

Review

# Therapeutic properties of meswak chewing sticks: A review

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Meswak “a chewing stick” usually 15 cm long and 1 cm in diameter is taken from the roots or young twigs of *Salvadora persica* L. Meswak has been used in folk medicine for a very long time for different medical condition treatments. The cultural and religious use of meswak for dental hygiene is still wildly spread, throughout parts of Asia, Africa, and Middle East, and because of its wide distribution. Clinical studies comparing adult habitual meswak users and habitual toothbrush users have shown better periodontal status in meswak users. However, the beneficial effects of meswak in respect of oral hygiene and dental health are partly due to its mechanical action and pharmacological actions. Different studies conclude that the values of these sticks are probably due to their different chemical components and ways of cleaning mechanisms. Previous literature reveals that meswak has strong antimicrobial (antibacterial, antifungal, and antiviral) and pharmacological (hypoglycemic, anti-platelet aggregation, anti-ulcer, and anti-oxidative) activities. The use of meswak has been recommended by Islam. Actually, meswak was known before Islam, but Islam added a religious prospective to the use of meswak. It is endowed by several characteristics supporting its use. In view of such facts, the ecology, geographical distribution, and the chemical constituents of the plant have been investigated time by time by several researchers. The therapeutic aspects of meswak and its important role in plaque control, gingival recession, tooth wear, bleeding gums, and periodontal health as well as its availability and cheap cost factor may be the major reasons for its recommendation by world health organization. The present review concludes the biology of meswak tree and cultural value of meswak with reference to current literature.

**Key words:** Meswak, folk medicine, Islam, dental, oral hygiene, antimicrobial, review.

## INTRODUCTION

Recently, there has been renewed interest in the use of natural medicine for the promotion of general health (Jones, 1996; Winslow and Kroll, 1998). In spite of the tremendous progress in the development of medical science, plants continue to be an important source of drugs in many countries around the world. It is expected that during the past two decades, reliability and usage of herbal product has become of increasing importance, due to the side effects and complications of many chemical

and synthetic medicines. Furthermore, the usefulness of traditional oral medicine in the control of oral diseases is gaining increasing interest, and clinical investigation of these indigenous means is emerging (Gazi et al., 1990; Mullally et al., 1995). The use of meswak for oral hygiene has a long tradition in Middle Eastern and African countries, going back several centuries (Bos, 1993). Moreover, in the Middle East, the most common source of chewing sticks is Arak (*Salvadora persica*) (Almas and Al-Lafi, 1995). Meswak (also called miswak, misswak, or mswaki) is a chewing stick prepared from the roots or twigs of *S. persica* (Elvin-Lewis, 1980). Sticks from these plants are usually chewed on one end until they become

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frayed into a brush like form, which is then used to clean the teeth in a similar manner to a toothbrush. In addition to strengthening the gums, it prevents tooth decay, eliminating toothaches and halt further increase in decay that has already set in. It creates a fragrance in the mouth, eliminates bad odor, improves the sense of taste, and causes the teeth to glow and shine. The other parts of the tree have therapeutic values as corrective, deobstruent, liver tonic, diuretic, analgesic, anthelmintic, astringent, lithontriptic, carminative, diuretic, aphrodisiac, and stomachic. Moreover, the beneficial effects of meswak in respect of oral hygiene and dental health are partly due to its mechanical action and pharmacological actions. It has been shown that the use of meswak chewing sticks may contribute to a higher level of gingival recession (Eid et al., 1991; Eid and Selim, 1994) and may also be associated with occlusal tooth wear (Johansson et al., 1991). The sticks are usually implemented for 3 to 5 min several times a day, and/or about 25 times a day in the religious category, often on the buccal and occlusal surfaces of teeth. The cultural and habitual use of meswak is still wildly spread throughout parts of Asia, Africa, and the Middle East (Elvin-Lewis, 1980). The easy access and low cost of meswak has made it a very cost effective plaque control tool in different communities (Bos, 1993; Darout et al., 2000; Wu et al., 2001; Hyson, 2003). The World Health Organization has recommended and encouraged the use of chewing sticks, because of its popularity and familiarity (WHO, 1987). Recently, chewing sticks have been reviewed comprehensively (Wu et al., 2003; Ra'ed and Almas, 1999) and examination of their effectiveness as an oral hygiene aid has been encouraged (FDI, 2000). Various medicinal properties are attributed to *S. persica* in traditional system of medicine. Hassan et al. (2011) conducted a detailed survey in different parts of Saudi Arabia to obtain information about the folklore uses, knowledge of local people, and traditional healers about this popular plant. Based on the results obtained, they concluded that *S. persica* is a versatile medicinal plant used to treat different human and livestock ailments. It is used for dental care, antiulcer, and possesses anti-inflammatory properties.

This review encompasses the literature on the general biology, that is, ecology, biogeography, phytochemistry, pharmacology, and traditional and modern cultural use of meswak. The literature abounds with papers describing wide spread and most potential effect of this natural remedy, evaluating it as the important and successful oral hygiene tool. This article gives a brief cultural and historical background of the subject and review current literature on Miswak.

## ECOLOGY AND BIOGEOGRAPHY OF MESWAK TREE

*S. persica* is a small tree or shrub having crooked trunk,

normally more than one foot in diameter. The bark of this tree is scabrous and cracked, whitish in color with pendulous extremities. The root bark has a pleasant fragrance, as well as a warm and pungent taste. It sheds its leaves from late December to January. It is an evergreen shrub or a tree, large, and much-branched. The bark is dull grey or grey-white, deeply cracked, and the leaves are variable in shape, elliptic-ovate or ovate-lanceolate, somewhat fleshy. The flowers are pedicellate, greenish-white or greenish-yellow in lax panicles, drupes are globose or round, smooth, red when ripe. The trees readily regenerate from seeds and coppice well

*S. persica* is widespread, and is found in the dry and arid regions of Asia and Africa and on saline lands and in coastal regions just above the high water mark, notably in thorn shrubs, desert floodplains, river and stream bank vegetation, and grassy savannahs (AFT, 2012) (Figure 1).

## PHYTOCHEMISTRY AND PHARMACOLOGY OF MESWAK TREE

The phytochemistry of meswak tree reveals an important drugs and chemicals which are the back bone of its pharmacological properties. Till now, due to advanced analytical techniques, a number of chemicals have been identified as shown in Table 1.

### Clinical studies contributing to the pharmacological effect of meswak

The efficacy of natural toothbrush or meswak in the prevention of dental caries has been investigated and compared with the efficacy of ordinary toothbrush and toothpaste. There is also evidence that miswak is more effective as an oral hygiene tool in buccal than lingual tooth surfaces (Gazi et al., 1990). Olsson (1978) assessed the oral hygiene efficacy in miswak, and meswak and the toothbrush showed similar oral hygiene effects. On the other hand, there are no valid population level data on the effects of using traditional oral hygiene means on periodontal health. Darout et al. (2000) reported that the periodontal status of miswak users in a Sudanese population was better than that of toothbrush users, suggesting that the efficiency of miswak use for oral hygiene is comparable or slightly better than toothbrush (Darout et al., 2000). Moreover, several clinical studies have reported that miswak has a positive effect on gingivitis and plaque removal (Olsson, 1978; Al-Otaibi et al., 2003). Clinical studies on saliva showed that using miswak sticks (Figure 2) or rinsing with aqueous miswak extract has an immediate inhibitory effect on salivary bacteria (Gazi et al., 1992; Darout et al., 2002; Almas and Al-Zeid, 2004). Clinical studies on habitual miswak users have shown some effects of miswak on the

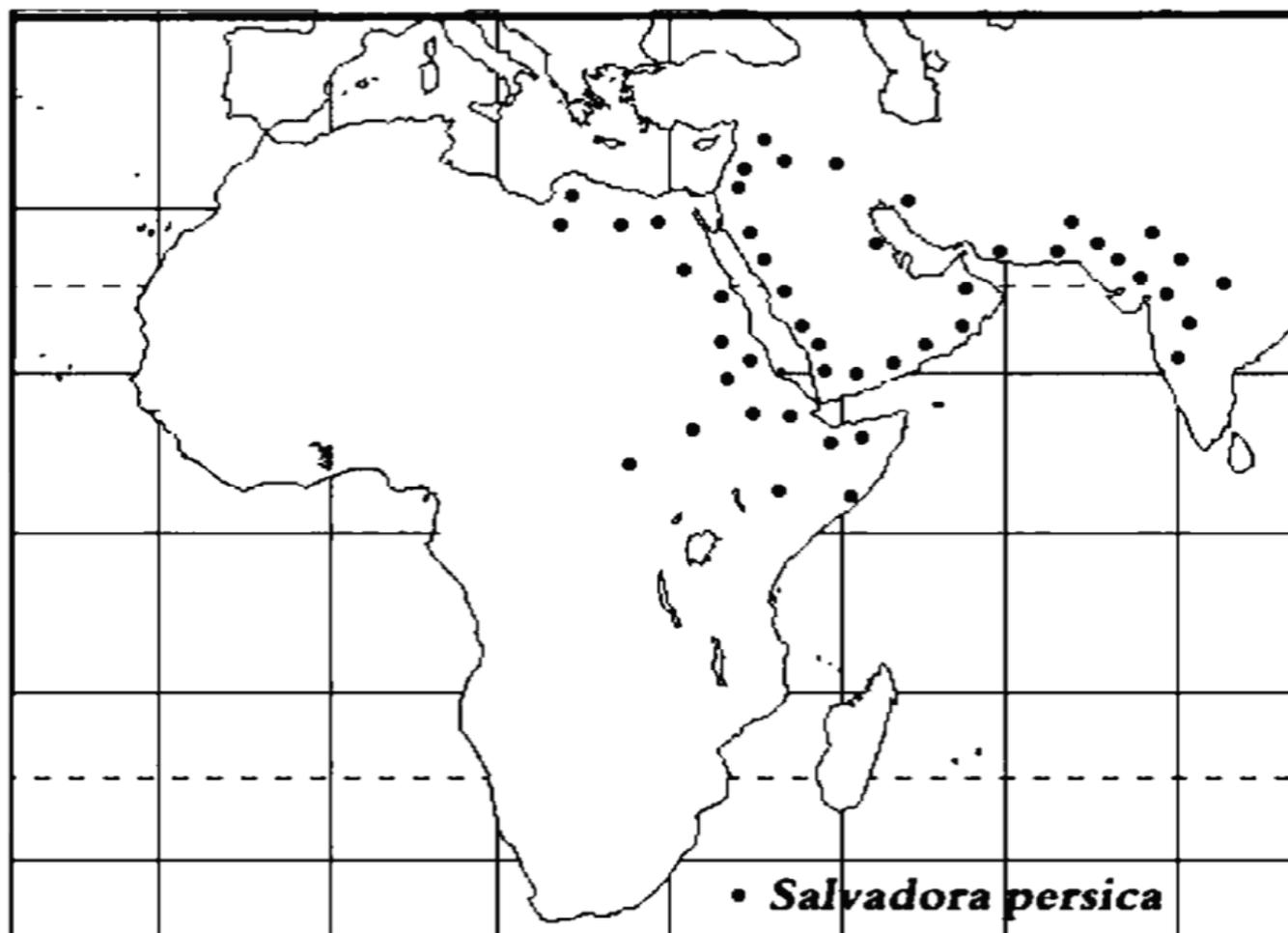


Figure 1. World distribution of *S. persica* L. (Thomas et al., 2008).

Table 1. Review of compounds/metals extracted from *S. persica*.

Compound/metal	Plant part	Reference
N4-Bis(phenylmethyl)-2(s)-hydroxy.butanediamide, N-benzyl.2.phenylacetamide, N-benzylbenzamide, and benzyl urea	Stem	Ashraf (2006)
$\beta$ -Sitosterol, stigmasterol, camp sterol, and cholesterol	Stem	Ma'ayergi et al. (1984)
Cu, Ni, Mn, V, Ti, and Mo	Leaf	Almas (2001)
$\alpha$ - and $\beta$ -Thujones, camphor, cineole, $\beta$ -cymene, limonene, $\beta$ -myrcene, borneol, linalool, and bornyl acetate and nonvolatile fraction contained humulene, caryophyllene, $\beta$ -santatol, and farnesol	Seed	Hyson ( 2003)
Benzyl isothiocyanate, benzyl nitrile, carvacrol, benzaldehyde, aniline and naphthalene	Stem, root	Emira et al. (2011) and Al-Bagieh (1992)
Benzyl nitril, isotymol, thymol, eugenol, $\beta$ -caryophyllene, eucalyptol, and isoterpinolene	Stem	Alali and Al-Lafi (2003)
1,8-Cineole , $\alpha$ -caryophyllene , $\beta$ -pinene, and 9-epi-(E)- caryophyllene	Stem	Alali et al. (2004).
Rutin and quercetin	Root	Abdel-Wahab et al. (1990)



**Figure 2.** Meswak sticks (Fatemh, 2010).

dental health of its users (Darout et al., 2000; Wu et al., 2001). Moreover, several studies have shown that chewing stick is as or more effective than the toothbrush in reducing plaque and gingivitis by using the checkerboard hybridization technique to compare subgingival plaque samples of regular miswak and toothbrush users (Olsson, 1978; Danielsen et al., 1989;

Gazi et al., 1990; Al-Otaibi et al., 2003).

#### **Pharmacological effect of different components of meswak**

The effectiveness of a topical fluoride preparation

depends on its ability to wet the tooth enamel and adequately reach caries susceptible sites, such as pits, fissures, and interproximal areas. Silica in meswak acts as an abrasive material to remove stains giving the teeth whiteness (El Mostehy et al., 1983). Tannins (tannic acid) are a mixture of esters of gallic acid with glucose whose exact composition varies according to its source. Tannic acid is an astringent that precipitates albumin. It exerts an astringent effect on the mucous membrane, thus reducing the clinically detectable gingivitis (Chawla, 1983). Tannins also inhibit the action of glucosyl transferase, thus, reducing plaque and gingivitis (Kubota et al., 1988). Resins are amorphous products with a complex chemical composition. They are end products of metabolism. Resin forms a layer over the enamel and thus protects against caries. Alkaloids are one of a large group of basic nitrogenous organic compounds found in plants, usually having strong physiological or toxic effects on the animal body. The alkaloid present in *S. persica* is Salvadorine, which yields trimethylamine on hydrolytical cleavage (Dorland, 1988). It exerts a bacteriocidal effect and stimulatory action on the gingival (Almas, 1993). Essential (volatile) oils possess characteristic aroma and exert carminative, antiseptic action (El Mostehy et al., 1983). The mild bitter taste stimulates the flow of saliva, which is antiseptic (Dorner, 1981). Sulfur compounds present in Miswak as shown by their pungent taste and smell have a bacteriocidal effect (Grant, 1990). Vitamin C helps in the healing and repair of tissues. Sodium bicarbonate (NaHCO<sub>3</sub>; baking soda) has mild abrasive properties and is, thus, used as a dentifrice, in addition to having a mild germicidal action (Abo and Al-Bagieh, 1996). High concentrations of chloride inhibit calculus formation and help in removing stains from the teeth (Almas, 1993). Calcium saturation of saliva inhibits demineralization and promotes remineralization of tooth enamel (Kubota et al., 1988). Moreover, the root of *S. persica* contains steam-distillable oil that composed of 10% benzyl nitrate and 90% benzylisothiocyanate (BIT) (Mohammad and Turner, 1983; Bader et al., 2002), which is one of its main constituent. BIT is classified as one of the chemo-preventive agents that are to prevent carcinogenic and other genotoxic compounds from reaching or reacting with the target sites on the treated tissue (Ezmirly and El-Nasr, 1981). Some results indicate that BIT retard the development of neoplastic changes induced by trauma or trauma plus DMBA. BIT is reported to have a virucidal activity against herpes simplex virus 1 (HSV-1) at a concentration of 133.3 mg/ml, it inhibits the growth and acid production of streptococcus mutans, and is fungistatic to *Candida albicans* (Al-Bagieh, 1992, 1998; Al-Bagieh and Weinberg, 1988).

Moreover, the hypoglycemic effect (Trovato et al., 1998), anti-platelet aggregation effect (Ashraf, 2006), antiulcer activity (Sanoqo et al., 1999), and anti-oxidative property (Ramadan and Morsel, 2004) of this herb have been elaborately studied. A brief list of microbes tested

for their sensitivity towards the meswak extracts are shown in Table 2.

## ETHNOBOTANY AND CULTURAL USE OF MESWAK

Traditional medicine is an art practiced by few elderly people whose empirical knowledge is respected by everyone in that area. Traditional medicine is accessible, affordable, culturally and socially acceptable and most people prefer it to the 'exorbitantly priced' conventional Western medicine. Plants and natural products from time immemorial are used for their pharmacological applications, namely, antiulcerogenic, wound healing, anti-inflammatory, antimicrobial, antioxidant properties, etc. The wealth of ethnobotanical knowledge and its religious practice regarding meswak has been documented from various parts of Indo-Arabian countries from time to time. Meswak (chewing stick) was used by the Babylonians some 7000 years ago; it was later used throughout the Greek and Roman empires, and has also been used by ancient Egyptians and Muslims. It is used in different parts of Africa, Asia-especially the Middle East and South America. According to Hyson (2003), meswak is one of the oldest oral hygiene in history. The frequency and duration of miswak use may additionally explain its efficacy. According to Bos (1993), the use of miswak for oral hygiene has a long tradition in Middle Eastern and African countries, going back several centuries. In Sudan, oral and dental cleaning with miswak has been practiced since ancient times, despite the availability of modern oral hygiene methods, and the use of miswak is still popular in urban and rural areas, particularly among males (Bos, 1993).

According to Farooqi and Srivastava (1968), the fresh leaves of this plant are eaten as salad and used in traditional medicine for cough, asthma, scurvy, rheumatism, piles, and other diseases. The flowers are small and fragrant, and are used as a stimulant and are mildly purgative. The berries are small and barely noticeable; they are eaten both fresh and dried (Farooqi and Srivastava, 1968) as obtained from the roots of the Arak tree, and some sticks are made from its branches and bark (Bos, 1993).

Studies reveal that the use of meswak was adhered to by the ancient Arabs to get their teeth white and shiny. It also contributed to ritual purity. The religious and spiritual impact of miswak probably is the principal reason why it is extensively used by Muslims all over the globe. Moreover, a study conducted by the Pew Research Center (PRC) in 2010 and released January 2011, found that there are 1.62 billion Muslims around the world, making up over 23% of the world population (PRC, 2011). This suggests the probability of more usage of meswak throughout the world. This custom was adopted and Islamized by Prophet Muhammad (PBUH) around 543 AD. Islam introduced basic oral hygiene by

**Table 2.** Reviewed list of microbes tested for their sensitivity against *S. persica* extract.

Microbes tested using <i>S. persica</i> extracts	References
<i>Staphylococcus aureus</i> ATCC 25923, <i>Staphylococcus epidermidis</i> CIP 106510, <i>Micrococcus luteus</i> NCIMB 8166, <i>Pseudomonas aeruginosa</i> ATCC 27853, <i>Salmonella typhimurium</i> LT2 and <i>P. aeruginosa</i> , <i>Candida albicans</i> , <i>Candida dubliniensis</i> , <i>Candida glabrata</i> , <i>Candida parapsilosis</i> , <i>Candida krusei</i> , <i>Candida famata</i> , <i>Candida kefyr</i> , <i>Candida sake</i> , <i>Candida holmii</i> , <i>Candida lusitanae</i> , <i>Candida intermedia</i> , <i>Candida atlantica</i> , <i>Candida maritima</i> , <i>Pichia guilliermondii</i> , and <i>Pichia jadinii</i> .	Emira et al. (2011)
<i>Streptococcus mutans</i> , <i>P. aeruginosa</i> , <i>Streptococcus faecalis</i> , <i>Streptococcus pyrogenis</i> , <i>Streptococcus faecalis</i> , <i>P. aeruginosa</i> , <i>Lactobacillus acidophilus</i> , and <i>C. albicans</i> .	Al-Bayati and Sulaiman (2008)
<i>Escherichia coli</i> , <i>S. aureus</i> , <i>Bacillus subtilis</i> , and <i>P. aeruginosa</i>	Alali et al. (2004)
<i>S. mutans</i> and <i>Staphylococcus aureus</i>	Hussein (1992)
<i>Actinomyces viscosus</i> , <i>S. mutans</i> , <i>Streptococcus sobrinus</i> , <i>Lactobacillus fermentum</i> , <i>Lactobacillus casei</i> and <i>Eikenella corrodens</i>	Vahabi et al. (2011)
<i>S. mutans</i> and <i>E. corrodens</i>	Abdeirahman et al. (2002)
<i>P. aeruginosa</i> , <i>E. coli</i> , and <i>C. albicans</i>	Ashraf (2006)
<i>Herpes simplex virus</i> , <i>S. mutans</i> , and <i>C. albicans</i>	Al-Bagieh (1992)
<i>Haemophilus influenza</i>	Abier et al. (2011)
<i>Aggregatibacter actinomycetemcomitans</i>	Al-Otaibi et al. (2004)
<i>Streptococcus and staphylococcus aureus</i>	Al-lafi and Ababneh (1995)
<i>S. mutans and lactobacilli</i>	Almas and Al-Zeid (2004)

incorporating it as a religious practice. Islam teaches the importance of cleanliness of the body as well as of the mind. Several quotations are found in the compendium of the Prophet Muhammad (PBUH), as to the benefits of meswak in oral hygiene (Almas and Al- Lafi, 1995). For example: Prophet Muhammad (PBUH) said that meswak purifies the mouth and pleases Allah and were it not to be a hardship on my community, he would have ordered them to use miswak for every ablution (Al Sadhan and Almas, 1999). In other quotes, it is said that, it cleanses and sweetens the mouth and checks its bad smell, it is a cause of Allah's pleasure and a blow to the devil; Allah and his angels love the person doing meswak, it strengthens the gums and improves eye-sight, it is a pure against bible and phlegm (Muhammad, 2008). Muslims, the followers of Prophet Muhammad (PBUH) take it as a compulsory act at some instances, likewise before they go for their prayers, after they enter their houses, and after waking up, which is approximately more than twenty times in a day, that is the reason most of them are

keeping miswak all times with them. In addition, various explanations for the cleansing efficacy of the miswak have been offered, including the mechanical effects of its fibers, the release of beneficial chemicals or a combination of both (Hardie and Ahmed, 1995).

## CONCLUSION

The usefulness of traditional oral medicine in the control of oral diseases is gaining increasing interest, and the clinical investigation of these indigenous means is emerging (Gazi et al., 1990; Mullally et al., 1995). The "Miswak", which is produced from the stolons and branches of *S. persica* is used as a substitute for ordinary tooth brushes (Ma'ayergi, 1984). Literature review revealed that ethnobotanical, pharmacological, and phytochemical studies carried out during the last 32 years have demonstrated the vast medicinal potential of meswak, especially its marked adaptogenic effect (Hilal

et al., 2012). Miswak was generally used for longer periods than the toothbrush (Akhtar and Ajmal, 1981). Other reasons that provoke interest in the study of miswak is its popularity, low cost, and habitual use as an oral hygiene tool in several developing countries. Because of its popularity and familiarity, the World Health Organization has recommended and encouraged the use of chewing sticks (WHO, 1987). Recently, chewing sticks have been comprehensively reviewed (Wu et al., 2003; Ra'ed and Almas, 1999) and examination of their effectiveness as an oral hygiene aid has been encouraged (FDI, 2000). Moreover, results from epidemiological and clinical studies suggest that the periodontal treatment need is low in habitual miswak users. Miswak appeared to be more effective than toothbrush for removing plaque from the embrasures, thus enhancing interproximal health (Al-Otaibi et al., 2003). Al-Khateeb et al. (1991) concluded that when miswak is used five times a day, it might offer a suitable alternative to a toothbrush for reducing plaque and gingivitis. Miswak is used by many people in different cultures and in many developing countries as a traditional toothbrush for oral hygiene. The religious and spiritual impact of miswak probably is the principal reason for using it in Islamic countries (Eid et al., 1990). It is often mentioned that the Islamic Prophet Muhammad recommended its use. Several quotations are found in the compendium of Prophet Muhammad (PBUH), as to the benefits of meswak in oral hygiene (Almas and Al-Lafi, 1995; Bos, 1993). Various explanations for the cleansing efficacy of the miswak have been offered, including the mechanical effects of its fibers, the release of beneficial chemicals or a combination of both (Hardie and Ahmed, 1995). The frequency and duration of miswak use may additionally explain its efficacy. Furthermore, reasons that provoke interest in the study of miswak is its popularity, low cost, and habitual use as an oral hygiene tool in several developing countries. Meswak is available, at low cost, and there has been motivation for its use in several developing countries. Researchers suggest significant health gains from using miswak as an oral hygiene tool.

The data summarized earlier strongly support the view that meswak has beneficial and worldwide use of therapeutic properties indicating its potential as an effective adaptogenic oral remedy. Moreover, its use predates the inception of Islam. It is therefore suggested that meswak use in motivated persons should be encouraged. However, further studies are needed to understand the complex pharmacological action and full phytochemical profile of the parent plant.

## REFERENCES

- Abdel-Wahab SM, Selim, MA, El-Fiki N M (1990). Investigation of the flavonoid content of *Salvadora persica* L. Bull. Fac. Pharm. Cairo Univ. 28:67-70.
- Abier S, Fernanda B, Meshari A, Anders G (2011). Short term clinical effect of active and inactive *Salvadora persica* miswak on dental plaque and gingivitis. J. Ethnopharmacol. 137(2011):1130-1134.
- Abo Al-Samh D, Al-Bagieh NA (1996). Study of antibacterial activity of the miswak extract *in vitro*. Biomed. Lett. 53:225-238.
- Akhtar MS, Ajmal M (1981). Significance of chewing sticks (miswak) in oral hygiene from a pharmacological view-point. J. Pak. Med. Assoc. x 31:89-95.
- Alali F, Al-Lafi T (2003). GC-MS analysis and bioactivity testing of the volatile oil from the leaves of the toothbrush tree *Salvadora persica* L. Natl. Prod. Res. 17:189-194.
- Alali F, Hudaib M, Aburjai T, Khairallah K, Al-Hadidi N (2004). GC-MS Analysis and Antimicrobial Activity of the Essential Oil from the Stem of the Jordanian Toothbrush Tree *Salvadora persica*. Pharmaceu. Biol. 42(8):577-580.
- Al-Bagieh NH, (1992). Antiherpes simplex virus type 1 activity of benzylisothiocyanate. Biomed. Lett. 47:67-70.
- Al-Bagieh, NH (1998). Effect of benzylisothiocyanate on the growth and acid production of *Candida albicans*. Biomed. Lett. 58:139-145.
- Al-Bagieh, NH, Weinberg ED (1988). Benzylisothiocyanate: a possible agent for controlling dental caries. Microb. Lett. 39:143-151.
- Al-Bayati FA, Sulaiman KD (2008). *In Vitro* antimicrobial activity of *Salvadora persica* L. extracts against some isolated oral pathogens in Iraq. Turk. J. Biol. 32:57-62.
- Al-Khateeb TL, O'Mullane DM, Whelton H, Sulaiman MI (1991). Periodontal treatment needs among Saudi Arabian adults and their relationship to the use of the Miswak. Com. Dent. Health. 8:323-328.
- Al-lafi T, Ababneh H (1995). The effect of the extract of the Miswak (chewing sticks) used in Jordan and the Middle East on oral bacteria. Int. Dent. J. 45:218-222.
- Almas K (2001). The antimicrobial effects of seven different types of Asian chewing sticks. Odontostomatol Trop. 24:17-20.
- Almas K (1993). Miswak (chewing stick) and its role in oral health. Postgrad. Dent. 3:214-18.
- Almas K, Al-Zeid Z (2004). The immediate antimicrobial effect of a toothbrush and miswak on cariogenic bacteria: a clinical study. J Contemp. Dent. Pract. 5:105-14.
- Al-Otaibi M, Al-Harthy M, Gustafsson A, Johansson A, Classon R, Angmar-Mansson B (2004). Subgingival plaque microbiota in Saudi Arabians after use of miswak chewing stick and toothbrush. J. Clin. Periodontol. 31(12):1048-1053.
- Ashraf TK (2006). Benzylamides from *Salvadora persica*. Arch. Pharm. Res. 29(11):952-956.
- Bader A, Flamini G, Luigi P, Morelli I (2002). The composition of the root oil of *Salvadora persica* L. J. Essent. Oil Res. 14:128-129.
- Bos G (1993). The Miswak, an aspect of dental care in Islam. Med. Hist. 37:68-79.
- Chawla HS (1983). A new natural source for topical fluoride. J. Indian Dent. Assoc. 55:419-422.
- Danielsen B, Baelum V, Manji F, Fejerskov O (1989). Chewing sticks, toothpaste, and plaque removal. Acta Odont. Scand. 47:121-125.
- Darout IA, Albandar JM, Skaug N (2000). Periodontal status of adult Sudanese habitual users of miswak chewing sticks or toothbrushes. Acta Odont. Scand. 58:25-30.
- Darout IA, Albandar JM, Skaug N, Ali RW (2002). Salivary microbiota levels in relation to periodontal status, experience of caries and miswak use in Sudanese adults. J. Clin. Period. 29:411-420.
- Dorland WA (1988). Newman. Dorland's Illustrated Medical Dictionary. 27th ed. Philadelphia: W.B.Saunders Co.
- Dorner WG (1981). Active substances from African and Asian natural toothbrushes Chemische Rundschau 34:19-23.
- Eid M, Al-Shammery A, Selim H (1990). The relationship between chewing sticks (Miswak) and periodontal health. II. Relationship to plaque, gingivitis, pocket depth, and attachment loss. Quintessence Int. 21:1019-1022.
- Eid MA, Selim HA (1994). A retrospective study of the relationship between miswak chewing stick and periodontal health. Egypt Dent. J. 40:589-592.
- Eid MA, Selim HA, Al-Shammery AR (1991). The relationship between chewing sticks (Miswak) and periodontal health. III. Relationship to gingival recession. Quintessence Int. 22:61-64.
- El Mostehy MR, Al-Jassem AA, Al-Yassin IA (1983). Miswak as an oral health device. Preliminary chemical and clinical evaluation. Hamdard

- 26:41-50.
- Elvin-Lewis M (1980). Plants used for teeth cleaning throughout the world. *Am. J. Preven. Med.* 6:61-70.
- Emira N, Mejdi S, Najla T, Hafedh H, Riadh K, Eulogio V, Amina B (2011). Antibacterial, anticandidal and antioxidant activities of *Salvadora persica* and *Juglans regia* L. extracts. *J. Med. Pl. Res.* 5(17):4138-4146.
- Farooqi MIH, Srivastava JG (1968). The toothbrush tree (*Salvadora persica*). *Quart. J. Crude Drug Res.* 8:1297-1299.
- Fatemh Ezoddni-Ardanaki (2010). Efficacy of meswak (*salvadora persica*) in preventing dental cares. 2-5:499-503 DOI: 10.4236/health.25074.
- FDI (2000). The proceeding of the FDI's second world conference on oral promotion. Consensus statement on oral hygiene. *Int Dent J.* 50:139.
- Gazi M, Saini T, Ashri N, Lambourne A,(1990). Meswak chewing stick versus conventional toothbrush as an oral hygiene aid. *Clin. Prev. Dent.* 12:19-23.
- Gazi MI, Davies TJ, Al-Bagieh N, Cox SW (1992). The immediate- and medium term effects of meswak on the composition of mixed saliva. *J. Clin. Period* 19:113-117.
- Grant J (1990). Miswak-toothbrushes that grow on trees. *Today's— FDA.* 2:60.
- Hardie J, Ahmed K (1995). The miswak as an aid in oral hygiene. *J. Phillip Dent. Assoc.* 47:33-38.
- Hassan S, Mohammed NA, Leonard W (2011). Ethnobotanical and antibacterial potential of *Salvadora persica* L: A well known medicinal plant in Arab and Unani system of medicine. *J. Med. Plant Res.* 5(7):1224-1229.
- Hilal A, Nizar A, John MD, Umargani JM (2012). Ethnobotany, Pharmacology and Chemistry of *Salvadora persica* L. A Review. *Res. Plant Biol.* 2(1):22-31.  
[http://www.worldagroforestrycentre.org/sea/products/afdbases/af/index.asp\(AFT database,\(2012\)\)](http://www.worldagroforestrycentre.org/sea/products/afdbases/af/index.asp(AFT database,(2012)))
- Hussein NS (1992). Benzofuranes from *Sececio desfontainei* (J). *Pharmazie* 47:468-469.
- Hyson JM (2003). History of the toothbrush. *J. Hist. Dent.* 51:73-80.
- Johansson A, Fareed K, Omar R (1991). Analysis of possible factors influencing the occurrence of occlusal tooth wear in a young Saudi population. *Acta Odontol. Scand.* 49:139-145.
- Jones FA (1996). Herbs: useful plants. *J. R Soc. Med.* 89:717-719.
- Kubota K, Tanaka T, Murata Y, Hirasawa M (1988). Effect of tannic acid on adherence of *Candida* to denture base. *J. Den. Res.* 67:183.
- Mohammad A, Turner JE (1983). *In vitro* evaluation of Saudi Arabian toothbrush tree (*Salvadora persica*). *Odontostomatol. Trop.* 3:145-148.
- Muhammad Z (2008). Fazail- e- Amaal, Farid book Depot (pvt) LTD. Delhi 1(1):3-14.
- Mullally BH, James JA, Coulter WA, Linden GJ (1995). The efficacy of a herbal-based toothpaste on the control of plaque and gingivitis. *J. Clin. Periodontol.* 22:686-689.
- Olsson B (1978). Efficiency of traditional chewing sticks in oral hygiene programs among Ethiopian schoolchildren. *Commun. Dent. Oral Epidemiol.* 6:105-109.
- Pew Research Center (2011). "Preface", *The Future of the Global Muslim Population* <http://features.pewforum.org/global-christianity/total-population-percentage.php>. Wikimedia Foundation, Inc. 20:14.
- Ra'ed IA, Almas K (1999). Miswak (chewing stick): A cultural and scientific heritage. *Saudi Dent. J.* 11:80-87.
- Ramadan MF, Morsel JT (2004). Oxidative stability of black cumin (*Nigella sativa* L.), coriander (*Coriandrum sativum* L.) and niger (*Guizotia abyssinica* Cass.) crude seed oils upon stripping. *Eur. J. Lipid Sci. Technol.* 106:35-43.
- Sanoqo R, Monforte MT, Daquino A, Rossitto A, Maur DD, Galati EM (1999). Antiulcer activity of *Salvadora persica* L.: structural modifications. *Phytomedicine* 6(5):363-366.
- Thomas J, Alfarhan AH, Ali A, Miller AG and Othman A (2008). Basic Appl. *Dryland Res.* 2(2008):12-22.
- Trovato AE, Galati A, Rossitto MT, Monforte A, d' Aquino, Forestieri AM (1998). Hypoglycemic effects of *Salvadora persica* L. in the rat. *Phytomedicine* 5(2):129-132.
- Vahabi S, Najafi E, Alizadeh S (2011). *In vitro* antimicrobial effects of some herbal essences against oral pathogens. *J. Med. Pl. Res.* 5(19):4870-4878.
- WHO (1987). Prevention of diseases. Geneva: AlMuslim (Ar). AlBoukare and Muslim. Egypt: AlHalabe Cooperation, Second, ed. In Zad AlMuslim ed; 1363 (Islamic calendar).
- Winslow LC, Kroll DJ (1998). Herbs as medicines. *Arch Int. Med.* 158:2192-2199.
- Wu CD, Darout IA, Skaug N (2001). Chewing sticks: Timeless natural toothbrushes for oral cleansing. *J. Periodont. Res.* 36:275-284.