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***Salvadora persica* (Meswak): Chewing Stick for Complete Oral Care**

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Abstract: The use of a wood stick *Salvadora persica* (meswak) for brushing the teeth continues to be an important tool for oral hygiene care in many Afro-Asian communities. It is inexpensive, customary and used for religious reasons as well. The pharmacological studies revealed that *Salvadora persica* is effective against dental caries, bacterial and fungal growth. Anti-plaque activity of *Salvadora persica* is comparable with Chlorhexidine gluconate and it is also found to reduce gingival bleeding. Phytochemical screening revealed the occurrence of glycosides, sterols, terpenes, flavonoids and alkaloids. Fluoride, calcium and phosphorus, minerals required for dental health are also present in *Salvadora persica*. Present review is written with objective to renew interest in use of *Salvadora persica* toothbrushes as environment friendly and cheap tool for dental care and oral hygiene.

Key words: *Salvadora persica*, gingival bleeding, dental caries, anti-bacterial, anti-plaque

INTRODUCTION

Toothbrushes are one of the essential items for people. They keep our teeth clean and free from disease causing bacteria which are produced by decaying food remains left in between our teeth. In our country toothbrushes are used by the majority of people in urban areas but in rural areas the use of factory made tooth brushes are less preferred. Rural people mainly the young use twigs of plants such as *Acacia arabica*, *Acacia senegal*, *Azadirachta indica*, *Capparis decidua* and *Salvadora persica* as toothbrushes and to treatment of dental problems (Goyal *et al.*, 2009; Kayode and Omotoyinbo, 2009). Clinical studies have shown that chewing sticks when properly used, can be as efficient as toothbrushes in removing dental plaque due to the combined effect of mechanical cleaning and enhanced salivation. It has also been suggested that antimicrobial substances that naturally protect plants against various invading microorganisms or other parasites may leach out into the oral cavity and that these compounds may benefit the users by protection against carcinogenic and periodontopathic bacteria (Cole *et al.*, 1981; Wu *et al.*, 2001).

The miswak chewing stick is an oral hygiene device used by the majority of people in developing countries. Despite its widespread use, few studies demonstrated its benefits or applications as an alternative and convenient means for cleansing the teeth. The review will provides information regarding the unique properties of the miswak

chewing stick with objective to renew interest in use of *Salvadora persica* (family: Salvadoraceae) toothbrushes as environment friendly and cheap tool for dental care and oral hygiene.

Salvadora persica is also know by its Persian name Darakht-i-miswak (tooth brush tree) from the fact that wood is much employed for manufacture of tooth brushes and it is supposed by the natives that tooth brushes made of it strengthen the gum, keep them from becoming spongy (Kirtikar *et al.*, 1975; Manavalan *et al.*, 2010).

The various ethno-medicinal surveys were conducted in various parts of desert and semi desert ecosystem documented ethnecological and medicinal value of *Salvadora persica* (Gupta *et al.*, 2008a, b; Marwat *et al.*, 2009; Alyemeni *et al.*, 2010; Sher *et al.*, 2010; Mothana *et al.*, 2011; Goyal *et al.*, 2011).

In a structured interview conducted with 1200 regular patients at two centers in the city of Makkah, revealed that 65% of the subjects used miswak daily and use of the miswak resulted in significant reductions in plaque ($p < 0.001$), gingival ($p < 0.01$) indices and *A. actinomycetemcomitans* concentration (Al-Otaibi, 2004).

According to Fischman and Yankell (1999) dentifrices (toothpowders, toothpastes and gels) are sold as either cosmetic or therapeutic products. If the purpose of a dentifrice is therapeutic, it must reduce some disease process in the mouth. Usually the actual or alleged therapeutic effect is to reduce caries incidence, gingivitis,

calculus formation, or tooth sensitivity. *Salvadora persica* is having anti-caries, anti-plaque and antibacterial effects.

Anti dental caries effect of *Salvadora persica*: Anti dental caries effect of *Salvadora persica* studied by many researchers. Ezoddini-Ardakani (2010) demonstrated efficacy of Miswak in preventing dental caries in the clinical trial carried out on three hundred eighty second years students of high school in the city of Yazd, Iran. The data showed a significant increase (55%) in the rate of dental caries in control group compared to case group. The risk of dental caries for each tooth in control group was 9.35 times more than case group (9.14 and 0.98%, respectively). The antibacterial effect special against *Streptococcus mutans* is responsible for anti-caries effect of *Salvadora persica* (Almas and Al-Zeid, 2004).

Effect of *Salvadora persica* on plaque index (PI), gingival index (GI) and bleeding index (BI): Gingival index and bleeding index have been widely used as indicators of periodontal status (Benamghar *et al.*, 1982). Amoian *et al.* (2010a) reported significant reduction in the Plaque Index (PI), Gingival Index (GI) and Bleeding Index (BI) by use of *Salvadora persica* extract chewing gum in a double-masked, randomized trial with 72 cases of moderate gingivitis. (Amoian *et al.*, 2010b).

Anti-plaque effect of *Salvadora persica* and comparison with Chlorhexidine gluconate: Chlorhexidine gluconate (CHX) is the-proven anti-plaque agents (Konig *et al.*, 2002), the comparative studies of *Salvadora persica* is carried out with Chlorhexidine gluconate. The effect of mouth rinse with different concentrations of aqueous *Salvadora* twigs extract and chlorhexidine digluconate on the adhesion of bacterial cells to buccal epithelial cells was investigated by Hammad and Sallal (2005). The mouth rinse with aqueous *Salvadora* twigs extract causes significant reduction (84%) in the adherence of bacterial cells (*Streptococcus mutans*) to buccal epithelial cells (Hammad and Sallal, 2005).

In the orthodontic patients, orthodontic appliances prevent the removal of plaque by brushing, mastication and salivary flow. Chlorhexidine mouthwash has shown the highest antimicrobial effects in orthodontic patients, however, some complications have limited its widespread use (Jamilian *et al.*, 2008). Comparison of antimicrobial effects against *Streptococcus mutans* of persica mouthwash and chlorhexidine was made in orthodontic patients. The numbers of *Streptococcus mutans* colonies available in the elastic rings around the two bracket bases were determined in culture mediums before and

immediately after a single application of water or mouthwashes and also following their daily uses for three weeks. The use of persica resulted in a significant ($p < 0.001$) reduction in the number of *streptococcus mutans* colonies, albeit it was not as potent as chlorhexidine. Thirteen and forty percent of patients using persica mouthwash experienced tooth discoloration and changes in taste, respectively. The corresponding figures for chlorhexidine were 86 and 73%, respectively (Salehi and Danaie, 2006).

Almas (2001) reported that *Salvadora persica* chewing stick cause occlusion of dentinal tubule and posses anti-plaque activity. Under Scanning Electron Microscope dentine treated with *Salvadora persica* showed removal of smear layer. When compared with Chlorhexidine and 50% miswak, the extract showed similar capacity in reducing smear layers (Almas, 2002).

Antibacterial effect of *Salvadora persica*: Antibiotics and antiseptics have been used successfully to treat moderate-to-severe periodontal diseases (Rams and Slots, 1996). It appears that the local application of antimicrobials that are effective against periodontal pathogens (Okuda *et al.*, 1992).

Various authors demonstrated antibacterial action of *Salvadora persica* against different strains of microbes. Almas and Al-Zeid (2004) measured the antibacterial effect of Miswak, Miswak extract, toothbrush and normal saline against *Streptococcus mutans* and *Lactobacilli*. The reduction of *Streptococcus mutans* was significantly greater in group using miswak in comparison to toothbrushing ($p = 0.013$) and there was no significant difference for *lactobacilli* reduction ($p = 0.147$) (Almas and Al-Zeid, 2004).

Sofrata *et al.* (2008) reported antibacterial effect of *Salvadora persica* against oral microorganisms associated with periodontitis and caries such as *Streptococcus mutans*, *Lactobacillus acidophilus*, *Aggregatibacter actinomycetemcomitans*, *Porphyromonas gingivalis* and *Haemophilus influenzae* (Sofrata *et al.*, 2008).

The study carried out by Darout *et al.* (2003) on the levels of 28 oral bacteria in subgingival plaque of adult Sudanese miswak and toothbrush users. The result indicated that Miswak users harbored significantly higher *Streptococcus intermedius*, *Actinobacillus actinomycetemcomitans*, *Veillonella parvula*, *Actinomyces israelii* and *Capnocytophaga gingivalis* and significantly lower *Selenomonas sputigena*, *Streptococcus salivarius*, *Actinomyces naeslundii* and *Streptococcus oralis* than did toothbrush users (Darout *et al.*, 2003).

Aqueous and methanol extracts of *Salvadora persica* was investigated for its antimicrobial activities against 7 isolated oral pathogens: *Staphylococcus aureus*, *Streptococcus mutans*, *Streptococcus faecalis*, *Streptococcus pyogenes*, *Lactobacillus acidophilus*, *Pseudomonas aeruginosa* and *Candida albicans* using disc diffusion and micro-well dilution assays. Aqueous extract inhibited all isolated microorganisms, especially the Streptococcus species and was more efficient than the methanol extract which was resisted by *Lactobacillus acidophilus* and *Pseudomonas aeruginosa*. The strongest antibacterial activity was observed using the aqueous extract against *Streptococcus faecalis*. Both extracts had equal antifungal activity against *C. albicans* based on the turbidity test (Al-Bayati and Sulaiman, 2008).

The antimicrobial effects of bark and pulp and entire *S. persica* extracts at 1, 5, 10 and 50% concentrations were tested against five different micro-organisms. Result revealed that 10 and 50% concentrations extracts were effective against *Streptococcus faecalis*. At 5% concentration only bark and whole miswak extracts were effective against *S. faecalis*. The study revealed that miswak is more effective compared with bark or pulp separately (Almas and Al-Bagieh, 1999).

Antifungal effect of *Salvadora persica*: *Candida albicans* is an important pathogen of humans, the ability to survive in mucosal surface oral cavity and vaginal mucosa causes disease when given the opportunity (Calderone and Fonzi, 2001). Noumi *et al.* (2010) reported antifungal activities of *Salvadora persica* extracts on different *Candida species*. Dried leaf extract of *Salvadora persica* was found effective against *Aspergillus niger*, *A. flavu* and *A. xylinium* (Paliwal *et al.*, 2007; Noumi *et al.*, 2010). Saadabi (2006) also reported antifungal action of *Salvadora persica* against *Aspergillus fumigatus* and *Candida albicans* (Saadabi, 2006).

Effects of extract of miswak on proliferation of Balb/C 3T3 fibroblasts and viability of cariogenic bacteria:

Aqueous extracts of miswak was prepared and its effects investigated on growth of Balb/C 3T3 mouse fibroblasts by measuring the mitochondrial succinic dehydrogenase activity. Furthermore, the effects on the viability of various cariogenic bacteria (*Streptococcus mutans*, *Streptococcus salivarius*, *Lactobacillus casei* and *Actinomyces viscosus*) was also determined. The data revealed that Balb/C 3T3 fibroblasts exposed to aqueous extracts of miswak showed an increase in cell proliferation, extracts from miswak had adverse effects on the growth of the cariogenic microorganisms. (Darmani *et al.*, 2006).

Phytochemical studies: *Salvadora persica* contains of fluoride, calcium, phosphorus and silica. Approximately 39% of the total fluoride in the sticks was in a form that could be leached out. The leached calcium and phosphorus averaged 582 $\mu\text{g mL}^{-1}$ and 34 g mL^{-1} , respectively, representing 19.6 and 26.4% of their total content in the sticks. There was a substantial amount of silica in the ashes of meswak. It appears that meswak is probably not particularly active against caries through its fluoride content but it does act as a brush for removing dental plaque and polishing the teeth (Hattab, 1997).

The structure elucidation by 2D NMR and HREIMS revealed presence of four benzylamides from a natural source namely butanediamide, N1, N4-bis (phenylmethyl)-2 (S)-hydroxy-butanediamide (I), N-benzyl-2-phenylacetamide (II), N-benzylbenzamide (III) and benzylurea (IV). These compounds found to have inhibitory effect human collagen-induced platelet aggregation and a moderate antibacterial activity (Khalil, 2006).

GC-MS analysis of the volatile compounds in crude *Salvadora persica* extracts revealed the presence of oleic, linolic and stearic acids in this plant. This study has led to the identification of a variety of low molecular weight compounds most of which are simple secondary metabolites (Abd Elrahman *et al.*, 2003).

The oil obtained by hydrodistillation stem of *Salvadora persica*, when analyzed by GC-MS, a mixture of monoterpene hydrocarbons (11%), oxygenated monoterpenes (54%) and sesquiterpene hydrocarbons (21%) were identified. The major components identified were 1,8-cineole (eucalyptol) (46%), α -caryophellene (13.4%), β -pinene (6.3%) and 9-epi-(E)-caryophellene (Alali *et al.*, 2004).

GC-MS analysis of the volatile oil extracted from *Salvadora persica* leaves, reported the presence of benzyl nitrile, eugenol, thymol, isothymol, eucalyptol, isoterpinolene and β -caryophyllene. Among the compounds identified are esters of fatty acids and of aromatic acids and some terpenoids (Alali and Al-Lafi, 2003).

Flavanoids isolated from *Salvadora persica* includes Kaempferol 3- α -L-rhamnosyl-7- β -xylopyranoside, Quercetin and Kaempferol (Kamil *et al.*, 2000).

Five glycosides were isolated from stems of *Salvadora persica*. Two are new and identified as sodium 1-O-benzyl- β -d-glucopyranoside-2-sulphate (salvadoside) and 5, 5'-dimethoxylariciresinol 4, 4'-bis-O- β -d-glucopyranoside (salvadoraside), in addition to syringin, liriiodendrin and sitosterol 3-O-glucopyranoside (Kamel *et al.*, 1992).

A new indole alkaloid salvadoricine (I) has been isolated from *Salvadora persica*. Its structure was

elucidated by spectral analysis and confirmed by synthesis. This constitutes the first report of naturally occurring 3-acetylindole alkaloid (Malik *et al.*, 1987).

Fatty acid, tocopherol, sterol and total phenolic compounds of *Salvadora persica* seeds as well as the potential antioxidant activity of the leaves, Gamma-tocopherol. Beta-sitosterol, campesterol, stigmasterol and Δ^5 -avenasterol were predominant (Mariod *et al.*, 2009).

DISCUSSION

Toothbrushes are one of the essential items for people. They keep our teeth clean and free from disease causing bacteria which are produced by decaying food remains left in between our teeth. In rural areas the use of factory made tooth brushes are less preferred. Rural people mainly the young use twigs of plants such *Salvadora persica* as toothbrushes. The use of these twigs (chewing sticks) have benefits of both toothbrush and toothpaste, keep the teeth healthy and make the teeth whiter so they look good.

The pharmacological studies revealed that *Salvadora persica* is effective against dental caries, bacterial and fungal growth. Anti-plaque activity of *Salvadora persica* is comparable with Chlorhexidine gluconate and it is also found to reduce gingival bleeding. Phytochemical screening revealed the occurrence of glycosides, sterols, terpenes, flavonoids and alkaloids. Plant also contains eugenol, Eugenol-containing dental materials are frequently used in clinical dentistry. Zinc Oxide-Eugenol (ZOE) is applied to a dentinal cavity as temporary filling and as a cement for provisional restorations. Eugenol-soaked pellets are occasionally placed on vital exposed pulps as a sedative dressing, eugenol exert antibacterial, anti-inflammatory and local anesthetic effects on the dental pulp (Markowitz *et al.*, 1992). The presence of fluoride, calcium and phosphorus has multifunctional advantage, these minerals are required for normal growth of teeth as well as they works as protective factors against dental caries and reverse the damage. Fluoride works primarily via topical mechanisms which include (1) inhibition of demineralization at the crystal surfaces inside the tooth (2) enhancement of remineralization at the crystal surfaces (the resulting remineralized layer is very resistant to acid attack) and (3) inhibition of bacterial enzymes. The effect of systemically ingested fluoride on caries is minimal (Featherstone, 1999). Fluoride supplements can be best used as a topical delivery system by sucking or chewing and that is quiet possible with tooth sticks. In addition, *Salvadora persica* reduce adhesion of bacterial cells to buccal epithelial cells and reduce the possibility periodontitis and dental caries.

In our country factory made plastic toothbrushes and abrasive based toothpaste are used by the majority of people in urban areas. The different types of toothpastes are there for different need such as sensitivity, shining or anti-plaque and antibacterial etc. For children's fluoride fortified tooth paste is also available. Using plastic brushes and tooth paste have no disadvantage but neither have advantage. *Salvadora persica* is advocated, since these are biodegradable, environment friendly and cheap in costing and offers benefits of both toothbrush and toothpaste.

CONCLUSIONS

Regular removal of dental plaque and food deposits is an essential factor in the prevention of dental caries and periodontal disease. Despite the widespread use of toothbrushes and toothpastes, natural methods of tooth cleaning using chewing sticks of *Salvadora persica* have been practised for thousands of years in Asia, Africa, the Middle East and the Americas. Selected clinical studies have shown that *Salvadora persica* chewing sticks when properly used, can be as efficient as toothbrushes in removing dental plaque due to the combined effect of mechanical cleaning and enhanced salivation. It has also been reported for antimicrobial, antifungal, anti-plaque and anti-caries properties, it also helpful in gingivitis and other periodontal infections. Hence, *Salvadora persica* should be considered as a tool for complete oral care.

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