

Review Article

Efficacy of Miswak on Oral Pathogens

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ABSTRACT

The oral cavity harbors a diverse and abundant number of complex oral pathogens causing different oral diseases. The development of dental caries and periodontal diseases has been found to be closely associated with various gram positive and gram negative microorganisms. Miswak, a natural toothbrush, has been documented as a potent antibacterial aid and its use is encouraged in different countries because of its good taste, texture, availability, cost and beneficial effect on teeth and supporting tissues. Different researches have been carried out to evaluate the antimicrobial effects of Miswak. This review encompasses the efficacy of Miswak on suppression of oral pathogens with respect to conducted on fungi as well as cariogenic, periodontal and endodontic bacteria.

Key Words: Antimicrobial effects, Miswak, oral pathogens, *salvadora persica*

Received: April 2012
Accepted: January 2013

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INTRODUCTION

Oral hygiene measures have been practiced by different populations globally since antiquity. The oral hygiene measures in certain population are adapted depending on factors, such as cultural background, religious norms, educational level, and socio-economic status.^[1] The widely used methods for maintaining oral health are toothbrushes and dentifrices. The traditional toothbrush or chewing stick called "Miswak" has had been used widely by different civilizations for centuries. It was initially used by Babylonians around 7000 years ago^[2] followed by Greek and Roman empires. Chewing sticks were also used by Jewish, Egyptian as well as

by old Japanese-communities.^[3] It is believed that the Europe was unfamiliar with such traditional hygienic methods of chewing stick until about 300 years ago. Today, chewing sticks are being widely used in Asia, Africa, South America, and throughout the Islamic countries.^[2,4] It is known with different other names in different cultures as siwak or arak [Figure 1].^[3]

Unlike other religious communities, which have been using chewing stick, Islam emphasized the use of Miswak for oral hygiene by incorporating it as a holy practice around 543 Anno Domini.^[5] Miswak is used to attain ritual purity and higher spiritual status and also used to get white and shiny teeth. Muslims use Miswak for cleaning teeth 5 times a day during ablution before worship. Some Muslims use Miswak fewer than 5 times a day or use a conventional toothbrush instead.^[5,6] Studies have demonstrated that Miswak has high efficacy compared to conventional toothbrush without toothpaste that makes us to understand why Islam emphasized the use of Miswak.^[3] It is a strong belief of Muslims that the use of Miswak has the potential to increase disease resistance in humans.^[6,7]

There are several shrubs and local tree being used as chewing stick in different parts of the world, which

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are selected due to good taste, texture like long bristle, availability and their beneficial effect on supporting tissues and teeth.^[3] There are around 173 different types of trees, which can be used as chewing sticks, belonging to the families Acacia, Fabaceae, Terminalia, Combretaceae, Lasianthera, Icacinaceae, Gouania, and Rhamnaceae.^[8,9] The most popular chewing stick or fibrous rolled sponges include *Salvadora persica* and *Azadirachta indica*^[10,11] [Table 1]. A widely used Miswak stick, so called *S. persica* or Arak tree [Figure 2], is often known by the name of tooth brushing tree in European countries or tooth pick tree in Middle East. It belongs to the species of *Salvadora* from the family of Salvadoraceae.^[9]

It is a small upright shrub, which is 3 m in height and 30 cm in diameter.^[2] It has white branches, aromatic roots, as well as warm and pungent taste. Its fruits are small size and round shape.^[12] It is used in many countries including Nigeria, Kenya, Tanzania, Zaire, Uganda, Ethiopia, Ghana, Yemen, Senegal, India, Sudan, Iraq, Saudi Arabia, and Pakistan.^[13]

The stick is chewed or tapered at one end until it becomes frayed into a brush. Soaking it in water for few hours softens the natural fibers, helping them to separate.^[14] The stick is held by one hand in a pen-like



Figure 1: Miswak

grip and the brush-end is used with an up-and-down or rolling motion. A two-finger and a five-finger grip technique are used [Figure 3].^[15] When the brushy edge is shred after being frequently used, the stick gets ineffective and it is then cut and further chewed to form a fresh edge. In this way, it can be used for few more weeks.^[2]

The traditional Miswak with a modern toothbrush is used commonly in Muslim countries. In Saudi Arabia, many youngsters combine modern and traditional oral hygiene methods.^[16] In Pakistan, the Miswak is more used among the rural than the urban population. Miswak appears to be more popular among older than the younger generation and for no clear reason appears to be much more common among men than women.^[17]

S. persica is considered to be a medicinal herbal plant.^[18] It contains salvadorine and trimethylamine,



Figure 2: *Salvadora persica* (arak tree)

Table 1: Different types of chewing sticks

Plants	Local name	Parts used	Useful properties
<i>Salvadora persica</i>	Miswak	Fresh young part of stem branches	Astringent, antibacterial
<i>Azadirachta indica</i>	Neem	Stem, branches	Bitter, astringent, antiseptic, antibacterial, analgesic, anti-inflammatory, antiviral, antifungal
<i>Acacia catechu</i>	Kher	Stem, bark	Astringent, cooling, antiseptic, anti-inflammatory, bitter
<i>Acacia nilotica</i>	Kikar	Stem, branches	Astringent, styptic, antibacterial, acrid, antifungal
<i>Acacia leucophloea</i>	Safed Babu;	Stem, branches	Astringent, styptic, antibacterial, antifungal
<i>Achyranthes aspera</i>	Apamarga	Stem, bark	Anti-inflammatory
<i>Aegle marmelos</i>	Bael tree	Stem, branches	Astringent, antibacterial
<i>Butea monosperma</i>	Dhak	Stem, branches	Astringent, bitter, anti-inflammatory, antifungal
<i>Calotropis procera</i>	Madar Ak	Stem	Astringent, antimicrobial, antiseptic, styptic
<i>Nerium indicum</i>	Kamer	Stem, branches	Antibacterial, analgesic, anti-inflammatory, antifungal
<i>Pongamia pinnata</i>	Karanj	Stem, root	Astringent, styptic, antibacterial, antifungal, antiseptic
<i>Pterocarpus marsupium</i>	Vijayasar	Stem	Astringent, styptic, antifungal, anti-inflammatory
<i>Terminalia arjuna</i>	Arjun	Stem, branches	Astringent, styptic, cooling, demulcent, antibacterial, antifungal
<i>Ficus racemosa</i>	Gular	Stem, branches and bark	Astringent, antiseptic, antibacterial, anti-inflammatory
<i>Zanthoxylum aromatum</i>	Tejovati	Stem, branches	Astringent, antiseptic, antibacterial

which are shown to exhibit anti-bacterial effects on cariogenic bacteria such as *Streptococcus mutans*. It has been shown that these active principles support periodontal health,^[19] reduces the accumulation of biofilm-like dental plaque formation and exhibits fungistatic activity against *Candida albicans*.^[4]

The traces of tannins, which have anticoagulant properties, are also found in *S. persica*. The oil extracted from this plant is shown to exert biological activity and is used to cure gall bladder disease, piles, polio, intestinal worm, gonorrhoea, and rheumatic joint pain. The oil has also been used for making candles, soaps and are used as a substitute of coconut oil.^[20] The fresh root bark paste can be used against vesical catarrh, gonorrhoea and as a tonic for low fever. The bark extract is used to relieve gastric and spleen pains because of its ascarifuge properties.^[21] Its leaves are bitter in taste and it possesses liver tonic, diuretic, analgesic, astringent, and antiscorbutic properties, which are useful in treating piles, scabies, leucoderma, ozoena.^[21,22] Decoction is used to alleviate symptoms of asthma and reduce the intensity of cough. It has been shown that phytochemical extract and essential oil can be used to both prevent and treat most common oral diseases.^[23] The other chemical components and its uses are highlighted in Table 2.^[16]



Figure 3: Application of Miswak

ANTIMICROBIAL EFFECTS OF MISWAK

Different clinical studies have demonstrated the effects of microbial species in oral cavity. More than 750 bacterial species reside in oral cavity and a number of them have been identified to cause oral diseases.^[24] According to several studies, Miswak has been reported to impart an essential antibacterial role, particularly on cariogenic bacteria and periodontal pathogens.^[25-27] The following anti-microbial effects of Miswak has been reviewed [Figure 4].

The major causative factor of gingivitis and periodontal disease is dental plaque. The process of periodontal disease can be arrested by effective removal of dental plaque. Different studies have identified Miswak as an effective measure for controlling gingivitis.

Table 2: Chemical components of Miswak

Chemical properties	Oral health benefits/effects
Fluoride	Remineralization of tooth structure from the repeated use of Miswak, which releases containing sap
Silica	An abrasive material to remove tooth stain
Tannins	A phenolic compound that has an astringent effect and premolar saliva production
Resins	Amorphous products that form a protective layer over the enamel to prevent caries
Alkaloids	Nitrogenous organic compounds found in plants, which have a bactericidal effects and stimulatory actions on the gingival, e.g., Salvodorine
Essential oils	Benzyl nitrite, eugenol, thymol, isothymol, eucalyptoi, isoterpinolene and g-caryophyllene that have anti bacterial effects; characteristic aroma; carminative action, mild bitter taste stimulates the flow of saliva
Sulphur compounds	Compounds have a pungent taste and smell and bactericidal effect
Vitamin C	Ascorbic acid promotes healing and tissue repair
Sodium bicarbonate	A compound used as a dentifrice, because of its mild abrasive properties
Calcium	A mineral that inhibit enamel demineralization and promotes remineralization
Chloride	An element that inhibit calculus formation and helps in removing extrinsic tooth stains
Benzyl isothiocyanate	A chemotherapeutic agent with anti-carcinogenic properties

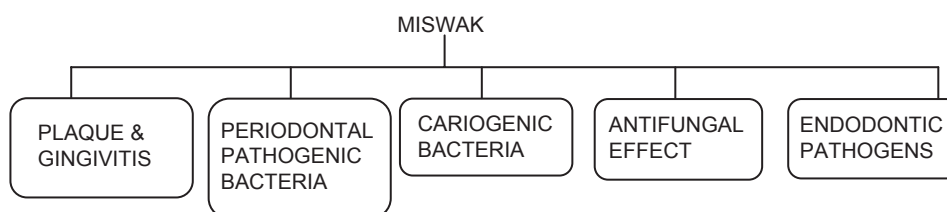


Figure 4: Antimicrobial effects of Miswak

Sofrata *et al.* demonstrated reduction in plaque and gingival index in Miswak users; however, no effective role was found in interproximal surfaces.^[28] Another comparative study was carried out to assess plaque removal in Miswak and toothbrush users. It was clearly evident from the experimental and clinical trials that Miswak was equally effective as traditional method of tooth-brushing on plaque removal.^[29]

The salivary pH is lowered to a very significant level after sucrose rinse. Thus, the role of Miswak in acidic oral environment after sucrose intake was studied. Miswak demonstrated elevated levels of plaque pH, indicating its potent role towards caries prevention.^[30]

The oral microbes along with dental plaque play a vital role in development of periodontal diseases. An *in vitro* study was carried out to assess the levels of periodontal bacterial species when treated with aqueous and ethanol extracts of Miswak. The periodontal pathogens under the investigation were gram-positive bacteria including, *Eikenella corrodens*, as well as gram-negative bacteria including *Streptococcus constellatus*, *Streptococcus sanguis* and



Figure 5: Digital photograph showing the inhibition of *Actinomyces actinomycetemcomitans* on a blood glucose agar plate in an area around a piece of Miswak

Streptococcus salivarius. The bacterial species were grown on Muller Hinton II agar and the inhibitory concentrations were observed. The results revealed that the ethanol extract of Miswak showed stronger anti-bacterial action than aqueous extract [Table 3].^[31]

The progression of gingivitis to more aggressive form of periodontitis has been reported due to predominance of gram-negative bacteria. Miswak demonstrated an assertive anti-microbial activity against gram-negative pathogens including, *Actinomyces actinomycetemcomitans*, *Porphyromonas gingivalis*, *Haemophilus influenza*, and *Salmonella enteric*.^[32]

Furthermore, Otaibi *et al.* exclusively studied the effect of Miswak on *A. actinomycetemcomitans* by DNA checkboard method and found a significant reduction in the multiplicity of the pathogen^[17] [Figure 5].

S. mutans has been identified as the most significant microbe contributing to dental caries.^[33] The efficacy of Miswak as an anti-dental caries herb was investigated by comparing its effects with the tooth-brush. The reduction in number of *S. mutans* was greater in Miswak users as compared to toothbrush users^[2] [Figure 6].

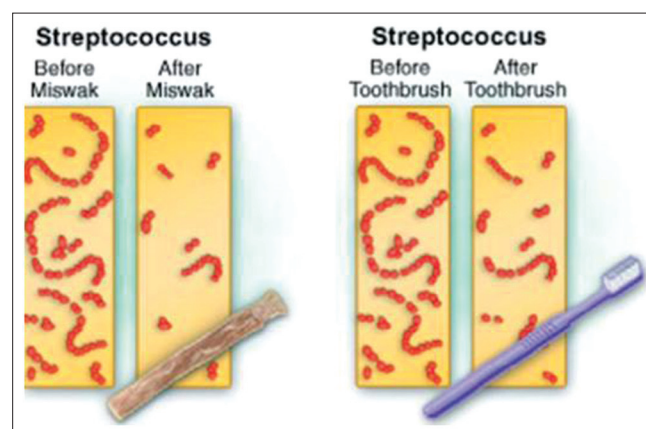


Figure 6: Marked reduction in levels of *Streptococcus mutans* in Miswak as compared to toothbrush users

Table 3: The bacterial growth seen with different Miswak extracts concentrations

Mouth wash bacteria	Ethanol Miswak extract				Aqueous Miswak extract				(-ve ctrl) sd H ₂ O	(+ve ctrl) oradex
	10%	15%	25%	50%	10%	15%	25%	50%		
<i>S. mutans</i>	+	-	-	-	+	+	+	+	+	-
<i>E. corrodens</i>	+	+	-	-	+	+	+	+	+	-
<i>S. salivarius</i>	+	+	-	-	+	+	+	+	+	-
<i>S. constellatus</i>	+	+	-	-	+	+	+	+	+	-
<i>S. sanguis</i>	+	-	-	-	+	+	+	+	+	-

+ = Bacterial growth; - = No bacterial growth

The susceptibility test performed on cariogenic micro-organism illustrated *S. mutans* being the most susceptible pathogen by Miswak; however, *Lactobacillus acidophilus* was the least susceptible.^[34] A DNA-DNA hybridization method has been carried out revealing inhibitory effect of Miswak on *S. mutans*, a cariogenic pathogen.^[35]

A comparative study between persica mouth-wash and chlorhexidine was carried out to characterize the effects of *S. mutans* in orthodontic patients. The results enlisted significant reduction in bacterial species but were not documented equivalent to chlorhexidine in potency. However, the complaints of tooth discoloration, unpleasant taste and burning mouth were minimal with persica relative to chlorhexidine mouthwash as illustrated in Table 4.^[36] The fluoride releasing property of Miswak makes it an effective oral hygiene tool against caries.^[37]

Candida is responsible for multiple infections of oral cavity and occurs most commonly in immunocompromised patients.^[38] Noumi, et al. has documented Miswak as an anti-fungal agent. The study illustrated the effects of dry and fresh Miswak on candidal species by agar diffusion assay. The results showed enhance activity of dry *S. persica* against pathogens as compared to fresh extracts.^[4]

Different aerobic and anaerobic bacteria reside in bacterial pulp. Miswak was reported as an effective root canal irrigant because it limits bacterial levels during endodontic treatment.^[39,40]

The efficacy of Miswak as a root canal irrigant was studied by comparing its effects with other currently used root canal irrigants. 15% Miswak extract was found to be highly effective against all the aerobic and anaerobic microbes in necrotic pulp, which was nearly similar to anti-microbial efficacy of 0.2% chlorhexidine. In addition, sodium hypochlorite showed highest anti-microbial effect, which was nearly significantly similar to Miswak extract and chlorhexidine.^[40]

Different extracts of Miswak were evaluated against other oral pathogens. The aqueous extract

of *S. persica* was found to be most active against *Staphylococcus aureus* followed by *L. acidophilus*; whereas, *Pseudomonas aeruginosa* was determined as the least susceptible. On contrary, the methanol extract of *S. persica* demonstrated least activity against *S. aureus*.^[41]

The anti-bacterial effect of Miswak was studied *in vitro* on five different microbes. *P. gingivalis* was found to be most susceptible followed by *A. actinomycetemcomitans* and *H. influenza*. However, *S. mutans* was identified less susceptible and *L. acidophilus* being least susceptible.^[21]

A clinical study was performed on a patient of denture stomatitis. Several strains of microorganisms were isolated from his oral cavity including gram-positive bacteria (*S. aureus*, *Staphylococcus epidermidis* and *Micrococcus luteus*), gram-negative bacteria (*P. aeruginosa*, *Salmonella typhimurium*), and fungi (*C. albicans*). The results obtained demonstrated inhibition zones around all the micro-organisms with gram-positive bacteria being more active than gram-negative bacteria.^[42]

Inhibition zones of different bacterias by Miswak were assessed using blood agar ditch plate method. The results showed that Miswak was active against *Streptococcus faecalis* only at minimum concentration of 5%; however, *S. mutans* were inhibited at a higher concentration. On contrary, Miswak was found to be ineffective against *S. aureus*, *S. epidermidis* and *C. albicans*.^[43]

Almas, et al. compared the anti-microbial activity of 50% Miswak extract and commercially available mouth-rinses against seven micro-organisms. The pathogens under study were *S. faecalis*, *Streptococcus pyogenes*, *S. mutans*, *C. albicans*, *S. aureus*, and *S. epidermidis*. The inhibition zones indicated that all the mouth-rinses under study exhibited anti-microbial activity except *Sensodyne mouth-rinse*, which did not demonstrate any microbial inhibition. On contrary, 50% Miswak extract showed effective microbial inhibition only against *S. faecalis* and *S. mutan*.^[44]

CONCLUSION

This review clearly enlightens the significant effect of Miswak as an anti-bacterial agent. The inhibitory role of Miswak on both gram-positive and gram-negative bacteria and fungi residing in oral cavity has been clearly demonstrated both clinically and experimentally. However, Miswak remains

Table 4: The percent of patients who complained of tooth discoloration and burning mouth in chlorhexidine and persica groups

Type of discomfort	Chlorhexidine (%)	Persica (%)
Tooth discoloration	86	13
Unpleasant taste and burning mouth	73	40

inactive in interproximal surfaces, suggesting its limiting action on micro-flora in these surfaces. The findings evidently support the view that Miswak can be used as a potent dental hygiene method acting against different oral diseases along with additional interproximal cleaning aides. The World Health Organization has also recommended and encouraged the use of these chewing sticks as an effective and alternate tool for oral hygiene (1984 and 2000 international consensus).

FUTURE RECOMMENDATIONS

1. It is recommended that further research should be carried out to study the role of Miswak on oral infections including, oral ulcers and other lesions in oral cavity
2. Further work is needed to evaluate the effects of Miswak in tooth-paste
3. The effects of Miswak on restorative filling materials is yet to be identified
4. The role of Miswak in patients with periodontitis needs to be assessed
5. Clinical trials needed to improve evidence on beneficial effects of Miswak and oral health.

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How to cite this article: Sukkarwalla A, Ali SM, Lundberg P, Tanwir F. Efficacy of Miswak on Oral Pathogens. *Dent Res J* 2013;10:314-20.

Source of Support: Nil. **Conflict of Interest:** None declared.