

MEDICINAL PLANTS AS ALTERNATIVE TREATMENTS FOR ORAL HEALTH PROBLEMS

ISHFAQ KHAN, AZHAR KHAN*

Molecular and Immuno-parasitology Research Laboratory, Faculty of Applied Sciences and Biotechnology, Shoolini University,
Solan - 173 212, Himachal Pradesh, India. *Email: mk.azhar1@gmail.com

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ABSTRACT

Oral flora plays an important role in the day-to-day life for human beings and also they are important part of human digestive system. Simultaneously, besides their beneficial activities, they can be harmful to the human, and this can be evaluated as normal oral flora as opportunistic pathogens. To elevate oral sanitation, medicinal plant-based mouthwash can be used as mediator and acts as a part of efficient home care medication. In dentistry, the importance of plants has been acknowledged to cure diseases generated by several oral pathogens. Chemical drugs possess many side effects and act as a key factor responsible for developing drug-resistant microorganisms. Herbal mouthwash products have fewer side effects than chemical drugs. The worldwide requirement for substitutive prevention, treatment choices, and products for oral infections that are harmless, efficient, and low cost comes from the boost in infection occurrence. For maintaining oral sanitation, ample research has been attempted to calculate the effect of plants. The review has established to aggregate the data on herbs and plants which possess great response to the pathogens concerned with oral infections. The review will assist the researchers to discover and choose the plant to develop adequate medicine for establishing cost-effective treatment for oral hygiene.

Keywords: Oral sanitation, Antimicrobial activity, Dental biofilm.

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INTRODUCTION

Oral sanitation is important to universal well-being and depicts the feature of life. The connection of oral infection and microbial activities by numerous species of microorganisms as a part of microflora of the dental cavity is well recognized [1]. More than 750 bacterial species occupy the dental cavity, of which 50% are unknown and many of these species are involved in oral infection [1]. The worldwide requirement for substitutive prevention, treatment choices, and products for oral infections that are harmless, efficient, and low cost comes from the boost in infection occurrence usually in developing countries and rises in multidrug resistance by several pathogenic microorganisms to antibiotics and several drugs [2,3]. Despite advancement in the medical sciences, plants are still thought to be a vital source of different drugs in various regions around the globe [4]. Dependability and practice of herbal product have become vital because of side effects such as tooth discoloration, change in taste, and formation of resistant microbes restricted its use particularly in children. Hence, herbal mouthwash is thought to be possible biofilm (plaque) reducer and can serve as a substitute in patients with unique health requirements [5]. At least 25% of medicines are obtained from various plants, and numerous others are extracted from prototype components isolated from many species of plants [6]. Two million classical health professionals use more than 7500 species of plants which have medicinal value [7]. The medicine from plants is contributive and defensive in its approach. The World Health Organization in 2007 reported that community health expenditure specific to dental care was 5–10%. Tooth decay and oral infection treatment are probably very expensive that people have to struggle with for lifetime [8]. Natural plant products are used even to correct numerous oral infections. In Burkina Faso, West Africa, more than 62 species of plants belong to 29 families documented to cure oral infections. It is supposed that quarter of recommended medicine contains constituents taken from the plants in industrialized countries [9]. Biofilms are gathering of bacteria which are fixed in an extracellular matrix of polymeric compounds [10]. To cure many human ailments, suffering plants were used, and knowledge about these plants is widespread in India. Ayurveda, Siddha, Unani, and Amici served the humanity for a long time. These conventional systems are

alive today over a large area of the world. About 80% of people from progressing countries rely on this system to cure human diseases. Dental plaque (biofilm) is the main cause of infection. The biofilm composition changes rely on the system. The important constituents are generally bacterial cells, water, and exopolysaccharides [11]. Asian countries have used traditional medicine to correct much oral disease for more than 2000 years [12].

MEDICINAL PLANTS AGAINST ORAL PATHOGENS

Azadirachta indica

A. indica is generally known as Neem. *Streptococcus sanguis* subjected to pre-treatment with extract of neem showed a considerable reduction of bacterial union to saliva conditioned hydroxy apatite, which is a complex of enamel and bone. Insoluble glucan synthesis was also repressed with neem extracts, indicating that neem can reduce the attachment of *Streptococcus* on tooth surface [13]. Neem extract formed the maximum inhibition zone on *Streptococcus mutans* at 50% concentration [14]. The effect of neem mouth rinse toward saliva levels of *S. mutans* has been studied. It was detected that the growth of *S. mutans* was repressed with or without the introduction of alcohol. The effectiveness of neem has been seen against *Candida albicans* and *Enterococcus faecalis*. Because of antioxidant and antimicrobial properties of neem plant, this makes it probable mediator substituent for root canal irrigation over sodium hypochlorite (Table 1) [15].

Allium sativum









A. sativum is generally called as garlic belonging to genus, Allium. Aqueous extract of garlic possesses antibacterial property toward a broad variety of Gram-negative, Gram-positive bacteria [16] and enterotoxin strains of *Escherichia coli* which are resistant to different types of chemical drugs [17] for this reason used to correct oral diseases [18]. Garlic extract remarkably inhibited *S. mutans* [19] derived from dental caries of human [20] because this microorganism shows resistance to antimicrobial mediators such as tetracycline, erythromycin, amoxicillin, and erythromycin. Fresh garlic extract displayed the efficient effect than the old one [21]. Adverse effects were reported such as undesirable taste, foul breath, and vomiting [22],

Table 1: Medicinal plants used in the treatment of several diseases

S. N.	Botanical name	Common name	Medicinal properties	Part used	Pictorial representation
1.	<i>Azadirachta indica</i>	Neem	It acts as a probable mediator substituent for root canal irrigation [15]	Leaf	
2.	<i>Allium sativum</i>	Garlic	Aqueous extract of garlic possesses antibacterial property toward a broad variety of oral pathogens which are resistant to different types of chemical drugs [16]	Bulb	
3.	<i>Rosmarinus officinalis</i>	Rosemary	Essential oils obtained from its leaf indicated antibiofilm properties [26]	Leaf	
4.	<i>Cinnamomum zeylanicum</i>	Cinnamon	Essential oils obtained from it indicated antimicrobial properties toward several bacteria [26]	Root	
5.	<i>Syzygium aromaticum</i>	Clove	Clove and its bud oil have a strong effect against five dental cavities causing microorganisms such as <i>Candida albicans</i> , <i>Staphylococcus aureus</i> , <i>Lactobacillus acidophilus</i> , and <i>Saccharomyces cerevisiae</i> [31]	Leaf	
6.	<i>Juglans regia</i>	Walnut	The walnut tree has antibiofilm property because of various phytochemical constituents present in it such as phenolic compounds, alkaloids, tannins, ellagic acid, flavonoids, and steroids [35]	Stem bark	
7.	<i>Mimusops elengi</i>	Medlar	Acetone extracts can be applied to cure diseases caused by oral pathogens [37]	Stem bark	
8.	<i>Punica granatum</i>	Pomegranate	The effect of extract toward numerous oral bacteria is because of phytoconstituents such as tannins and alkaloids in leaves, fruits, root, and stem [38]	Fruit leaves root	
9.	<i>Emblica officinalis</i>	Gooseberry	They have a capability to prevent oral infections by reducing the negative factors of pathogenic microbes such as <i>Streptococcus mutans</i> [50]	Fruit	

(Contd...)

Table 1: (Continued)

S. N.	Botanical name	Common name	Medicinal properties	Part used	Pictorial representation
10.	<i>Terminalia chebula</i>	Chebolic myrobalan	The main phytochemicals of the plant are hydrolysable tannins such as chebolic acid, corilagin, chebulagic acid, and gallic acid [51]. These acids possess antimicrobial activity. These acids possess great effects toward oral pathogens	Fruit	
11.	<i>Salvadora persica</i>	Miswak	Over the centuries, the parts of this medicinal plant such as roots and stems have been used as oral sanitation substitutes in various regions of the world [56] and possess various properties anti-biofilm and anti-inflammation property [57]	Stem	
12.	<i>Sanguinaria canadensis</i>	Bloodroot	At a concentration of 16 µg/L, this plant reduced 98% of microbial population from dental biofilm of human [67]	Root stem	
13.	<i>Cratogeomys formosum</i>	Mempat	Mempat shows a great effect toward <i>Streptococcus mutans</i> and can act as a good herbal product against dental cavities [68]	Gum	
14.	<i>Acacia catechu</i>	Mimosa	The heartwood extract from <i>Acacia catechu</i> possesses an efficient effect against various microbes which cause dental cavities [69]	Stem	
15.	<i>Aloe vera</i>	Aloe	<i>Aloe vera</i> has great role in preventing oral diseases; it contains many components such as anthraquinone, glycosides, aloesins, and polysaccharides [90]	Leaf	
16.	<i>Curcuma longa</i>	Turmeric	The oil from turmeric possesses oncopreventive activity, cures numerous oral diseases, and reduces gum inflammation [81]	Tubers	
17.	<i>Melaleuca alternifolia</i>	Paperbark	Paperbark tree produces important oil known as tea tree oil. In 1930's, tea tree oil was already identified as possessing importance in oral sanitation [73], and tea tree oil contains almost 100 constituents and has revealed immense range of anti-swelling and antibacterial properties [74]	Leaf	

but the effectiveness of garlic extract was greater than chlorhexidine toward the particular bacteria and therefore can be considered as an efficient mouth rinse. Mouth rinse having 10% of garlic in a quarter Ringer solution showed an immense decrease of oral pathogenic bacteria (Table 1) [23].

Piper betle

P. betle is a vine leaf included in a family of *Piperaceae*. Aqueous extract from leaves in crude form showed decreased effect on the growth, attachment capability, and glucosyltransferase action against the *S. mutans* [24]. Nalina *et al.* also reported the effect of *P. betle* leaf extract on the ultrastructure of *S. mutans* and she concluded that this might be due to the presence of fatty acids and hydroxy fatty acid ester components present in the leaves extract. Relating to dental biofilm, the repressed growth of bacteria can hinder the biofilm on the surface of the tooth. Consequently, the introduction of this extract in mouthwash can control oral plaque (Table 1).

Rosemary and cinnamon

Rosemary officinalis is a woody herb with sweet smelling indigenous to Mediterranean area. Rosemary showed great effects against *S. mutans* [24]. Its antimicrobial activity was greater than chlorhexidine mouthwash [25]. More studies are recommended for making of herbal mouth rinse. Essential oils obtained from it indicated antimicrobial properties toward several bacteria [26]. Higher antimicrobial property was seen against the strains *Arcobacter butzleri* using extracts of cinnamon, sage, barberry, chamomile, and rosemary [15]. Aqueous extract from cinnamon acquires great antimicrobial property toward *Pseudomonas aeruginosa* [27]. When a mixture of Chinese chive, corni fructus, and cinnamon extract was formed, it possessed antimicrobial property toward *E. coli*. These extracts showed high stability toward pH and heat [28]. Chamomile reduced the number of *Helicobacter pylori* (Table 1) [29]. The extracts of chamomile have reasonable antimicrobial properties [30].

Syzygium aromaticum

S. aromaticum generally known as clove is indigenous to Indonesia which is used as a spice throughout the world. The clove oil is commonly used to cure toothache. Without any dilution, the clove oil from clove is applied to the tooth cavity using cotton plug. Methanolic extracts in crude form possessed great effect toward Gram-negative pathogen which causes gum diseases (Table 1) [31]. Kaempferol and myricetin represented an increased antimicrobial effect toward oral pathogens which can cause tooth decay. Clove and its bud oil have a strong effect against five dental cavity causing microorganisms such as *C. albicans*, *Staphylococcus aureus*, *Lactobacillus acidophilus*, and *Saccharomyces cerevisiae*. The authors recommend that clove and its oil can be used as antimicrobial mediators.

Juglans regia

The plant commonly known as walnut is a big deciduous tree which is found in Iran, Baluchistan, Himalayan regions of India, Armenia and several temperate regions [32]. Almost all the parts of this large tree like stem, bark, root, seeds, leaves and oil are used to cure several diseases [33]. Efficiency of acetone and aqueous extracts of walnut has been determined by testing these extracts on saliva samples obtained from patients who have problems related to dental cavities [34]. Using disc diffusion procedure, antimicrobial analysis was done, and the acetone extracts were depicted to be more efficient as antipathogenic medicine. The walnut tree has antimicrobial property because of various phytochemical constituents present in it such as phenolic compounds, alkaloids, tannins, ellagic acid, flavonoids, and steroids (Table 1) [35].

Myristica fragrans

M. fragrans evergreen tree mainly found in Moluccas Islands of Indonesia. The ethanolic extracts possessed excellent antimicrobial activities toward *Porphyromonas* and *Fusobacterium* (Table 1) [36].

Mimusops elengi

This is an average-sized tree which is evergreen and concentrated to Tropical forests in Asia and Australia. In general, it is called as Spanish

Cherry, Maulsari in Hindi, Bokul in Assamese, and Bakul in Bengali. The extract from the bark was examined to check its effect against the oral microbes taken from the children 6–12 years of age. The outcome verified the effect of this plant and showed that acetone extracts can be applied to cure diseases caused by oral pathogens (Table 1) [37].

Punica granatum

P. granatum is indigenous to Asia. The effect of extract toward numerous oral bacteria is because of phytoconstituents such as tannins and alkaloids in leaves, fruits, root, and stem [38]. There is growing curiosity in using tannins as antimicrobial mediators to eliminate oral pathogens responsible for many oral diseases [39]. This plant has been detected for efficiency [40-42]. The extracts from plant usually ethanolic extract, aqueous extract, methanolic extract, and acetone extract showed a high effect in several studies on numerous bacteria [38,43-45]. In another study, the gel obtained from this plant showed the positive effect by hindering the biofilm formation [41]. A study of hydroalcoholic extracts of fruits of this plant showed an efficient antimicrobial property toward dental plaque pathogens [40]. Due to its anti-inflammatory properties, it is used to correct many throat infections, cough, and fever [46]. The most important constituents present in pomegranate are flavonoids, anthocyanidins, ellagic acid, ellagitannins, flavones, estrogenic flavonols, and punonic acid. Juice, seed oil, and peel extract of pomegranate possess reduced effect on prostate cancer [47]. A study reported that extract from pomegranate was more efficient to decrease the biofilm than chemical drugs when three or more organisms were involved in biofilm formation (Table 1) [48].

Emblica officinalis

In general, it is known by different names such as amala, Indian gooseberry, oval, and amlaki. The various phytoconstituents such as phenols, flavonoids, tannins, polyphenols, ellagic acid, and gallic acid are present in this plant [49]. They have a capability to prevent oral infections by reducing the negative factors of pathogenic microbes such as *S. mutans* and *Lactobacillus*, (Table 1) [50]. The effect of amala was greater than chlorhexidine and can serve as an effective mouth rinse.

Terminalia chebula

The plant also called as kadukka. The main phytoconstituents of the plant are hydrolysable tannins such as chebulic acid, corilagin, chebulagic acid, and gallic acid [51]. These acids possess antimicrobial activity. These acids possess great effects toward oral pathogens [52]. It has been depicted that kadukka can be an efficient anticavity mouth rinse, (Table 1) [53]. The aqueous extract greatly reduced the growth and sucrose-induced attachment of *S. mutans* [54,55]. The aqueous extracts were more efficient than chlorhexidine.

Salvadora persica

This tree also called Miswak tree. Over the centuries, the parts of this medicinal plant such as roots, and stems have been used as oral sanitation substitutes in various regions of the world [56] and possess various properties anti-biofilm and anti-inflammation property [57]. Furthermore, low dental cavities have been seen among people who frequently use miswak [58]. In a study, alcoholic and aqueous extracts of this plant possessed antimicrobial properties toward various types of pathogenic microbes such as *S. mutans* and *Embllica corrodens* [59,60].

According to a study, persica mouth rinse decreases the growth of various oral pathogenic bacteria and reduced the occurrence of oral infection and gum inflammation [58,61]. In several studies, low-to-medium antimicrobial effect was reported for the ethanolic and aqueous extracts of miswak [62,63] and discovered that miswak parts fixed in an agar medium possessed very efficient effect than the aqueous extract of miswak [63]. Several researchers depicted from a study of children that the frequent use of miswak for cleaning teeth reduced the gum inflammation [64].

In vitro studies depicted that numerous bacteria as Streptococcus are particularly susceptible to antimicrobial effects possessed by miswak [62]. In a study, it was depicted that the formation of dental

cavities in control group was 9–30 times greater than the case group [65]. Various clinical studies depicted that daily use of miswak decreases the biofilm on the surface of the teeth. The gum inflammation was greatly reduced than pre-treatment group [61]. For reducing biofilm formation and swelling of gums, it was found that the use of miswak was efficient substitute for controlling oral diseases, (Table 1) [66].

S. mutans were very sensitive to antimicrobial activity possessed by miswak than Lactobacilli [58]. Mouth rinse with persica extracts seems to have no side effects. In another study, it has shown that mouth rinse with persica considerably decreases the biofilm on teeth surface and inflammation of gums without any side effects. This also controls the biofilm on teeth surfaces and cavities, and the miswak extracts can be introduced into mouth washes and tooth pastes [60].

Sanguinaria canadensis

S. canadensis generally called as bloodroot is a flowering perennial plant found in North America and Canada. Various studies were performed to know its effects on microbes. A mouthwash and toothpaste with extract of *S. canadensis* given for at least 6 months during the medical treatment decreased the dental biofilm by 57% and inflammation of gum by 60% than the control group where the effect was 27% and 21%, respectively. At a concentration of 16 µg/l, this plant reduced 98% of microbial population from dental biofilm of human and combining effect of extract from *S. canadensis* and zinc suppressed the number of different *Streptococci* found in the mouth, (Table 1) [67].

Cratoxylum formosum

The plant is generally called as Mempat. The gum obtained from Mempat is a natural mediator that has been used broadly by tribal people in Thailand to reduce dental cavities. A gum obtained from Mempat showed a great effect toward *S. mutans* and can act as a good herbal product against dental cavities (Table 1) [68].

Acacia catechu

A. catechu belonging to family Fabaceae and subfamily Mimosoideae is broadly used Ayurveda for the treatment of many diseases. The heartwood extract from *A. catechu* possesses an efficient effect against various microbes which cause dental cavities [69]. A research on this plant concluded that about 80–95% of reduction was seen in biofilm until 15 days [70]. Excellent results were shown with petroleum ether extract toward *P. aeruginosa* followed by aqueous extract against *Bacillus subtilis*, and chloroform extract showed effect toward *S. aureus* [71]. Effective and broadest antimicrobial effect was found with ethanolic extract (Table 1) [72]. Hence, acacia proved to be a great antimicrobial mediator toward oral infections which are caused mainly by *S. mutans*.

Tea tree oil

Paperbark tree produces important oil known as tea tree oil. In 1930's, tea tree oil was already identified as possessing importance in oral sanitation [73]. Tea tree oil contains almost 100 constituents and has revealed an immense range of anti-swelling and antibacterial properties [74]. A broad variety of oral microorganisms is sensitive to this oil [74]. Toothpaste such as Melafresh T-96 made by an Australian company added this oil into it with a concentration of 0.2%. It still possesses great effect against the numerous bacteria even after the loss of activity during manufacturing process (Table 1) [75]. Effect toward *S. mutans* was showed by this oil [76]. The oil can also act as root canal irrigant but not efficient than EDTA [77], and various evidences indicated that this oil can be a substitute to chlorhexidine.

Turmeric

Turmeric requires a temperature of 20–30°C. Turmeric consists of tubers whose length is 2–3 inches and having a diameter of one inch. Due to its antibacterial properties, it is used to eliminate dental diseases [78,79]. Phytoconstituents in turmeric are diferuloylmethane and many volatile oils including atlantone. In Ayurveda, it is extensively

used a for long time having no side effects and has different medicinal properties which include analgesic, anti-inflammatory, antioxidant, antiseptic, and anticarcinogenic activity [80]. In another study, it was detected that curcumin can cure different pre-cancerous situations such as oral submucous fibrosis, lichen planus, and leukoplakia. The oil from turmeric possessed oncopreventive activity [81] and cure numerous oral diseases. Application of roasted, ground turmeric reduces the pain and swelling [80]. Another study concluded that turmeric solution can greatly reduce the gum inflammation than chlorhexidine (Table 1) [82].

Aloe vera

A. vera also known *A. vera* barbadensis miller is perennial, xerophytic green color plant. It grows abundantly in dry areas of Asia, Europe, and America. *A. vera* is a good wound healer [83]. Components in *A. vera* are salicylic acid, urea, cinnamic acid, and phenols, and all these components have reducing effect on bacteria, viruses, and fungi. *A. vera* was found to be vital for preventing cancer, mucositis, aphthous stomatitis, and radiation dermatitis [84-87]. It is an anti-inflammatory mediator which has inhibitory effect on cyclooxygenase pathway and decreases prostaglandin E2 formation from arachidonic acid. *A. vera* has great antibacterial, antifungal, antiviral, and anticarcinogenic properties [88]. In another study, its leaf pulp extract reduced the blood sugar level, and as an antioxidant agent, it eliminates the free radicals (Table 1) [89]. *A. vera* has a great role to cure oral disease, and it contains many components such as anthraquinone glycosides, aloeresins, galactomannans, and polysaccharides [90]. Phenolic antioxidative substances were recently extracted from it and recognized as derivatives of oleoresins [91]. Many medicinal properties, no side effects, and less cost make it an important substituent to control biofilm on the surface of teeth and hence reduce gum inflammation and other oral diseases [92]. Acetylated mannans from it play a key role to increase immune system functioning. The gel obtained from it possesses anticancer, antidiabetic, and antibiotic properties [90]. 30 days of mouthwash with *A. vera* reduced the biofilm on the teeth surface (Table 1) [93].

HERBAL ORAL RINSES AND HERBAL MIXTURE

Different mouth rinses are commercially used. Herbal oral rinses which contain *Yavani satva*, *Bibhitaka* (*Terminalia bellirica*), and *Peppermint satva* are effective toward gingivitis. As compared to chlorhexidine, the usage of herbal oral rinses such as neem [94], turmeric [95], and triphala [96] showed a higher decrease in biofilm, inflammation of gums, and gum bleeding. The herbal mixture mainly in crude form can be introduced as a component for toothpaste [97]. Mixture of various herbal components helps in maintaining the good oral hygiene as a result reduces dental biofilm and decreases inflammation of gums [98].

CONCLUSION

Herbal antimicrobial mediators may inhibit the biofilm and oral infections. Therefore, the antimicrobial mediators need to have the capability of eliminating the oral microbes and preventing many oral infections. Medicinal plants and important oils such as paperbark oil are becoming successful as substituent's of chemical drugs for their effectiveness in preventing many oral diseases. It is supposed that a quarter of recommended medicine possesses constituents taken from plants in industrialized countries [9]. The challenge is to discover medicinal plants which have capability eliminate oral diseases. Therefore, the plant should possess antimicrobial activities without affecting the epithelial cells of human.

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CONTRIBUTION OF AUTHORS

Ishfaq Khan: Compiled the literature sources, data analysis, and interpretation and wrote the manuscript. Azhar Khan: Helped in data

interpretation, conceptualization of work, and its realization and manuscript evaluation

CONFLICTS OF INTEREST

The authors declared that they have no conflicts of interest.

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