America and Canada. Several clinical studies have been carried out into its effects. A sanguinarine mouth rinse and toothpaste regime given for 6 months during orthodontic treatment reduced plaque by 57% and gingival inflammation by 60% compared with figures of 27% and 21% for the placebo control group. It has also been shown that sanguinarine at a concentration of 16 microgram per milliliter completely inhibited 98% of microbial isolates from human dental plaque and that sanguinarine and zinc act synergistically in suppressing the growth of various oral strains of streptococci (Eley, 1999).

Quercus infectoria

Quercus infectoria (Fabaceae) is a small tree, the galls arise on young branches of this tree as a result of attack by the gall-wasp, Adleria gallae-tinctoria. The plant is known as Mayaphal and Majufal in Hindi. *Quercus infectoria* gall extract has the potential to generate herbal metabolites. The crude extracts demonstrating anti-dental caries activity could result in the discovery of new chemical classes of antibiotics (Vermani and Navneet 2009).

Nidus vespae

Nidus vespae is widely distributed in China and is typically harvested in the autumn and winter seasons and dried in the open air, after removal of dead wasps. The well-known pharmacopoeia of traditional Chinese medicine also lists the use of *Nidus vespae* for toothaches, through tooth brushing. A study showed significant inhabitation of glucosyltransferases activity and biofilm formation by *Nidus vespa* extract. The researchers concluded it to be a promising natural product for the prevention of dental caries. *Nidus vespa* have been extensively used in traditional Chinese medicine, given their multiple pharmacological activities, including antimicrobial, anti-inflammatory, anti-virus and anesthetic properties (Xiao et al., 2007).

Cratoxylum formosum

The gum of *Cratoxylum formosum*, commonly known as mempat, is a natural agent that has been used extensively for caries prevention by hill tribe people residing in Thailand. A research showed *Cratoxylum formosum* gum has high antimicrobial activity against *Streptococcus mutans* and may become a promising herbal varnish against caries (Suddhasthira et al. 2006).

Acacia

Acacia catechu

Acacia catechu Willd. (Family: Fabaceae and subfamily: Mimosoideae.) is widely used in Ayurveda for many diseases. *Acacia catechu* heartwood extract is found to be an effective antibacterial agent. A study conducted in ethanolic and aqueous heartwood extract of *Acacia catechu*, proved its efficacy as a potent anti bacterial agent. *Acacia catechu* heartwood extract on dental caries causing microbes and organism associated with endodontic infections like *Streptococcus mutans*, *Streptococcus salivarius*, *Lactobacillus acidophilus* and *Enterococcus faecalis* using disc diffusion method (Geetha et al., 2011).

A clinical study on this herbal dentifrice, reported 87-95%, 70-72% and 80-95% reductions in plaque, gingivitis and dental calculus respectively, in about 15 days of treatment (Kumar et al., 2009). Antimicrobial testing demonstrated excellent results with the petroleum ether extract against *Pseudomonas aeruginosa* (10 µg/mL), followed by the aqueous extract against *Bacillus subtilis* (20 µg/ml) and the chloroform extract against *Staphylococcus aureus* (30 µg/mL) (Patel et al., 2009). Ethanolic extract was found to possess the broadest and potent antimicrobial activity (Gulzar et al., 2010). Hence, with all these literature review *Acacia catechu* wild is proved to be a potent antimicrobial agent against dental infections like dental caries caused primarily by *Streptococcus mutans*.

Acacia Arabica

This evergreen tree is commonly found in dry forest areas. In a clinical trial with Gumtone (a commercially available gel containing *Acacia Arabica*) showed significant clinical improvement in gingival and plaque index scores as compared to a placebo gel. Gumtone gel was not associated with any discoloration of teeth or unpleasant taste (Pradeep et al 2010).

Cichorium intybus

Common chicory, *Cichorium intybus*, is a somewhat woody that commonly found in Europe, North America and Australia. In an in vitro study a greater anti-plaque effect was observed in all toothpastes containing chicory extract in comparison to the same toothpastes without extract. In another study, bacteria in plaque samples showed high sensitivity to chloramphenicol and streptomycin, and their sensitivity to chicory extract was between the sensitivity to chloramphenicol and streptomycin (Patel and Venkatakrishna-Bhatt, 1983).

Prunella vulgaris and *Macleya cordata*

The extract of *Prunella vulgaris* L. (Labiatae) showed marked cytoprotective, antioxidant/radical scavenging, antiviral and anti-inflammatory effects both in vitro and in vivo (Adamkova et al., 2004). In a clinical trial *Prunella vulgaris* and *Macleya cordata* found effective in reducing plaque and symptoms of gingivitis.

Chitosan plus herbal extracts

Chitosan, an abundant natural polymer, is obtained by alkaline N-deacetylation of chitin. Chitosan nanoparticles have found as drug carriers. In a study a chitosan-based poly herbal toothpaste significantly reduced the plaque index by 70.47% and bacterial count by 85.29% (Mohire and Yadav 2010).

Trigonella foenum-graecum

Trigonella foenum-graecum seeds (Billaud, 2001) and leaves (Sharma et al., 1996) are used as an ingredient in traditional medicine and have been reported to exhibit pharmacological properties which have different therapeutic effects, for example Saponins and Fenugreekine of its seeds introduced as antiinflammatory, antiviral and antimicrobial elements of the plant (IHP, 2002). In our study, *Trigonella foenum-graecum* extract was one of the strongest antibacterial extracts with inhibition zones between 0 to 18 mm. No report was found about the effect of *Trigonella foenum-graecum* on oral bacteria. It was shown that *Trigonella foenum-graecum* extract had a strong and broad spectrum antimicrobial activity (Shahidi, 2004), which was in lined with our study. On the other hand Alzoreky et al. (2003) reported that *Trigonella foenum-graecum* was not active against any strains at tested concentrations.

Saussurea lappa

Saussurea lappa is traditionally used in the treatment of halitosis, dental caries and periodontal disease. An ethanolic extract of the roots of *Saussurea lappa*, at a concentration of 1 mg/ml, inhibited the growth of *Streptococcus mutans;* the acid production; as well as lowered the adherence of *Streptococcus mutans*. It also inhibited the formation of water-insoluble glucan by *Streptococcus mutans,* an essential component of biofilm formation (Yu et al., 2007).

Myristica fragrans

Myristica fragrans, known as 'nutmeg', has a wide variety of uses, including being anti-inflammatory and anti-fungal. Macelignan, an isolated compound from *Myristica fragrans,* exhibited an inhibitory activity of 3.9 µg/ml against *Streptococcus mutans.* Macelignan also showed preferential activity against *Streptococcus salivarius, Streptococcus sobrinus, Streptococcus sanguis, Lactobacillus acidophilus* and *Lactobacillus casei* with an MIC range of 2-31.3 µg/ml (Chung et al., 2006).

Melaphis chinensis

Melaphis chinensis (Chinese nutgall) extracts are rich in gallotannins. These extracts have anti-adherence properties as well as the ability to inhibit insoluble glucan production among streptococci. A high-molecular weight constituent, isolated from *Vaccinium macrocarpon* (cranberry juice), reduced and even reversed bacterial co-aggregation of *Fusobacterium nucleatum, Actinomyces naeslundii* and *Escherichia coli* in dental biofilms and reduced the enzymatic activity of glucosyltransferase within the biofilm (Nowack and Schmitt, 2008). A clinical trial showed a significant reduction of *Streptococcus mutans*. *Vaccinium macrocarpon* macromolecules have been shown to halt lipopolysaccharide, as well as induced the bacterial production of pro-inflammatory cytokines and proteolytic enzymes by *Porphyromonas gingivalis, Tannerella forsythia* and *Treponema denticola*, thereby aiding in the reduction of periodontal diseases (Nowack and Schmitt, 2008).

Tea tree oil

Melaleuca alternifolia, a tree indigenous to Australia, produces an essential oil that is more commonly known as tea tree oil (TTO). In the 1930's TTO was already recognized as having potential in oral hygiene (Carson and Riley, 1993). Tea tree oil has approximately 100 components

and has shown broad-spectrum antimicrobial and anti-inflammatory properties in vitro (Hammer et al., 2003).

Scientific evidence has now indicated that a wide variety of oral bacteria are susceptible to TTO (Hammer et al., 2003). The anti-adhesion capability of TTO has also been determined using *Streptococcus mutans*. Melafresh T-96, is a toothpaste produced by the Australian company Southern Cross Botanicals, which incorporates TTO into the formula at a concentration of 0.2%. Even after loss of activity during manufacturing it still possess a high potency and a broad spectrum of antibacterial activity of Gram-positive and Gram-negative organisms (Bolel, 2009). The tea tree oil group showed antimicrobial activity against *Streptococcus mutans* (Groppo et al., 2002). Tea tree oil is also used as root canal irrigant, but less effective compared to EDTA and NaOCl (Sader et al., 2006). Cumulative evidence suggests that tea tree oil can be used as an alternative to chlorhexidine.

Peppermint essential oil

Evidence that four *Mentha piperita* essential oils from various sources, and its components, menthol and methone are active against *Staphylococcus aureus, Staphylococcus epidermis, Klebsiella pneumoniae, Escherichia coli* and *Candida albicans,* was found. Similar observation was found by Işcan, et al., (2002).

Herbal Mouthwash and Herbal Mixture

Various mouthwashes are commercially used in different countries. Herbal mouthwash containing Pilu (*Salvadora persica*), Bibhitaka (*Terminalia bellirica*), Nagavalli, Gandhapura taila, Ela (Cardamomum), *Peppermint satva*, and *Yavani satva* are used in treatment of gingivitis as an adjunct to scaling. Studies showed that usage of herbal mouthwashes such as turmeric (Waghmare et al., 2011), neem (Chatterjee et al., 2011) and triphala (Anupama et al., 2010) compared to chlorhexidine showed a significant reduction in plaque indices scores, gingival indices scores, and gingival bleeding index scores as in the present study with a value of plaque index (PI) <0.0001, gingival index (GI) <0.0014 and gingival bleeding index (GBI) <0.0001.

The crude herbal mixture composed of (10% *Qurecus aegilops* L. (ground of oak bark), 20% *Salvadora persica* L.(ground of miswak), 20% *Cinnamomum zeilanicum* (ground of Cinnamon bark), 10% *Mentha spicata* L. (leaves of mint), 5% *Syzygium aromaticum* (dried flower buds of clove), 30% glycerin oil and 5% *Matricaria chamomilla* L. (flowers of camomile) was found to possess strong antibacterial activity against range of studied bacteria including *Streptococcus mutans, Staphylococcus aureus, Staphylococcus epidermidis, Micrococcus* and *Lactobacillus* isolated from seventy oral infection samples. The crude herbal mixture can be used as tooth paste component (Al-Taee et al., 2012). It is indicate that polyherbal mouthwash holds promise in improving the oral hygiene in healthy individuals and help in preventing dental caries and gingivitis through plaque control (Atul et al., 2011).

CONCLUSION

Based on the search online it is observed that few studies have been done on antimicrobial effects of medical plants against oral pathogens. More studies are needed to see the effect of herbal extracts on other oral bacteria that have cariogenic activity. Because of the antimicrobial effects of some medical plants, which have minimal side effects in comparison with chemical drugs, more in vivo and in vitro investigations about oral cavity flora should be recommended. It is suggested that more research should be carried out to find plants with antimicrobial activity for producing herbal mouthwashes.

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