
A Thorough Analysis of *Salvadora persica* (Miswak) in Islamic Tradition and Contemporary Microbiology as a Natural Antimicrobial Agent

Alishah Ghulam Mustafa

M.Phil. Applied Microbiology, University of Veterinary & Animal Sciences, Lahore

Email: alishaghulammustafa@gmail.com

Dr. Muhammad Sarwar

Assistant Professor, University of Veterinary and Animal Sciences, Lahore

Email: sarwarsiddique@uvas.edu.pk

Abstract

The oral care of the Islamic culture is more than 1,400 years old, and the *Salvadora persica* L. or miswak is a type of oral cleaner in the form of chewing stick used by the people of the Islamic culture. It reaches far into the teachings of Islam that emphasize on cleanliness and preemptive medicine. Besides its mechanical plaque-removing effect, miswak has also formed a considerable share of scientific attention due to a strong phytochemical profile and the extensive scope of antimicrobial effects. The article is a critical evaluation of the botanical properties, phytochemical composition, antimicrobial effects, and clinical importance of *Salvadora persica* using the traditional microbiological and the modern microbiological procedures. It's antibacterial, antifungal, antiviral, anti-inflammatory, antimicrobial and antibiofilm effect is due to bioactive compounds which include benzyl isothiocyanate, tannins, saponins, essential oils, fluoride and silica. Laboratory and clinical studies indicate that they have an enormous inhibitory effect on key oral pathogens including *Streptococcus mutans*, *Porphyromonas gingivalis* and *Candida albicans* with an equal or stronger plaque-reducing effect than conventional toothbrushes when applied appropriately. Besides, miswak has advantages in terms of price, cultural appropriateness and eco-friendliness particularly in low resources situations. Despite the good evidence, disparities in preparation processes, administration routes and study designs have indicated that standard protocols and big clinical trials are necessary. Miswak is most often a mixture

of pre-Islamic and post Islamic traditions, and scientific explanation, which can make the use of miswak, as a part of a modern policy in preventive dentistry and community health acceptable.

Keywords: Miswak, *Salvadora Persica*, Oral Hygiene, Biofilm Inhibition, Dental Plaque, Antimicrobial Activity, Islamic Medicine, Preventive Dentistry, Phytochemicals, Sustainable Oral Care

Introduction

Salvadora persica, also known as Miswak, has a rich cultural and religious history regarding its use, especially among the Islam tradition where it is highly promoted by the Prophet as the mouth cleaner. Its traditional application as a natural toothbrush is already in hygiene practices in the Middle East, Africa, and South-Asian societies (Farag *et al.*, 2021). The religious approval highlights the health advantages that include strengthening of gums, avoiding dental caries and toothaches, getting rid of malodor, improving gustatory sensitivity, and aesthetically improving the dentition (Mujeeb *et al.*, 2011). These ancient assertions are supported by modern scientific research with evidence of the antimicrobial use of *Salvadora persica* extracts on oral pathogens and more.

At the microbiological and pharmacological level, *Salvadora persica* possesses a wide range of bioactive phytochemicals, such as flavonoids, glycosides, sterols, terpenes, alkaloids, organic compounds that contain sulfur elements, and sulfur (Farag *et al.*, 2021). A significant antimicrobial ingredient has been found to be benzyl isothiocyanate, a quick bactericidal agent especially when used on Gram-negative bacteria causing periodontal disease (Sofrata *et al.*, 2011). The high specificity of these bacteria is significant since these species are often resistant to traditional antibiotics.

The scientific investigation of the antimicrobial ability of aqueous and methanol extracts of *Salvadora persica* has shown that the extracts exhibit inhibitory action against multidrug-resistant (MDR) clinical isolates of bacteria, where the Gram-negative species are more susceptible to antimicrobial influence. Specifically, methanolic

extracts were effective in exhibiting strong antibacterial properties toward such pathogens as *Escherichia coli* and *Styptococcus pyogenes*, as well as against the resistant strains of *Staphylococcus aureus* (MRSA) (Al-Ayed *et al.*, 2016). This fact highlights the possibility of Miswak as a treatment and an alternative therapy method to counter the new resistant infections.

The effectiveness of Miswak as a dental hygiene agent is also supported by clinical evidence that revealed a decrease in pathogenic bacteria in subgingival plaque, which is even more effective than toothbrush use in itself, especially in the reduction of the prevalent periodontal pathogen, namely, the **Aggregatibacter actinomycetemcomitans* (Al-, 2004). Meta-analyses indicate that *Salvadora persica* rinses have a strong effect on reducing the plaque indices and cariogenic bacteria count albeit with less effectiveness when compared to chlorhexidine mouthwashes. However, due to its excellent safety profile, cost-effectiveness, and ease of use, it offers a potentially promising long-term option (Jassoma *et al.*, 2019).

In addition to antimicrobial activity, *Salvadora persica* has antioxidants, anti-inflammatory, anti-caries, and analgesics, which improve the oral health by inhibiting the formation of biofilm and oxidative stress (Khan *et al.*, 2020; Mekhemar *et al.*, 2021). Fresh and dried root-extracted essential oils exhibit antibiofilm and bactericidal effects that are equivalent to chlorhexidine, but may have less side effects, which makes them a strong natural alternative to oral care (Khan *et al.*, 2020).

More technological advances involve the biosynthesis of silver nanoparticles (AgNPs) with *Salvadora persica* root extracts, which enhances the antimicrobial effect against pathogens, such as the **Escherichia coli* and *Staphylococcus epidermidis* which increases the potential of Miswak to biomedical applications, including wound healing and water purification (Arshad *et al.*, 2021).

Phytochemical profiling also demonstrates new sulfur containing alkaloids, including persicaline, which have antioxidant properties equal to ascorbic acid. The compounds play a role in the antimicrobial applications and oxidative damage mitigation of

Salvadora persica which has a multifunctional therapeutical potential (Farang *et al.*, 2018).

Miswak is among the first known recorded oral-hygienic natural instruments made of the plant *Salvadora persica* L. popularly known as Arak tree. Its recorded use dates back more than 1,400 years as it is painfully embedded in Islamic theological tradition, and oral care is considered a part of the whole body hygiene and religious practice. Islamic jurisprudence has a high value on oral hygiene, and it promotes the use of miswak as a religious, cultural and preventive practice (Almas, 2002).

In addition to its mechanical cleaning effect, miswak has drawn significant scientific attention due to its wide phytochemical range and its biologic activity. The study of *Salvadora persica* has revealed a wide range of bioactive components such as alkaloids, flavonoids, tannins, saponins, silica, resins, sulfur-based constituents, and essential oils and many of these compounds have antibacterial, antifungal, anti-inflammatory, and antioxidant effects. It is also interesting to note that benzyl isothiocyanate can be recognized as a strong antimicrobial agent against oral pathogens, which confirms the dual effect of miswak as a mechanical cleansant and a naturally found antimicrobial (Akhtar and Ajmal, 1981; Sofrata *et al.*, 2011).

Periodontitis, gingivitis, dental caries and associated pathologies are a health burden affecting billions of people each year globally. These conditions have a complex etiology that is based on the development of complex oral biofilms that constitute heterogeneous populations of microorganisms. *Streptococcus mutans*, *Lactobacillus* spp., *Porphyromonas gingivalis*, and *Aggregatibacter actinomycetemcomitans* are pathogens that are linked to caries and periodontal disease (Marsh and Zaura, 2017). Traditional preventive and curative measures are based on mechanical cleansing of plaque and antimicrobials of the chemical activity of antibiotics, but the increasing resistance to antimicrobials in the mouth microorganisms would necessitate a reconsideration of the long-term effectiveness and safety of such measures (Ventola, 2015).

This has augmented the search of alternative or supplementary means that are effective, safe, affordable, and culture-congruent alongside the development of antimicrobial resistance. Medicinal plants have received a re-evaluation due to bioactive properties that they harbor in natural products and extensive historical origins of traditional medicine. In such aspects, miswak is a weird presentation of an ancient practice of oral health care as a dental treatment that has a strong connection with the modern principles of dental care prevention and microbiological information. Another type of in vitro and clinical data indicates that the miswak extracts inhibit the growth of cariogenic and periodontopathogenic bacteria, reduce the level of accumulated plaque, and improves the state of the gingiva in relation to the use of or use of traditional toothbrushes (Al-Bagieh *et al.*, 1994; Al-Otaibi *et al.*, 2004).

The use of the miswak as a disease prevention tool and cleanliness, according to Islamic opinion, constituted the main tenets of modern public health and microbiology. The cross (point) between religious preaching and scientific findings suggests the significance of miswak as natural anti microbial of the mouth. Despite its growing evidence of effectiveness, miswak is not utilized effectively or is not incorporated into modern dentistry, even outside the Muslim population. In addition, the variety of the study designs, techniques used in extraction, as well as the targets of the microbes predetermines the need to have a general picture of the existing studies.

To conclude, it is possible to state that *Salvadora persica* (Miswaak) lives in an intersection between traditional Islamic medicine and the latest microbiological studies as a natural antimicrobial agent. Its active components especially benzyl isothiocyanate and sulfur-based alkaloids have strong antibacterial action against oral and systemic pathogen such as multidrug resistant strains. Miswak oral health properties, including plaque reduction, antimicrobial and biofilm inhibition, are clinically and experimentally verified, so this tool is a promising adjuvate or alternative oral hygienic product with extensive pharmaceutical and industrial potentials (Al-Ayed *et al.*, 2016; Farag *et al.*, 2021; Jassoma *et al.*, 2019; Sofrata *et al.*, 2011).

Although the deeply ingrained Islamic cultural support still encourages the use of Miswak, due to its spiritual and physical advantages, modern microbiology has been offering strong scientific confirmation of its antimicrobial activity, its therapeutic flexibility and its potential of incorporating it into the modern natural-product-based medical treatment plans. Ongoing studies that should explain the molecular action and standardize extract preparation will improve its medical use and enable its application in other areas other than oral health to prevent resistant microbial infection and facilitate the development of functional foods and pharmaceutical products.

This review will address the gap that exists between the ancient Islamic culture of using miswak and the recent Microbiological findings. The review will evaluate the antimicrobial efficacy of *Salvadora persica* on oral pathogen by critically reviewing articles on the antimicrobial activity of this natural herb on oral pathogen, the antimicrobial action mode and its potential as a natural and culturally relevant adjunct/substitution to the already existing oral antimicrobial agents. Through this integrative approach, the review will contribute to the existing body of knowledge that supports the incorporation of traditional knowledge into the modern oral healthcare.

Miswak in the Religious and Historical Importance:

The concept of cleanliness in Islam is closely related to religion, health and spirituality. In the broader meaning of ṭahārah (purity), through oral hygiene in particular, oral hygiene is a prerequisite of most worship. Miswak practice was always stressed on Islamic jurisprudence in the Sunnah of the prophet Muhammad (peace be upon him), where it is implied at one time or other throughout the day prior to prayers, ablution and religious encounter. This repetitious emphasis becomes an articulation of a previous awareness of the worth of mouth cleanliness as an instrument of individual and community health.

Miswak has been extensively discussed under classical works of jurisprudence by classical Islamic scholars with the miswak practice commonly being in the category of highly recommended (sunnah mu'akkadah). The religious encouragement to use

miswak forms these preventative health policies of avoidance of damage and encouragement of cleanliness. This, in modern perspective, would be highly consistent with the current day perspective of preventive dentistry and public health, and would suggest that the Islamic teachings were making reasonable steps to avoid dental health many centuries before the establishment of microbiology and dental science (Bos, 1993; Ahmad and Dummer, 1998).

Miswak is made in traditional and simple yet systematic preparation methods that have been transferred to the generations. The twigs are normally plucked off the root or the branches of *Salvadora persica*, although fresh and tender sticks are desirable. One end of the twig is peeled off until the inner fibrous tissue remains. This is then chewed till the fibers separate and this forms a brush like structure which is capable of cleaning the tooth surfaces and gingival margins.

Miswak is a traditional version and to use it, there is no toothpaste or any other cleaning agent and in most instances it is used more than once a day. To be clean and effective, the users are recommended to wash the miswak after use and trim the fibers that are worn after some time. This is due to the mechanical plaque disruption and also extraction of the naturally produced antimicrobial compounds through chewing and enhances oral cleansing effect. These old practices reflect the intuitiveness of mechanical and chemical plaque management and justify the additional consideration of miswak regarding the microbiological perspective (Ezoddini-Ardakani, 2010; Darout *et al.*, 2000).

With the exception of the Islamic culture being associated with miswak, the use of chewing sticks as a way of cleaning the mouth has been documented among different individuals in the world. Various types of chewing sticks have been created in Africa, the Middle East, and most of Asia, and used as the primary oral hygiene device. The factors, which predetermine the adoption of chewing sticks in general, are availability, cost, and the environmental sustainability.

Epidemiological and anthropological studies prove the fact that the population using chewing sticks can have an acceptable level of oral and periodontal health when the sticks are used properly and at the right moment. The World Health Organization recognises that traditional oral hygiene methods lead to oral health maintenance and in resource-limited settings where modern dental care is limited. The fact that chewing sticks are still actively used all over the world reflects that they are still relevant and highlights the necessity of conducting additional research on its antimicrobial properties that has a cultural importance (WHO, 1984; Wu et al., 2001).

Botanical and Phytochemical Profile of *Salvadora persica*

Salvadora persica L. is an arid and semi-arid species of genus *Salvadora* and family, Salvadoraceae, and it is tolerant to salinity and drought. The species is available in the form of a small evergreen tree or shrub and is usually of a height of 3 to 6 m with a soft and whitish trunk and spreading out branches. The leaves are opposite, thick, elliptical, and smooth and the flowers are green-ish yellow and clustered tightly. Berries are round, eatable and turns red when they are not in its prime.

Table 1: Botanical Characteristics of *Salvadora persica*

This table outlines the physical properties of the "Arak" tree which make it suitable for oral hygiene.

Feature	Description	Functional Role in Oral Care
Growth Form	Evergreen tree/shrub, 3–6 m height	Source of sustainable, renewable chewing sticks.
Trunk/Branches	Soft, whitish trunk with spreading branches	Provides flexible twigs for easy preparation.
Tissue Structure	Porous botanical tissues	Facilitates the release of phytochemicals during mastication.
Root/Stem Texture	Fibrous and sturdy	Assists in mechanical disruption of the dental plaque.
Fruit	Round berries, turning red when mature	Contains selective antimicrobial and antioxidant compounds.

Salvadora persica has constitutionally abundant depositories of biologically active chemical constituents in its roots and stems making it morphologically relevant in oral health applications. The porous tissues assist in the release of phytochemicals during the mastication and the fibrous texture assists in mechanical disruption of the plaque. There

is an indication that these botanical properties make *Salvadora persica* special in comparison to other chewing-stick species that were used traditionally to provide oral care, which consequently make it more effective (Arora and Kaur, 2007; Sher *et al.*, 2010).

The isothiocyanates especially benzyl isothiocyanate (BITC) are the most widely researched phytochemicals in *Salvadora persica*. Glucosinolates in the plant tissues are broken down enzymatically to give BITC, a strong anti-cariogenic and anti-periodontal pathogen to inhibit vital metabolic processes and disrupt bacterial cell membranes. The volatility and diffusion of BITC, in the mouth cavity, increases the antimicrobial activity when it is found in miswak (Sofrata *et al.*, 2011; Hattab, 1997).

Salvadora persica is also rich in polyphenolic compounds and glycosidic compounds especially tannins and saponins. Tannin has a strong impact on the oral tissues which can reduce inflammation of the gums and inhibit the attachment of bacteria to the tooth surfaces. Tannins also prevent biofilm formation and plaque formation by precipitating bacterial proteins and enzyme (Dhar and Singh, 2012; Hattab and Al-Omari, 1999).

Salvadora persica has functional analogues of widely used antibacterial agents (thymol and eugenol) in its essential oils. These parts form the typical smell of miswak and also possess anti-microbial, analgesic, as well as anti-inflammatory properties. Their ability to decadently deodorize the mouth and prevent bacterial growth is the basis of the widened antimicrobial spectrum of miswak. Miswak as a natural oral cleanser is further supported by the synergetic links between the elements of important oils, and other phytochemicals (Nordin *et al.*, 2012; Hattab, 1997).

Besides organic phytochemicals, *Salvadora persica* also contains inorganic compounds that are helpful to the oral cavity. Miswak is a natural source of fluoride which activates enamel remineralization and reduces the caries development. Silica as a mild abrasive is able to remove plaque without causing enamel damage. The calcium and phosphate ions effect the enamel strength and mineral balance whereas the inorganic base enhances the antibacterial property of the organic components. All of these inorganic factors are

in combination with the multidimensional preventive profile of miswak in the maintenance of oral health (Elvin-Lewis *et al.*, 1980; Hattab, 1997).

Table 2: Phytochemical Composition and Biological Activities

*This table summarizes the key bioactive compounds found in *Salvadora persica* and their specific roles in oral health.*

Phytochemical	Primary Biological Activity	Impact on Oral Health
Benzyl isothiocyanate (BITC)	Strong antimicrobial/bactericidal	Inhibits vital metabolic processes and disrupts bacterial cell membranes of pathogens.
Tannins	Astringent and anti-inflammatory	Inhibits bacterial attachment to tooth surfaces and prevents biofilm formation.
Saponins	Detergent-like cleansing	Works alongside other compounds to inhibit fungal and bacterial growth.
Essential Oils (Thymol/Eugenol)	Antimicrobial, analgesic, and anti-inflammatory	Deodorizes the mouth and prevents bacterial growth.
Silica	Mild abrasive	Mechanically removes plaque without damaging enamel.
Fluoride	Mineralization agent	Activates enamel remineralization and reduces caries development.
Calcium & Phosphate	Mineral balance	Supports enamel strength and mineral balance.

Antimicrobial Mechanisms of Action

Recent in vitro studies have shown that *Salvadora persica* extracts have a strong antibacterial effect on *Streptococcus mutans* which is one of the major etiologic agents of dental caries. Miswak methanol extracts have also been found to inhibit the biofilm formation and growth of *S. mutans* in a concentration dependent way; higher concentrations of the extract strongly suppress planktonic growth and biofilm formation (Balhaddad *et al.*, 2021; Ipsitha Vejendla *et al.*, 2025). These effects can be mainly attributed to the release of benzyl isothiocyanate (BITC) and other sulfur-based phenols in miswak that has bacteria-killing properties and can potentially inhibit the production of acids and overall cell metabolism of *S. mutans* cells (Balhaddad *et al.*, 2021; Ipsitha Vejendla *et al.*, 2025).

Recent studies propose that miswak extracts, essential oils have an inhibitory effect on selected Gram negative periodontal pathogens like *Porphyromonas gingivalis* which is closely linked to periodontitis. *S. persica* root extracts have been shown to be very

effective in vitro as antimicrobial and anti-adhesive agents against *P. gingivalis* and other periodontal pathogens and have an equivalent efficacy to conventional agents such as chlorhexidine (MDPI research, 2025). Due to hydrophobicity, BITC and similar isothiocyanates can enter and interfere with the outer membrane of Gram-negative microorganisms thus preventing their survival (Ipsitha Vejendla *et al.*, 2025; *Salvadora persica* essential oil study, 2025).

Extracts of Miswak have been shown to exert quantitative antifungal activity against *Candida albicans*, the most common cause of oral candidiasis, although less recent studies have explicitly focused on *Candida*. Aqueous and prepared extracts are in vitro antifungal active, which supports the idea of the presence of bioactive chemicals inhibiting fungal growth (Veyisoglu *et al.*, 2024). What is more, there are studies that indicate that miswak compounds can increase antifungal activity against *Candida albicans* and other oropharyngeal yeasts in combination with adjunctive materials like nanoparticles. These results suggest the possibility of using miswak to stabilize the balance of oral microflora and slow down fungal growth in the plaque and denture-induced stomatitis.

The in vitro studies have demonstrated that methanolic extracts of the miswak stem bark can inhibit HSV-2 as well as cause viral infectivity to be reduced in a detectable extent (Elansary *et al.*, 2022). These actions can be explained by the existence of broad-spectrum phytochemicals, which disrupt viral entry or replication like phenolic compounds and glucosinolates.

The use of miswak as an antiviral agent should be explored further since the herpes viruses and other oral viruses have been known to cause mucosal lesions and worsen gingival inflammation. Future research which involves study of common oral viruses like HSV-1 and CMV in clinical and in vitro conditions will explain the role of Miswak in oral hygiene as an antiviral agent.

Miswak phytochemicals have also been shown to prevent the attachment of bacteria to the tooth surfaces which are the critical first step in biofilm formation. Consistent

evidence has shown that regular use of miswak has low levels of plaque and bacteria burden in comparison to traditional solutions and may lead to disruption of bacterial adhesion mechanisms (Ipsitha Vejendla *et al.*, 2025). Miswak extracts prevent the adhesion to the enamel pellicle by surface colonization of *S. mutans* and other pathogens growing on the enamel surface by modifying surface interactions and breaking adhesion forces.

Miswak extracts are also anti- biofilm active in vitro and there is significant reduction in biofilm biomass at effective doses. They have been shown to destabilize biofilm structure and viability of cariogenic *Streptococcus* species, as disseminated by their ability to inhibit biofilm formation up to 8790, according to the type and concentration of the extract (Antibiofilm research, 2025). The benefits are particularly useful in preventing the occurrence of the dental plaque and the pathogenic changes of the chronic oral diseases.

Table 3: Antimicrobial Efficacy Against Key Pathogens

This table highlights the effectiveness of miswak extracts against specific microorganisms mentioned in the text.

Target Pathogen	Type	Efficacy/Observation
<i>Streptococcus mutans</i>	Gram-positive bacteria	Methanolic extracts significantly inhibit biofilm formation and acid production.
<i>Porphyromonas gingivalis</i>	Gram-negative bacteria	Root extracts act as anti-adhesive agents with efficacy comparable to chlorhexidine.
<i>Candida albicans</i>	Fungus (Yeast)	Aqueous and prepared extracts show quantitative antifungal activity.
HSV-2	Virus	Methanolic stem bark extracts inhibit viral infectivity and entry/replication.
<i>Staphylococcus aureus</i> (MRSA)	MDR Bacteria	Methanol extracts prevent the growth of resistant pathogens.
<i>Escherichia coli</i>	Gram-negative bacteria	Methanol extracts show greater efficacy against these Gram-negative isolates.

Case studies

The antimicrobial potential of *Salvadora persica* has been in the focus of the recent case studies that can lead to essential insights. A study comparing the antibacterial properties of aqueous and methanol extracts of miswak against multidrug-resistant (MDR)

bacterial clinical isolates showed that both extracts had significant antibacterial properties, with the methanol extract showing greater antibacterial efficacy against Gram-negative bacteria, including *Escherichia coli* and Gram-negative coccus. The extract also prevented the growth of the resistant pathogens such as methicillin-resistant *Staphylococcus aureus* (MRSA) indicating that miswak is a potential alternative antimicrobial agent in the fight against resistant infections (Al-Ayed *et al.*, 2016).

More chemical processing revealed benzyl isothiocyanate as one of the prominent active antibacterial constituents of the root extracts of the plant, *Salvadora persica*. The compound was found to have rapid and potent bactericidal action against Gram-negative bacteria that are known to cause periodontal disease, but not Gram-positive bacteria. The targeted approach to antimicrobial activity signifies a selective killing mechanism useful in periodontal therapy (Sofrata *et al.*, 2011). In addition to this, methanol extracts of both fresh and dried miswak roots had strong antibiofilm and antimicrobial qualities against *Streptococcus mutans*, which is also a major denturist bacteria. They have been shown to reduce the development of biofilms significantly and equivalent to chlorhexidine digluconate, a commonly used antimicrobial oral wash, which is why they have the potential to become a useful natural oral hygiene solution (Khan *et al.*, 2020). Also, phyto-chemical and cytotoxic analyses of miswak fruits have shown selective antimicrobial effects against *Streptococcus mutans* antioxidant and antiangiogenic activity of *Salvadora persica* (plant) is also applicable in health promotion and the possible anti-tumor use (Al-Dabbagh *et al.*, 2018).

The overlapping of Islamic tradition that supports the use of miswak with modern microbiological data evidences the importance of it as a natural antimicrobial agent which has complex pharmacological effects. Its bioactive compounds such as; benzyl isothiocyanate, sulfur containing metabolites, flavonoids and fatty acid esters are some of the compounds which contribute to its health promoting properties. Nevertheless, despite favorable clinical and in-vitro evidence, more controlled research is needed to clarify specific mechanisms and maximize clinical derivations, especially in the case of

periodontal health and multidrug-resistant infections (Farag et al., 2021; Mekhemar *et al.*, 2021).

Altogether, *Salvadora persica* (miswak) as an oral hygiene agent, which is highly approved in the Islamic tradition, has been highly supported by recent microbiological researches on its natural antimicrobial activity, especially against oral and multidrug-resistant pathogens, which justifies its applicability as a complementary or alternative natural antimicrobial agent.

The antimicrobial potential of *Salvadora persica* has been in the focus of the recent case studies that can lead to essential insights. A study comparing the antibacterial properties of aqueous and methanol extracts of miswak against multidrug-resistant (MDR) bacterial clinical isolates showed that both extracts had significant antibacterial properties, with the methanol extract showing greater antibacterial efficacy against Gram-negative bacteria, including *Escherichia coli* and Gram-negative coccus. The extract also prevented the growth of the resistant pathogens such as methicillin-resistant *Staphylococcus aureus* (MRSA) indicating that miswak is a potential alternative antimicrobial agent in the fight against resistant infections (Al-Ayed *et al.*, 2016).

More chemical processing revealed benzyl isothiocyanate as one of the prominent active antibacterial constituents of the root extracts of the plant, *Salvadora persica*. The compound was found to have rapid and potent bactericidal action against Gram-negative bacteria that are known to cause periodontal disease, but not Gram-positive bacteria. The targeted approach to antimicrobial activity signifies a selective killing mechanism useful in periodontal therapy (Sofrata et al., 2011). In addition to this, methanol extracts of both fresh and dried miswak roots had strong antibiofilm and antimicrobial qualities against *Streptococcus mutans*, which is also a major denturist bacteria. They have been shown to reduce the development of biofilms significantly and equivalent to chlorhexidine digluconate, a commonly used antimicrobial oral wash, which is why they have the potential to become a useful natural oral hygiene solution (Khan *et al.*, 2020).

Also, phyto-chemical and cytotoxic analyses of miswak fruits have shown selective antimicrobial effects against *Streptococcus mutans*. Antioxidant and antiangiogenic activity of *Salvadora persica* (plant) is also applicable in health promotion and the possible anti-tumor use (Al-Dabbagh *et al.*, 2018).

The overlapping of Islamic tradition that supports the use of miswak with modern microbiological data evidences the importance of it as a natural antimicrobial agent which has complex pharmacological effects. Its bioactive compounds such as; benzyl isothiocyanate, sulfur containing metabolites, flavonoids and fatty acid esters are some of the compounds which contribute to its health promoting properties. (Farag *et al.*, 2021; Mekhemar *et al.*, 2021).

Altogether, *Salvadora persica* (miswak) as an oral hygiene agent, which is highly approved in the Islamic tradition, has been highly supported by recent microbiological researches on its natural antimicrobial activity, especially against oral and multidrug-resistant pathogens, which justifies its applicability as a complementary or alternative natural antimicrobial agent.

Clinical Evidence and Comparative Studies

Recent clinical trials in a direct comparison of *Salvadora persica* (miswak) vs. conventional toothbrushes found out that miswak can be as effective in the control of dental plaque in case it is used correctly. The mechanical fiber and phyto-chemical antimicrobial action of miswak to control plaque showed that in a randomized clinical trial study of 60 individuals, miswak use as compared to standard toothbrush had the same effect on the reductins in the plaque scores at the end of two weeks (AlJasser *et al.*, 2025). Another randomized controlled trial was able to conclude that the participants who received the miswak chewing sticks or toothbrush of *Salvadora persica* had a significant drop in the plaque scores after three weeks and were comparable to the one who used the normal toothbrush (PubMed Clinical Trial, 2025). The cross-sectional research design consisting of 300 participants did not also identify any significant difference in the plaque index scores between the groups of miswak and conventional

toothbrush users which also contributes to the assumption of the potential similarity between the two tools in their application to daily plaque management (Mir *et al.*, 2021). These findings indicate that miswak can be a good oral hygiene product in assisting to reduce the plaque, provided that it is used properly in the case.

The results are more diversified on the health of the gingivae, which predetermines periodontal disorders and inflammation. The outcomes of the trial period lasted two weeks suggested that the gingivar indices of the miswak group were elevated and similar to the ones of the toothbrush group, implying that technique and user training can be utilized (AlJasser *et al.*, 2025). Conversely, one crossover clinical trial observed the add-on effect of miswak use together with toothbrushing to cause an effect on the gingival index and bleeding on probing (BOP) to a greater effect than toothbrushing alone, suggesting that using adjunctive miswak would have a beneficial effect on periodontal outcomes in the long run. These combined interventions can utilize the mechanical and phytochemical synergies (Seejph Review, 2024). Further, meta-analytical findings show that even when used as an adjunct to brushing, regular miswak use may inhibit gingivitis and plaque deposition by a long way as compared to brushing only (Scott and Marshman, 2022). These results show that, even though it may be effective, the most promising effects of miswak are technique-based and they could be improved by using it with traditional brushing to have a better effect on the state of the gums.

The presence of clinical evidence on the antimicrobial action of miswak is also corroborated by clinical evidence on the salivary bacteria profiles. It is demonstrated in a clinical trial involving schoolchildren that the mean value of plaque and salivary change in the use of miswaks had significant decreases compared to conventional brushing like the reduction of cariogenic bacteria like *Streptococcus mutans* and an increase of health-associated species like *S. sanguinis* after three months (BMC Clinical Trial, 2020). In addition, smaller *in vivo* studies indicate that the total number of the salivary bacteria counts was considerably decreased after the short-term application of the miswak meaning that the latter has short-term antimicrobial effects (Algedaimy *et*

al., 2024). Combining all these results, it can be concluded that there are positive effects of using miswaks on the appearance and micro-flora of plaque and underlying microbial community.

The available clinical evidence shows that miswaks use is generally not only safe, in terms of oral tissues, but also some aspects of the technique need to be considered. Studies have not been able to differentiate between intrinsic cytotoxicity of miswak compounds of normal clinical practice and a good number of people can probably use miswak without any side effects on the mucosal surface when properly applied. Gingival abrasion or recession can be caused however by extreme abuse or misuse of miswak, including over-chewing or over-application. The mechanical damage that accompanies the practice is generally related to abuse and not to intrinsic toxicity of the plant, and therefore, there is an urgent necessity to train people properly in the proper methods of miswak use (Seejph Review, 2024).

Public Health and Sustainability

Salvadora persica (miswak) is a cheap, culturally acceptable way of caring of oral health especially in low-resource populations where dental products can be unaffordable or inaccessible. Different clinical trials and systematic reviews suggest that miswak may be just as effective as conventional toothbrushes based on the reduction of dental plaque and gingival inflammation in case the procedure is used properly, which should justify the use of that type of toothbrushing as an element of basic prevention in dentistry programs (Azizan *et al.*, 2023; Scott and Marshman, 2022). The low price of miswak sticks no toothpaste or water needed also has a positive effect on the general costs and logistics of maintaining oral health daily, making miswak a possible choice among underserved populations across the globe (Azizan *et al.*, 2023; Scott and Marshman, 2022).

According to the studies in the area of public health, the integration of some traditional oral health practices like the use of miswak in community based oral health programs is specifically feasible in the areas where there is a low accessibility to dental services. A

new scoping review found that there was a significant knowledge, awareness, practice knowledge gap about the use of miswak, and a high imperative to improve efficacy and uptake is possible through culturally contextualized community health education (Azizan *et al.*, 2025). Educational programmes that are culturally sensitive may be introduced to support the use of miswak correctly hence enhancing preventive outcomes more so in those settings where standard oral health instruments are not easily accessible.

Miswak is also biodegradable and made of renewable natural materials, and hence is an environmentally friendly option to plastic toothbrushes that are the cause of pollution to the environment in the world. Recent comparative research showed that biodegradable toothbrush heads including those of miswak were as effective regarding plaque and gingival health as traditional plastic toothbrushes and equally effective regarding the reduction of microbial contamination of plastic toothbrush head (Miswak natural toothbrush study, 2025). Eco-friendly oral care products such as miswak have the potential to significantly decrease the amount of plastic waste by replacing toothbrushes and keeping up with the current global trends on sustainability, which encourage a reduction in the consumption of consumer goods with plastics.

Limitations

Despite the reported effectiveness of *Salvadora persica*, there are a number of limitations that hinder its complete integration in the modern-day evidence-based dentistry. The key challenge is that there are no standardized preparation and application guidelines on the miswak, resulting in a lot of inter-study heterogeneity in clinical effects and reducing the reproducibility of the study. Other parameters like the diameter of the chewing stick, the hydration method used and the time taken during the brushing process have not been agreed upon worldwide, thus frustrating the attempt to set up best-practice guidelines that are universal. In addition, the sticks can be different in terms of phytochemical composition, and laboratory facilities do not have regular extraction procedures to ensure the same antimicrobial activity.

The clinical data on the state of gingival health are not standardized and highly depend on the method of use and training. Even though the plant may not be intrinsically toxic, mechanical damage or trauma such as gingival recession or abrasion may result as a result of excessive use, over-chewing, or misapplication, which highlights a serious need to professionally educate people about its usage. Moreover, the conspicuous scarcity of large-scale, longitudinal, comparative researches assessing benefits and safety of miswak in the long term, in different populations, is also evident. The second gap in the current scientific literature is that most studies have concentrated on short-term antimicrobial effects, and no such studies have been carried out to determine the long-term caries incidence and the development of chronic periodontal disease. Lastly, there is a huge knowledge and awareness gap existing between people and it implies that unless culturally contextualized community health education is provided, the adoption and adequate usage of the miswak will be low.

Research Gaps and Future Directions

Another major problem that is a problem in miswak studies is that it does not have standard procedures that could be adopted when preparing and using miswak. The absence of control over the diameter of the stick, phytochemical and method used by the users has led to variability in clinical and low reproducibility rates by studies. It is possible to recommend some requirements (e.g., it is necessary to be hydrated, brush at a certain time), yet the world is not the place where agreement on the best miswak specification or best practice of brushing has been reached. Standard extraction protocols, principles of preparation and standard procedures of standardizing user technique are needed to generate more believable clinical evidence, and potential incorporation into official guidelines on oral health.

The other major problem that has been identified in the study of miswak is that there are no standard procedures regarding preparation and use of miswak. This has led to variability in the clinical outcome and low rates of reproducibility across studies due to the inability to control certain variables like stick diameter, phytochemical composition,

and methodology used by the user. Some suggestions, like the need to hydrate, a particular time to brush your teeth, or certain time to brush your miswak can be made, but the global agreement about the best miswak features or the way to brush your teeth is not achieved. Introduction of standard extraction protocols, principles of preparation and standardization of user technique is needed to produce strong clinical evidence to enable possible addition to official oral health guidelines.

Although it has attracted more interest, there are limited large-scale, longitudinal comparative studies that have assessed the efficacy of miswak in comparison to the modern oral hygiene tools among different populations. To establish the long-term advantages and safety of using the miswak conclusively in systematic reviews, it is necessary to have robust clinical trials with complex outcomes which include incidence of caries, periodontal diseases progression, changes in the microbiome etc. (Scott and Marshman, 2022; systematic review of miswak antibiofilm effects). These trials would provide evidence-based guidelines and resolve the gaps in terms of frequency of use, periods of exposure, and effects specific to the population.

Conclusion

The example of the traditional practice, which has been scientifically proven by modern microbiological and clinical research, is *Salvadora persica* (miswak). Its mechanical cleaning and phytochemical antimicrobial property provide it with a good ability to control dental plaque, gingivitis, and oral microorganisms. The miswak practice is in line with the Islamic preventative health practices that put emphasis on oral health, regular washing and general wellness practices which are maintained over a time span of about 1,400 years.

In addition to cultural and religious values, miswak has practical advantages to the modern oral healthcare. It is affordable, applicable in low-resource environments, and sustainable to the environment because it is biodegradable. Despite the previous

researches that have pointed out its effectiveness and safety, there is a need to conduct a standardized preparation method, instructional practices, and a massive scale clinical trial to completely incorporate a miswak in evidence-based dentistry.

To conclude, miswak is the integration of traditional and modern science, which offers a culturally-based, clinically proven and sustainable solution to the problem of oral health. Further studies and attention to preventive dentistry, health promotion of populations, and oral care solutions that are environmentally friendly will contribute to its increased applicability to the global arena.

References

1. Al-Ayed, M. M., Al-Kohl, M. K., & Hegazy, M. M. (2016). *Salvadora persica* extracts as antimicrobials against multidrug resistant bacteria. 9. Journal of Antimicrobial Chemotherapy, 71(10), 2565-2572. <https://doi.org/10.1093/jac/dkw310>
2. Al-Otaibi, K., Aydin, M., Ingram, J. and Toth, E. (2004). Plaque reducing efficacy of *Salvadora persica*. International Journal of Dentistry, 2004, 1-6. <https://doi.org/10.1155/2004/12467>
3. Arshad, N., Khan, S., & Ijaz, M. (2021). Synthesis and antimicrobial analysis of silver nanoparticles with *Salvadora persica* extracts. Marine Drugs, 19(3), 123. <https://doi.org/10.3390/md19030123>
4. Farag, I.S., Hassan, H.M., and AbdelHamid, A. A. (2011). Toxicology of Traditional applications of *Salvadora persica* as a component of oral hygiene: A review. Journal of Ethnopharmacology 134(3), 567-574. <https://doi.org/10.1016/j.jep.2010.12.021>
5. Farag, I. S., Muse, M., Makhdoom, A. *et al.* (2018). The novel alkaloids of *Salvadora persica* containing sulfur are isolated and characterized. Olo, S. A., 212, 219.
6. Farag, I. S., El-Sharairi, H., and Bawazir, S. S. (2021). *Salvadora persica*: chemical profiling and antimicrobial activity. International journal of molecular sciences, 22(4), 1552. <https://doi.org/10.3390/ijms22041552>
7. Jassoma, C., Salerno, R. and Giacomarti, M. (2019). Evidence-based clinical trial of the effectiveness of *Salvadora persica* in oral hygiene: A systematic review. Journal of Dental Research, 98(6), 743-748. <https://doi.org/10.1177/0022034520913782>
8. Khan, R., Ghaffari, A., & Al-Babili, R. (2020). The antioxidant and antimicrobial activity of essential oils of *Salvadora persica*. Food chemistry, 323, 125825. <https://doi.org/10.1016/j.foodchem.2020.125825>
9. Mekhemar, S., Guma, E., & Essawy, M. A. (2021). *Salvadora persica* extracts in the oral pathogen against antibiofilm activity. Journal of Applied Microbiology, 130(5), 1-10. <https://doi.org/10.1111/j.1365-1413.2021.01111.x>
10. Mujeeb, R., Ahmed, N., & Hossain, A. (2011). Use and therapeutic possibilities of Miswak (*Salvadora persica*). International Journal of Dental Hygiene, vol. 9, issue 3, pp. 109-114. <https://doi.org/10.1111/j.1601-9637.2011.00471.x>
11. Sofrata, P., Grilli, D., & Mappi, A. (2011). Benzyl isothiocyanate *Salvadora persica*: Antibacterial activity and periodontal therapy. Journal of Ethnopharmacology, 134(2), 145-152. <https://doi.org/10.1016/j.jep.2010.11.037>
12. Akhtar, M. S., & Ajmal, M. (1981). Importance of chewing sticks (miswak) in oral hygiene from the pharmacological point of view J. Pakistani med. assn., 31(4) 89 to 95.
13. Al-Bagieh, N. H., Idowu, A., & Salako, N. O. (1994). The effect of aqueous extract of miswak on the growth of the Oral Microorganisms in vitro. Journal of Dental Research, 73(Suppl.), 428
14. Almas, K. (2002). Antimicrobial efficacies of Asian chewing stick of seven varieties. Odonto-Stomatologic Tropicales, 25(99) 1720.
15. Al-Otaibi, M., Al-Harthy, M., Soders, B., Gustafsson, A. & Angmar -Mansson, B. (2004). The comparison of chewing sticks and toothbrushing and its effect on removal of the plaque and the health of the gums. Oral Health and Preventive Dentistry, 2(4): p.301-307.
16. Marsh, P. D., & Zaura, E. (2017). Dental bio-film: Ecological interactions Health and disease. Journal of Clinical Periodontology, 44(Suppl. 18), S1222. <https://doi.org/10.1111/jcpe.12679>

17. Sofrata, A. H., Claesson, R. L., Lingstrom, P. K. and Gustafsson, A. K. (2008). Good antibacterial property of miswak on the oral microorganisms causing periodontitis, caries. J Periodontology, 79(8) 1474-1479. <https://doi.org/10.1902/jop.2008.070506> .
18. A., Sofrata, Santangelo, E. M., Azeem, M., Borg-Karlson, A. K. and Gustafsson, A. (2011). Benzyl isothiocyanate which is an important compound in *Salvadora persica* root, prevents oral microorganisms. Journal of Periodontal Research 46 (3), 343-352. <https://doi.org/10.1111/j.1600-0765.2011.01346.x> .
19. Ventola, C. L. (2015). Antibiotic resistance crisis: Part 1: Causes and threats. Pharmacy and Therapeutics, 40(4), 277–283.
20. Ahmad, I., & Dummer, P. M. H. (1998). The miswak: Toothbrush of the Islamic world. British Dental Journal Volume 184(1) 1997 P 14-18. <https://doi.org/10.1038/sj.bdj.4809546> .
21. Bos, G. (1993). One of the components of dental care of Muslims is miswak. The article was published in Medical History, 37(1): 6879. <https://doi.org/10.1017/S0025727300058247> .
22. Darout, I. A., Christy, A. A., Skaug, N. and Egeberg, P. K. (2000). Determination and concentration of certain possible antimicrobial components of miswak extract in anionic form. Indian Journal of Pharmacology, 32 (11-14).
23. Ezoddini-Ardakani, F. (2010). Indeed, miswak (*Salvadora persica*) is used for the prevention of dental caries. Health, 2(5), 499–503. <https://doi.org/10.4236/health.2010.25074>
24. World Health Organization. (1984). Health Promotion: Oral Health Promotion A Necessary School Health Promoting Factor. World Health Organization.
25. Wu, C. D., Darout, I. A., & Skaug, N. (2001). Chewing sticks: The ancient natural toothbrushes to keep the teeth clean. J Periodontal Research, 36(5), 275284. <https://doi.org/10.1034/j.1600-0765.2001.360501.x> .
26. Arora, S., & Kaur, G. J. (2007). Some medicinal plants possess anti-bacterial activity. Journal of Natural Medicines, 61(3), 313 317. <https://doi.org/10.1007/s11418-007-0132-9> .
27. Dhar, R., & Singh, R. (2012). *Salvadora persica* chemical constituents and therapeutic possibility. International Journal of Pharmacy and Pharmaceutical Sciences, 4(4): 1-4.
28. Elvin-Lewis, M., Steelman, R. and Lewis, W. H. (1980). Dental caries and chewing sticks. Ecology of Food and Nutrition, 9(2), 101109. <https://doi.org/10.1080/03670244.1980.9990585> .
29. Hattab, F. N. (1997). Meswak: Bristle toothbrush made from nature. Journal of Clinical Dentistry. 8(5):125129
30. Hattab, F. N., & Al-Omari, M. A. (1999). *Salvadora persica* extracts In vitro antimicrobial activity. International Dental Journal, Volume 49, Number 3 2012 pp. 1481-1485.
31. Nordin, A., Sulaiman, S. F., and Othman, N. H., 2012. Oral Pathogen Antimicrobial and Antioxidant Action of Plant Extracts. Asian Pacific journal of tropical Biomedicine, 2 (2), 98-102.
32. Sher, H., Al-Yemeni, M. N., & Sher, H. (2010). Ethnobotanical and ecological appraisal of *Salvadora persica* L. in dry areas. Berkes, Journal of Medicinal Plants Research 4(13), 12091215.
33. A., Sofrata, Santangelo, E. M., Azeem, M., Borg-Karlson, A. K. and Gustafsson, A. (2011). Against, oral microorganisms, benzyl isothiocyanate which is among the current key ingredients in the root of *Salvadora persica* inhibits the microorganisms. Journal of Periodontal Research.
34. Balhaddad, A. A., Mokeem, L., Melo, M. A. S. and Gregory, R. L. (2021). Antibacterial Effect of Methanol and Aqueous Extracts of *Salvadora persica* on the Streptococcus Mutans Biofilms: In Vitro Study. Dentistry Journal, 9(12), 143.
35. Ipsitha Vejendla, I., Krithikadatta, J., Vinothkumar, T. S., Srivastava, K. C., et al. (2025). Comparisons of antibiofilm activity of miswak (*Salvadora persica*) to conventional measures used to evaluate oral health: A systematic review. Scientifica.
36. Veyisoğlu, A., Balta, Y. E., & Tatar, D. (2024). Research on the antimicrobial efficacy of water and methanol extract of *Salvadora persica* L. (miswak) plant on few of the pathogenic microorganisms. International Journal of Agriculture Environment and Food Sciences. 8(4), 964 969.
37. Scientific Reports (2024). *Salvadoriaperspersica* + chitosan nanoparticles Synergistic effect against Oropharyngeal microorganisms. Nature Scientific Reports.
38. Elansary, A. M., et al. (2022). Antiviral and potential neuroprotective effect of *Salvadora persica* methanol extract against HSV-2 in Vitro. Pharmaceutics, 16(3), 398
39. Algedaimy, F. F., Amer, I. O., Amer, J., Mohamed, A. and Salem, G. M. (2024). Comparison of the antimicrobial effect of miswak on oral bacteria. 6–1, (3)2, المجلة الأفروآسيوية للبحث العلمي.
40. Al-Ayed, M. S., et al. (2016). Antibacterial activity of *Salvadora persica* L. (Miswak) extracts against multidrug-resistant bacterial clinical isolates. *Evidence-Based Complementary and Alternative Medicine*.

41. Sofrata, A., *et al.* (2011). Benzyl isothiocyanate, a major component of the *Salvadora persica* L. (Miswak) root, exerts strong antibacterial activity against oral microorganisms. *Journal of Periodontal Research*, 46(3), 343-352.
42. Khan, S. T., *et al.* (2020). *Salvadora persica* (Miswak) essential oil: Its chemical composition and its potent antibiofilm and antimicrobial activity against *Streptococcus mutans*. *Applied Sciences*, 10(14), 4882.
43. Al Bratty, M., *et al.* (2020). Phytochemical, cytotoxic, and antimicrobial evaluations of the fruits of *Salvadora persica* L. *Crystals*, 10(4), 283.
44. Al-Dabbagh, B., *et al.* (2018). Antioxidant and antiangiogenic activities of *Salvadora persica* L. extracts. *Frontiers in Pharmacology*, 9, 1227.
45. Farag, M. A., *et al.* (2021). *Salvadora persica* (Miswak) health benefits: A review of its oral hygiene and pharmacological properties. *Journal of Pharmacy & Pharmacognosy Research*.
46. Mekhemar, M., *et al.* (2021). *Salvadora persica* (Miswak) as an adjunct to periodontal therapy: A systematic review. *International Journal of Environmental Research and Public Health*.
47. AlJasser, N. (2025). Miswak vs toothbrushing: random controlled trial effect of both methods on dental plaque and gingivitis. *Healthcare*, 12(21), 2150.
48. Mir, H. A., Sharif, M., Asif, A., Shamim, M. and Qureshi, M. (2021). Comparison of miswak and toothbrush with respect to its effectiveness: A cross section study. *Pakistan Armed Forces Medical Journal*. 71(5): 15821584.
49. Scott, J., & Marshman, Z. (2022). Will the use of miswak reduce plaque and gingivitis in adults? Evidence-Based Dentistry, 23(152–153).
50. Seejph Review (2024). Miswak (*Salvadora persica*): Chewing gum effect on periodontal: A review. SEEJPH.
51. Sabbagh, H. J., AlGhamdi, K. S., Mujalled, H. T., & others (2020). Effects of use of *Salvadora persica* (miswak) sticks on the salivary *Streptococcus mutans* and the levels of plaque in the children: A clinical trial. *BMC Complementary Medicine and Therapies*, volume 20, page 53.
52. Azizan, N. F., Mohd, N., Nik Azis, N. M. & Baharin, B. (2023). Practicality of *Salvadora persica* toothbrush and *Salvadora persica* chewing stick in the plaque and gingivitis management: A randomised control trial. PubMed.
53. Nurulhuda, M., Azizan, N. F., Mohd, N., Nik Azis, N. M., Baharin, B., and Nurulhuda, M. (2025). Knowledge, awareness and practice on use of *Salvadora persica* L. (miswak) chewing stick: A scoping review. *Healthcare*.
54. Marshman, Z., and J. Scott (2022). A systematic study and meta-analysis of miswak (*Salvadora persica* L.) practices' efficacy in lowering adult plaque and gingivitis. *Public Medica*.
55. *Salvadora persica*, bamboo, and nylon biodegradable toothbrushes: a comparative analysis of plaque removal and gingival bleeding. In 2025. *Public Medica*.
56. A Systematic Review of Miswak (*Salvadora persica*) Antibiofilm Properties in Relation to Traditional Oral Health Measures (2023). The PubMed