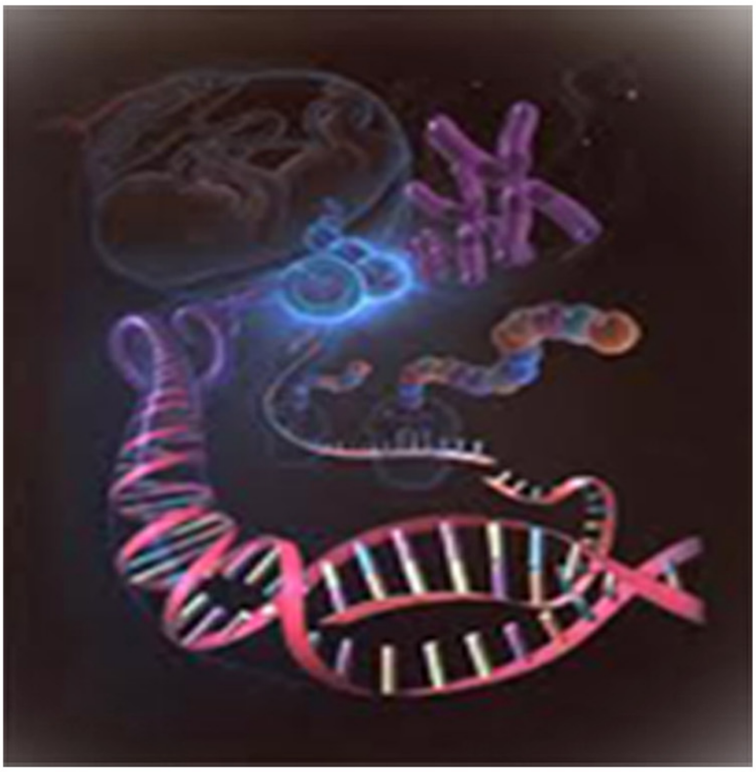
IJLBPR

ISSN 2250 - 3137
Vo1. 3, No. 3, July 2014

International Journal of
Life Sciences Biotechnology and Pharma Research



www.ijlbpr.com

International Journal of Life Sciences Biotechnology and Pharma Research
Hyderabad, INDIA

Email : editorijlbpr@gmail.com or editor@ijlbpr.com

International Journal of Life Sciences Biotechnology and Pharma Research

ISSN 2250-3137 www.ijlbpr.com
Vol. 3, No. 3, July 2014
© 2014 IJLBPR. All Rights Reserved

Review Article

THE NATURAL TOOTHBRUSH "MISWAK" AND THE ORAL HEALTH

Ismail A Darout[1]*

*Corresponding Author: **Ismail A Darout** ✉ idarout1959@gmail.com

Oral hygiene measures have been practiced by different populations and cultures around the world since the antiquity with evidence for various oral hygiene products including toothpicks and toothpowders dating back to 4000 BC. Ancient Greek and Roman literature discusses toothpicks that were chewed on to help clean the teeth and mouth. The evolution of the modern toothbrush has its origin in chewing sticks that were used by the Babylonians as early as 3500 BC. Miswak or siwak (tooth cleaning stick) for mechanical tooth cleaning can be traced back at least to pre-Islamic times. Currently, many of the world populations still use chewing sticks as the only method for tooth cleaning. It has been estimated that between 21%-70% of adults in India and Pakistan use miswak, especially in the rural areas. Its use is also very common in Arab countries and most of the Muslim world. Chewing sticks are also the predominant tools that are used for oral hygiene procedures among African populations. Reasons for continuing the use of traditional tooth cleaning methods include low cost and availability. Customs and religious reasons because toothbrushes are not acceptable to all Muslims as an alternative or substitute for miswak during some months (Holy months) of a year. Therefore, chewing sticks have continued to be important for oral hygiene in these communities.

Keywords: Miswak cleaning sticks, Oral hygiene practice, Manual toothbrush

INTRODUCTION

Miswak (miswaak, misswak, miswaki, meswak, mswaki, sewak, siwak and siwaki are all synonyms used in different Arabic dialects and countries) is an Arabic word meaning tooth cleaning stick (Hattab, 1997; Al Sadhan and Almas, 1999). In English, miswak has been mentioned as the "natural toothbrush". In geographical regions in which the Arak (synonymous with Araak) tree grows, miswak is interpreted as tooth sticks prepared from the Arak tree. *Salvadora persica L* (family: Salvadoracae) is the botanical name of the Arak tree. It is a small upright evergreen tree or shrub with white branches and aromatic roots, seldom more than 30 cm in diameter and three meters in height (Kassas and Zahran, 1965). It is known in English as the "toothbrush tree", the "toothbrush tree of the Orient" or the "Persian toothbrush tree".

[1] Department of preventive Dental Sciences, College of Dentistry, Jazan University Kingdom of Saudi Arabia.

This article can be downloaded from http://www.ijlbpr.com/currentissue.php

Geographically, *S. persica* is widely distributed: from Rajasthan (India) in the east (Gupta and Sakena, 1968) through Southern Arabia, Iran, Iraq, Israel, Egypt to Mauritania in the west, and from North Africa in the north through Sudan, Ethiopia, Central Africa to South West Africa in the south (Engler and Prantl, 1942). The roots, twigs and stems of *S. persica* have been used for many centuries as oral hygiene tools (Elvin, 1980) and are today commonly used as tooth and tongue cleaning sticks by Muslims in the Middle East as well as in Asian and various African countries (Raied *et al.,* 1999; Corbet *et al.,* 2000).

PREPARATION OF MISWAK STICK

Most chewing sticks share a common design and method of preparation. Pencil-sized sticks 15-20 cm long with diameter ranging from 1.0 cm to 1.5 cm are prepared from the root, stem, twigs or bark of the Arak tree. The stick is chewed or tapered at one end until it becomes frayed into a brush (Figure 1). Soaking in water for a few hours will soften the natural fibers helping them to separate while tapering or chewing. The term "chewing stick" may therefore be misleading since the stick is chewed only briefly to fray its fibers before its common use as a toothbrush. When the mouth cleaning procedure that includes brushing of teeth, gums (Figure 2) and tongue is completed, the chewing stick is removed from or may be left in the mouth for some additional time. Left in the mouth, the miswak will stimulate salivation and thus there will be a better cleansing effect. After having been used several times, the chewing stick is either replaced by a new one or its bristles are cut off to expose a fresh end at which new bristles are prepared by further chewing or tapering.

Figure 1: Chewing Sticks Prepared From *S. persica,* One End is Frayed into a Brush Through Chewing

Figure 2: Miswak Used to Clean Teeth and Gums

BRUSHING TECHNIQUE

When miswak is used for teeth and tongue cleaning, it is held by one hand in a pen-like grip and the brush-end is used with an up-and-down or rolling motion (Elvin, 1974; Hollist, 1981). A two-finger and five-finger grip techniques have also been described.

CHEMICAL COMPONENTS

Chemical analysis of *S. persica* root extracts demonstrated the presence of β-sitosterol, *m*-anisic acid (Ray *et al.,* 1975) and elemental sulphur as well as substantial amount of silica (Ezmirly *et al.,* 1979). Chlorides, salvadourea and high content of gypsum have been found in the stem (Porters, 1974; Massassati *et al.,* 1981; Galletti, 1983). Organic compounds identified in *S. persica* included pyrrolidine, pyrrole and piperidine derivatives (Kamel *et al.,* 1992); glycosides such as salvadoside and salvadoraside (Abdel *et al.,* 1990); flavonoids such kaempferol, quercetin, quercetrin, rutin, and a quercetin glucoside (Abdel, 2003); and sugar terpenoids, alkaloids, esters of fatty acids and of aromatic acids, and fats (Almas and al-Lafi , 1995).

BIOLOGICALLY ACTIVE COMPOUNDS

The substantial amount of silica detected in *S. persica* ashes has been thought to contribute to miswak's mechanical action in plaque removal (al-Bagieh, 1992). Benzylisothiocyanate is a component exhibiting antiviral and antimycotic activity of miswak extracts but its mode of action was not clearly delineated (al-Bagieh , 1994). Dorner (1981) has speculated that the high amount of NaCl and KCl, sulphur-containing organic substances (salvadourea and salvadorine), and an alkaloid yielding trimethylamine on hydrolytic cleavage might somehow be responsible for the observed antibacterial and gum stimulating effect. Decoction of *S. persica* has been used for the treatment of spleenomegaly, rheumatism, tumors, and renal stones in humans by folk medicine practitioners (Harfi, 1997). It was also shown to possess hypoglycemic effects and an incremented oral-glucose tolerance in normal rats, and to enhance plasma immunoreactive insulin level (Trovato *et al.,* 1998).

A protective action of *S. persica* decoction against ethanol and stress-induced ulcers has been observed in rats (Sanogo *et al.,* 1999). Extracts from the roots and stems of *S. persica* have been used for treatment of oral infections in animals (Sulaiman *et al.,* 1986). In humans, miswak extracts have been shown to induce morphological changes in tissue culture using L929 cells (Abo Al-Samh *et al.,* 1997) and IgE-mediated allergic reactions in humans (Mohammad and Turner, 1983). However, fresh plant materials from *S. persica* demonstrated no cytotoxic effect in a mammalian monolayer cell culture while cytotoxicity was demonstrated after 24 h (Babay and Almas , 1999). Recent studies showed that aqueous and ethanol extracts of *S. persica* were able to remove the smear layer from dentin surfaces and occlude dentine tubules (Almas, 2001; Lafi and Ababneh, 1995).

ANTIMICROBIAL ACTIVITY

Some *in vitro* studies have shown that *S. persica* extracts inhibited growth of various oral aerobic and anaerobic bacteria as well as *Candida albicans* (Almas K, al-Lafi, 1995; Al-Bagieh, 1994). Inhibition of *in vitro* plaque formation, growth and acid production of various cariogenic bacteria by such extracts have also been demonstrated (Almas and al-Bagieh, 1999). Almas and al-Bagieh (1997) found that aqueous extracts of *S. persica* bark, pulp as well as whole miswak were effective against various bacteria including *Streptococcus mutans*, and noted some differences in antimicrobial activities between the pulp and bark extracts. *S. persica* alcoholic extracts were more antimicrobial potent than water extracts (Almas and al-Bagieh, 1997).

Regarding the effect of storage on the activity of miswak extracts, there was no noticeable difference in antimicrobial effect between fresh and one-month-old miswak. When extracts prepared from *S. persica* and *Azadirachta indica* (neem) chewing sticks were compared, both were able to suppress growth of *S. mutans* and *Streptococcus faecalis* at 50% concentration, only the *S. persica* extract was reported to be more effective at lower concentrations (Almas and al-Bagieh, 1997). Recently, AbdElRahman *et al.* (2002b) using various *S. persica* extracts showed *in vitro* that root alcoholic extracts were more antimicrobially potent against *S. mutans* whereas *Lactobacillus acidophilus* was the least susceptible one and that minimum inhibitory concentration values for the various *S. persica* extracts ranged from 100 mg/mL to 300 mg/mL indicating moderate to weak antimicrobial activity. Another recent study Al-Mohaya (2002) showed that renal transplant patients that used miswak had significantly lower prevalence of oral candidiasis than had such patients using modern toothbrush.

COMPARATIVE EFFICACY OF MISWAK AND TOOTHBRUSHES

Development of the Modern Toothbrush

The earliest trace of an implement remotely similar to today's toothbrush was 1000 AD in China with horse hair set in ivory handles (Kimery and Stallard, 1968). Brushes more similar to those of today were hogs bristles set in Ox bone dating back the 14^{th} century, again in China. The bristle brush appears to have been reinvented in the 18^{th} century, although cost limited its widespread use. The nylon toothbrush with a plastic handle was developed in the 1930s and being relatively inexpensive had the potential for universal ownership. Thus, the Workshop on Dental Plaque Control and Oral Hygiene Practices 1985 concluded that toothbrushing with toothpaste was arguably the most common form of tooth cleaning practiced by individuals in developed countries (Fradensen, 1986).

Mechanical Efficiency

Mechanical cleaning procedures are reliable means of controlling dental plaque, provided cleaning is sufficiently thorough and performed at regular intervals (Loe, 2000). In developed countries, this is achieved by tooth brushing with a manual or electric toothbrush in combination with dentifrice or toothpowder. Chewing sticks are often used as the sole cleansing agent in developing countries. Since most studies on chewing sticks lack specific details concerning the duration and frequency of miswak use, it has been difficult to assess the effect miswak practice has on oral health (Hardy, 1995). For example, Eid *et al.* (1990a) reported a range of frequency of miswak use from one or two times per day to weekly or irregular use. Gazi *et al.* (1990), concluded that miswak had to be used five times per day in order to significantly decrease plaque accumulation.

Various explanations for the cleansing efficacy of miswak have been offered including: (i) the mechanical effects of its fibers, (ii) its release of beneficial chemicals; or (iii) a combination of (i) and (ii) (Hardy and Ahmed, 1995). The miswak is generally used for a longer period of time than is the modern toothbrush, the cleaning is usually implemented for 5 to 10 min each time and the plant fibers remove plaque and simultaneously massage the gum. Unlike a modern toothbrush, the bristles of the miswak are situated along the long axis of its handle (see, Figures 1 and 2).

Consequently, the facial surfaces of the teeth can be reached more easily than the lingual surfaces or the interdental spaces. Eid *et al*. (1990) reported that the majority of miswak users applied the miswak to both aspects of their teeth and no significant differences in facial plaque scores were noted between the miswak and toothbrush users. Additional studies suggested miswak efficacy to be comparable with that of the conventional toothbrush (Olsson, 1978) or demonstrated plaque scores to be significantly lower following the use of miswak as compared with the conventional toothbrush used without toothpaste (Eid *et al*., 1990).

Clerehugh *et al.* (1995) reported relatively high mean plaque scores among 14-year-old Ghanaian schoolchildren and no significant differences among the three groups using chewing sponge, chewing stick or toothbrush for tooth cleaning. A few other studies suggested that chewing sticks could be as efficient as the conventional toothbrush if proper instruction and supervision were given to the children (Van, 1992).

Comparative Oral Health Status of Miswak and Toothbrush Users

Dental Caries

In a dental health survey in the Sudan, Emslie (1966) reported for the first time less caries in people using chewing sticks than in those using a toothbrush. In a controlled clinical study Baghdady and Ghose (1979) compared the caries prevalence between Iraqi and Sudanese schoolchildren using the WHO DMFT (diseased, missing, filled teeth) index (WHO, 1979). They reported that Sudanese schoolchildren showed lower caries prevalence due to the use of miswak and their diet. Similar results were noted in Saudi children aged 13 to 15 years when compared with children in western countries (Younes and El-Angbawi , 1982). Again, the main preventive factor reported was miswak use by these children. Carl and Zambon (1993) reported that dental caries was relatively rare among Kenyan primary school children who were using only miswak as an oral hygiene tool. The authors concluded that caries in adults was mostly in older persons and usually involved the maxillary and mandibular second and first molars, which are difficult to reach for cleaning with the miswak. It has also been demonstrated that users of chewing sticks other than those prepared from *S. persica* had low caries prevalence compared to modern toothbrush users (Sathananthan *et al.,* 1996).

Periodontal Status

Low periodontal treatment needs have been reported among Saudi adults who used miswak (al-Khateeb *et al.,* 1991; Guile, 1992). Furtheremore, Gazi e*t al.* (1990) compared habitual miswak users and toothbrush users on periodontal status and showed that the former had lower gingival bleeding and interproximal bone height than the toothbrush users. The authors also indicated that there were no significant differences in plaque scores and pocket depths between the two groups. In the northern Kenya, Carl and Zambon (1993) suggested that advanced periodontal disease was very rare among persons over the age of 50 years who used miswak for teeth brushing. The authors concluded that absence or presence of periodontal disease seemed to go hand in hand with the use or misuse of miswak. Eid *et al*. (1990a) reported that there were no significant differences in gingival or bleeding indices between miswak and toothbrush users.

GENERAL DISCUSSION

Resources for oral health care are limited in many developing countries and the need to explore and test easily available and inexpensive traditional preventive tools is recognized and supported WHO (1987). This is also in line with a recent consensus statement (2000) stating that "chewing sticks may have a role to play in the promotion of oral hygiene" and that "evaluation of their effectiveness warrants further research". Compared with the modern toothbrush, which is principally developed from chewing sticks, the latter have a very long tradition, being economical, more ecological, readily available, and can be used without dentifrice.

It has been demonstrated that miswak users had significantly lower numbers of sextants with dental calculus in the posterior sextants than had the modern toothbrush users (Darout *et al.,* 2000). Almas and al-Lafi (1995) indicated that miswak chemical components contribute to its mechanical action in dental calculus removal. Miswak extracts contained high amounts of chloride and substantial amounts of silica (Darout *et al.,* 2000). Recently, it has been shown that the commercially available dentifrice (Whitening Toothpaste) which contains 10% of silica is efficacious for control of supragingival calculus formation (Sowinski, 2002). Furthermore, miswak is generally used for a longer period of time than is the modern toothbrush, the cleaning is usually implemented for 5 to 10 min each time (Akhtar and Ajmal, 1981), and the plant fibers remove plaque and simultaneously massage the gum. It has been suggested that the level of supragingival calculus is a fairly good measure of the oral hygiene level and the frequency of professional dental care in a population (Mandel and Gaffar, 1986). Calculus promotes and retains dental plaque on its outer surface and consequently is an important risk factor of progression of attachment loss (Albandar *et al.,* 1998).

Gazi *et al.* (1990) demonstrated that there were no significant differences in plaque scores and periodontal pocket measurements between habitual miswak and toothbrush users. Eid *et al.* (1990) also indicated that there were no significant differences in plaque scores and attachment loss between habitual miswak and toothbrush users.

Miswak users have lower caries experience than toothbrush users (Darout *et al.,* 2002). The lower caries experience in the miswak users may be due to its thiocyanate (SCN^-) contents. Tenovuo *et al*. (1981) showed *in vitro* that acid production by *Streptoccocus mutans* in human dental plaque was almost totally inhibited when supplementing saliva with SCN^- and hydrogen peroxide. This is also in agreement with observations by Lenander-Lumikari *et al.* (1992). The finding of lower caries experience of miswak users can also be explained by the cleansing effect of miswak. When the mouth cleaning procedure is completed, miswak is often left in the mouth for some additional time. Left in the mouth, it will stimulate salivation and thus promoting a better cleansing and anti-cariogenic effect.

It has also demonstrated that the type of oral hygiene had a significant effect on the salivary levels of 19 out of the 25 bacterial species investigated, and that the type of effect also depended on the type of bacteria. Thus, 10 of these species were present in significantly higher numbers, and 9 were found in significantly lower numbers in the saliva of miswak users than of toothbrush users. These microbial differences may be due to release of antimicrobial substances of miswak (69). Four out of the six *Streptococcus* spp. examined were detectable in significantly lower levels in the miswak group which can be explained by the results reported in Darout *et al.* (2003). Several of the anionic components detected in miswak are known to have antimicrobial effects. Silva Mendez *et al*. (1999) reported that nitrite exerted in vitro inhibitory effects against cariogenic bacteria including *S. mutans*, *Lactobacilus casei* and *Actymices naeslundii* at acidic pH. The authors also demonstrated that the ability of these bacteria to recover from nitrite exposure was markedly affected by nitrite concentration. At acidity levels below pH 7, low concentrations of nitrite (0.2 mM) caused complete killing of the test bacteria. Gazi *et al*. (1990) demonstrated that the use of miswak significantly decreased salivary pH due to its high chloride content. This condition may increase the bactericidal effect of nitrite leaching from miswak in the mouth. Moreover, the bactericidal effect of nitrite is significantly enhanced by SCN^- (Xu *et al.* (2001).

The higher levels of some periodontal pathogens in the saliva of miswak users may be due to a microbial shift from more streptococci to more periodontitis-associated species (Darout *et al.* (2002). If so, this would be in line with the ecological plaque hypothesis (Marsh, 1994 and 1991). Also, Hillman *et al.* (1985) and Socransky *et al. (*1988) reported an antagonistic interrelationship between streptococci species and periodontitis-associated species. Thus, it has been suggested that growth of *Aggregatibacter actinomycetemcomitans* was inhibited by the potentially beneficial species such as *Streptoccocus sanguis*. The groups of periodontal pathogens that include *Tannerella forsythia*, *Fusobacterium* spp, *Porphyromonas gingivalis, Provetella intermedia* and *Peptostreptoccous micros* are considered a causal factor in therapy-resistant periodontitis (Edwardsson, 1999). Presumably these pathogens are present in saliva in the presence (Kononen *et al.,* 2001) or absence (Srinian *et al.,* 2002) of periodontal disease.

Data on the active ingredients in miswak extracts responsible for inhibition of growth and/ or virulence factors of oral pathogens is lacking. Although the likely effects in the mouth are difficult to extrapolate from *in vitro* results, these data may partly explain the low prevalence of dental caries and periodontal disease among miswak users. Darout *et al.* (2000) used capillary electrophoresis as an analytical technique to show that miswak aqueous extracts contained potentially antimicrobial anionic components including $Cl^–$, $SO_4^{2–}$, $NO_3^–$ and $SCN^–$. The finding of $Cl^–$ in *S. persica* root and stem extracts is consistent with observations of Farooqui and Srivastava (1968). SO_4^{2-} and SCN^- in *S. persica* root and stem water extracts are released from hydrolysis of glucosinolates by myrosinase enzyme in the plant tissue (Darout *et al.,* 2003). Certain isothiocyanates under neutral conditions and in the presence of the enzyme myrosinase may decompose into their respective alcohol derivatives and SCN^- (Luthy and Benn, 1977). Darout *et al*. (2000) indicate that the root and stem of *S. persica* are rich in SO_4^{2-}. The presence of SO_4^{2-} compounds in *S. persica* root and twigs has previously been reported. Chemical analysis of air-dried *S. persica* stem extract showed high SO_4^{2-} content.

Antibacterial and weak anti-inflammatory effects of *S. persica* root and twig extracts have been attributed to their content of beta-sitosterol, SO_4^{2-} compounds and Cl^-. In addition, Cl^- leaching into saliva from miswak while in the mouth may mediate the innate host defense systems in human saliva. Cl^-, I^- and SCN^- (pseudohalides) are substrates for salivary peroxidase and/or the myeloperoxidase hydrogen peroxide antimicrobial system. The peroxidase-hydrogen-peroxide-chloride system is a part of the innate host defense that is mediated by polymorphonuclear leukocytes in humans (84). It has been shown that the latter system was more bactericidal against *A. actinomycetemcomitans* than with the myeloperoxidase-thiocyanate and hydrogen peroxide system (Ihalin *et al*., 1998). Recently, Ihalin *et al*. (2001) indicated that the oxidation product of lactoperoxidase and myloperoxidase with I^- and/or Cl^- was bactericidal against *P. gingivalis, Fusobacterum nucleatum* and *S. mutans*. NO_3^- in *S. persica* root and stem water extracts may be released from the residual nitrate ions taken up by the *S. persica* plant or from the oxidation of ammonia and other nitrogen compounds. Nitrate, nitrite and nitrosamines have been demonstrated to occur naturally in vegetables (Silva *et al.,* 1999). The antimicrobial agent nitric oxide (NO) is formed in the mouth and its concentration is directly related to salivary nitrite, which in turn is related to dietary nitrate intake (Silva *et al.,* 1999). It has been demonstrated that nitrite, upon its ingestion and mixture with gastric acid, is a potent bacteristatic and/or bactericidal agent. Acidified nitrite is bactericidal against gastrointestinal, oral, and skin pathogens.

Recently, Allaker *et al.* (2001) reported that acidified nitrite exhibited growth-inhibitory effect on *F. nucleatum Eikenella corrodens* and *P. gingivalis*. Furthermore, it has been shown that the salivary nitrite exerted bactericidal effect on several pathogens such as *Escherichia coli*, *Salmonella typhimurium*, *Yersinia entrocolitica*, *Shigella sonnei* and *C. albicans* at acidic pH. The bactericidal effect of acidified nitrite is due to the production of nitrogen oxide (NO) and nitrogen dioxide (NO_2). However, the real mechanisms of the bactericidal action and the chemistry of acidified nitrite are still unclear. Another possibility is that nitrite, in synergy with acid in the stomach, mouth, or skin may be an element of innate immunity. The salivary generation of nitrite is accomplished by a symbiotic relationship involving nitrate-reducing bacteria on the tongue surface, which are designated to provide a host defense against microbial pathogens in the mouth and lower gut via NO production.

CONCLUSION

Resources for oral health care are limited in many developing countries and the need to explore and test easily available and inexpensive traditional preventive tools is recognized and supported by W.H.O. This is also in line with a recent consensus statementstating that "chewing sticks may have a role to play in the promotion of oral hygiene" and that "evaluation of their effectiveness warrants further research". Compared with the modern toothbrush, which is principally developed from chewing sticks the study finds:

1. Similar periodontal status of miswak users to that of the toothbrush users, suggesting that the efficacy of miswak use for oral hygiene was comparable to that of the modern toothbrush.

2. Miswak may have a selective inhibitory effect on the level of certain bacteria in saliva, particularly several oral *streptococcus* species (spp.).
3. The type of oral hygiene used had a significant effect on the levels of 11 out of the 28 species investigated. This effect was dependent on the type of bacteria and probing pocket depths.
4. The results showed that miswak extracts contained potential antimicrobial components including Chlorides, Sulphates, thiocyanate, and nitrate oxides.
5. The results also show for the first time that free and bound thiocyanate exist in miswak root and stem extracts.
6. Demonstration of high levels of thiocyanate in aqueous miswak extracts complies with this hypothesis concerning antimicrobial effect of miswak which may be due to its thiocyanate content.

REFERENCES

1. AbdELRahman H F, Skaug N, Whyatt A M and Francis G W (2003), "Volatile compounds in crude Salvadora persica extracts", *Pharmaceutical Biology*, Vol. 41, pp. 399-404.
2. AbdElRahman HF, Skaug N, Francis G. *In vitro* antimicrobial effects of crude miswak extracts on oral pathogens. Saudi Dent J 2002b; 14:26-32.
3. Abdel-Wahab S M, Selim M A and El-Fiki N M (1990), "Investigation of the flavonoid content of *Salvadora persica* L.", *Bull Fac Pharm Cairo Univ.,* Vol. 28, pp. 67-70.
4. Abo Al-Samh D A and Al-Nazhan S (1997), *"In vitro* study of the cytotoxicity of the miswak ethanol extracts", *Saudi Dent J.,* Vol. 9, pp. 125-32.
5. Akhtar M S and Ajmal M (1981), "Significance of chewing-sticks (miswaks) in oral hygiene from a pharmacological viewpoint", *J Pak Med Assoc.,* Vol. 31, pp. 89-95.
6. Al lafi T, Ababneh H. The effect of the extract of the miswak (chewing sticks) used in Jordan and the Middle East on oral bacteria. Int Dent J 1995; 45:218-22.
7. Al Sadhan R I and Almas K (1999), "Miswak (chewing stick): A cultural and scientific heritage", *Saudi Dent J.,* Vol. 11, pp. 80-7.
8. Al-Bagieh N H (1992), "Antiherpes simplex virus type1 activity of benzylisothiocyanate", *Biomed Letters, Vol.* 47, pp. 67-70.
9. Al-Bagieh N H, Idowu and Salako N O (1994), "Effect of aqueous extract of miswak on the *in vitro* growth of *Candida albicans*", *Microbios,* Vol. 80, pp. 107-13.
10. Albandar J M, Kingman A, Brown l J and Löe H (1998), "Gingival bleeding and subgingival calculus as determinants of disease progression in early-onset periodontitis*", J Clin Periodontol.,* Vol. 25, pp. 231-7.
11. Al-Khateeb T L, O'Mullane D M, Whelton H and Sulaiman M I (1991), "Periodontal treatment needs among Saudi Arabian adults and their relationship to the use of the Miswak", *Community Dent Health* , Vol. 8, pp. 323-8.
12. Allaker R P, Silva Mendez L S, Hardie J M and Benjamin N (2001), "Antimicrobial effect of acidified nitrite on periodontal bacteria", *Oral Microbiol Immunol.,* Vol. 16, pp. 253-6.

13. Almas K and al-Lafi T (1995), "The natural toothbrush. World Health Forum", Vol. 16, pp. 206-10.

14. Almas K, al-Bagieh N H and Akpata E S (1997), "*In vitro* antibacterial effect of freshly cut and 1-month-old Miswak extracts", *Biomed Letters* 1997; 56:145-9.

15. Almas K and al-Bagieh N H (1999), "The antimicrobial effects of bark and pulp extracts of miswak", *Salvadora persica*. *Biomed Letters* , Vol. 60, pp. 71-5.

16. Almas K (2001), "The effects of extracts of chewing sticks (*Salvadora persica*) on healthy and periodontally involved human dentine: a SEM study", *Indian J Dent Res.,* Vol. 12, pp. 127-32.

17. Al-Mohaya M A, Darwazeh A and Al-Khudair W (2002), "Oral fungal colonization and oral candidiasis in renal transplant patients: The relationship to Miswak use", *Oral Surg Oral Med Oral Pathol Oral Radiol Endod*., Vol. 93, pp.455-60.

18. Asadi S G and Asadi Z G (1997), "Chewing sticks and the oral hygiene habits of the adult Pakistani population", *Int Dent J., Vol.* 47, pp. 275-8.

19. Babay N and Almas K (1999), "Effect of miswak extracts on healthy human dentin: an *in vitro* study", *Saudi Dent J., Vol.* 11, pp. 46-52.

20. Baelum V and Scheutz F (2000), "Periodontal diseases in Africa", *Periodontol,* 2002; Vol. 29, pp. 79-103.

21. Baghdady V S and Ghose L J (1979), "Comparison of the severity of caries attack in permanent first molars in Iraqi and Sudanese schoolchildren", *Community Dent Oral Epidemiol.,* Vol. 7, pp. 346-8.

22. Bos G (1993), "The miswak, an aspect of dental care in Islam", *Med Hist*, Vol. 37, pp. 68-79.

23. Carl W and Zambon JJ (1993), "Dental health of the Rendille and Samburu of the northern frontier district of Kenya", *N Y State Dent J.,* Vol. 59, pp. 35-9.

24. Clerehugh V, Laryea U and Worthington H V (1995), "Periodontal condition and comparison of toothcleaning using chewing sponge, chewing sticks and toothbrushes in 14-year-old schoolchildren in Ghana", *Community Dent Oral Epidemiol.,* Vol. 23, pp. 319-20.

25. Concensus Statement on Oral Hygiene, *Int Dent J.,* 2000, Vol. 50, p. 139.

26. Corbet EF, Zee K Y and Lo EC (2000), "Periodontal diseases in Asia and Oceania", *Periodontol.,* 2002; Vol. 29, pp. 122-52.

27. Darout I A, Albandar J M and Skaug N (2000), "Periodontal status of adult Sudanese habitual users of miswak chewing sticks or toothbrushes", *Acta Odontol Scand.,* Vol. 58, pp. 25-30.

28. Darout I A, Albandar J M, Skaug N and Ali R W (2002), "Salivary microbiota levels in relation to periodontal status, experience of caries and miswak use in Sudanese adults", *J Clin Periodontol.,* Vol. 29, pp. 411-420,

29. Darout I A, Christy A A, Skaug N and Egeberg P K (2000), "Identification and quantification of some potentially

antimicrobial anionic components in miswak extract", *Indian Journal of Pharmacology,* Vol. 32, pp. 11-14.

30. Darout I A, Skaug N and Albandar J M (2003), "Subgingival microbiota levels and their associations with periodontal status at the sampled sites in an adult Sudanese population using miswak or toothbrush regularly", *Acta Odontologica Scandinavia, Vol.* 61, pp. 115-22.

31. Dorner W G (1981), "Active substances from African and Asian natural toothbrushes", *Chem Rundschau,* Vol. 34, pp. 50.

32. Edwardsson S, Bing M, Axtelius B, Lindberg B, Soderfeldt B and Attstrom R (1999), "The microbiota of periodontal pockets with different depths in therapy-resistant periodontitis", *J Clin Periodontol.,* Vol. 26, pp. 143-52.

33. Eid M A, al-Shammery A R and Selim H A (1990), "The relationship between chewing sticks (Miswak) and periodontal health. 2. Relationship to plaque, gingivitis, pocket depth, and attachment loss", *Quintessence Int., Vol.* 21, pp. 1019-22.

34. Eid M A, Selim H A and al-Shammery A R (1990a), "Relationship between chewing sticks (Miswak) and periodontal health. Part 1. Review of the literature and profile of the subjects", *Quintessence Int* , Vol. 21, pp. 913-7.

35. Elvin-Lewis M (1974), "The technique of using African chewing sticks for teeth cleaning*", J Dent Res.,* Vol. 53, p. 125.

36. Elvin-Lewis M (1980), "Plants used for teeth cleaning throughout the World", *J Prev Dent.,* Vol. 6, pp. 61-70.

37. Emslie R D (1966), "A dental health survey in the Republic of the Sudan", *Br Dent J.,* Vol. 120, pp. 167-78.

38. Engler A and Prantl K (1942), *Die natürlichen Pflanzenfamilien*, 2nd edn. Leipzig: Engelmann, p. 20.

39. Ezmirly S T, Cheng J C and Wilson S R (1979), "Saudi Arabian medicinal plants *Salvadora persica", Planta Medica,* Vol. 35, pp. 191-2.

40. Farooqui M I H and Srivastava J G (1968), "The toothbrush tree (*Salvadora persica*)", *J Crude Drug Res.,* Vol. 8, pp. 1297-9.

41. Fischman S L (2000), "The history of oral hygiene products: how far have we come in 6000 years?", *Periodontol* , 1997; Vol. 15, pp. 7-14.

42. Frandsen A (1986), "Mechanical oral hygiene practices", In: H Loe DV Klemman (eds), *Dental plaque control measures and oral hygiene practices,* Oxford: IRI. Press; pp. 93-116.

43. Galletti G C, Chiavari G and Kahie Y D (1993), "Pyrolysis/gas chromatography/ ion-trap mass spectrometry of the "tooth brush" tree (*Salvadora persica* L.)", *Rap Com Mass Spectrometry*, Vol. 7, pp. 651-5.

44. Gazi M, Saini T, Ashri N, Lambourne A (1990), "Meswak chewing stick versus conventional toothbrush as an oral hygiene aid", *Clin Prev Dent* , Vol. 12, pp. 19-23.

45. Guile E E (1992), "Periodontal status of adults in central Saudi Arabia", *Community Dent Oral Epidemiol.,* Vol. 20, pp. 159-60.

46. Gupta R K and Sakena M A (1968), "Resource survey of *Salvadora oleoides*

Deene and *S. persica* Linn", *For no-edible oil in Western Rajasthan. Trop Ecol* ., Vol. 9, pp. 140-52.

47. Hardie J Ahmed K (1995), *The miswak as an aid in oral hygiene. FDI World.*, Vol. 4, pp. 5-10.

48. Harfi H A and Lundberg M (1997), "Meswak, a novel allergen", *Allergy*, Vol. 52, pp. 474-9.

49. Hattab F N (1997), "Meswak: the natural toothbrush", *J Clin Dent.,* Vol. 8, pp. 125-9.

50. Hillman J D, Socransky S S and Shivers M (1985), "The relationship between *streptococcal species* and periodontopathic bacteria in human dental plaque", *Arch Oral Biol.,* Vol. 30, pp. 791-5.

51. Hollist N O (1981), "The technique and use of chewing stick", *Odontostomatol Trop.*, Vol. 4, pp. 171-4.

52. Ihalin R, Loimaranta V, Lenander-Lumikari M and Tenovuo J (1998), "The effects of different (pseudo)halide substrates on peroxidase-mediated killing of *Actinobacillus actinomycetemcomitans*", *J Periodontal Res.,* Vol. 33,pp. 421-7.

53. Ihalin R, Loimaranta V, Lenander-Lumikari M and Tenovuo J (2001), "The sensitivity of *Porphyromonas gingivalis* and *Fusobacterium nucleatum* to different (pseudo)halide-peroxidase combinations compared with mutans streptococci", *J Med Microbiol.,* Vol. 50, pp. 42-8.

54. Kamel M S, Ohtani K, Assaf M H, Kasai R, El-Shanawani M A, Yamasaki K, *et al*. (1992), "Lignan glycosides from stems of *Salvadora persica*", *Phytochemistry,* Vol. 31, pp. 2469-71.

55. Kassas M and Zahran M A (1965), "Studies of Red Sea Costal land. II. The district from El Galala El Quibliya to Hurghada", *Bull Soc. Geiger D' Egypt Economic Bot.,* Vol. 22, pp. 165-77.

56. Khoory T (1983), "The use of chewing sticks in preventive oral hygiene", *Clin Prev Dent.,Vol.* 5, pp. 11-4.

57. Kimery M J, Stallard R E (1968), "Literature review. The evolutionary development and contemporary utilization of various oral hygiene procedures", *Periodontal Abstr,* Vol. 16, pp. 90-7.

58. Kononen E, Di Tella P, Tanskanen V and Jousimies-Somer H (2001), "Salivary carriage of main periodontal pathogens in adult Helsinki citizens in relation to age and gender", *J Dent Res.,* Vol. 80, pp. 700.

59. Lenander-Lumikari M, Mansson-Rahemtulla B and Rahemtulla F (1992), "Lysozyme enhances the inhibitory effects of the peroxidase system on glucose metabolism of *Streptococcus mutans*", *J Dent Res*., Vol. 71, pp. 484-90.

60. Loe H. Oral hygiene in the prevention of caries and periodontal disease. Int Dent J 2000; 50:129-39.

61. Luthy J and Benn M H (1977), "Thiocyanate formation from glucosinolates: a study of the autolysis of allylglucosinolate in *Thlaspi arvense* L. seed flour extracts", *Can J Biochem*., Vol. 55, pp. 1028-31.

62. Mandel I D and Gaffar A (1986), "Calculus revisited: A review", *J Clin Periodontol*., Vol. 13, pp. 249-57.

63. Marsh P D (1991), "Sugar, fluoride, pH and microbial homeostasis in dental plaque", *Proc Finn Dent Soc., Vol.* 87, pp. 515-25.

This article can be downloaded from http://www.ijlbpr.com/currentissue.php

64. Marsh P D (1994), "Microbial ecology of dental plaque and its significance in health and disease", *Adv Dent Res.,* Vol. 8, pp. 263-71.

65. Massassati A, Frank R M, Arends J and Klein J P (1981), "Etudes ultrastructurales, cristallographiques et microbiologiques de batonnets frotte-dents (Miswak) utilises pour hygiene dentaire dans les pays islamiques", *J Biol Buccale,* Vol. 9, pp. 53-60.

66. Mohammad A R and Turner J E (1983), "*In vitro* evaluation of Saudi Arabian toothbrush tree (*Salvadora persica*)", *Odontostomatol Trop.,* Vol. 6, pp. 145-8.

67. Olsson B. Efficiency of traditional chewing sticks in oral hygiene programs among Ethiopian schoolchildren. Community Dent Oral Epidemiol 1978; 6:105-9.

68. Porteres R (1974), "UN curieux element culturel arbo-islamique et Neo-African: Les baguettes vegetables machees servant de fotte-dents", *J Agric Trop Bot.,* Vol. 21, pp. 1-36.

69. Raed I A and Almas K (1999), "Miswak (chewing stick): A cultural and scientific heritage", *Saudi Dent J* ., Vol. 11, pp. 80-7.

70. Ray A B, Chand L and Dutta S C (1975), "Salvadourea. New urea derivative from *Salvadora persica*", *Chem Ind* (London) , Vol. 12, pp. 517-8.

71. Ring M (1985), *Dentistry. An illustrated history*, New Yrok: Abrams.

72. Sanogo R, Monforte M T, Daquino A, Rossitto A, Maur D D and Galati E M (1999), "Antiulcer activity of *Salvadora persica* L.: structural modifications", *Phytomedicine*, Vol. 6, pp. 363-6.

73. Sarita P T and Tuominen R (1992), "Tooth cleaning methods and their effectiveness among adults in rural Tanzania", *Proc Finn Dent Soc.,* Vol. 88, pp. 139-45.

74. Sathananthan K, Vos T and Bango G (1996), "Dental caries, fluoride levels and oral hygiene practices of school children in Matebeleland South, Zimbabwe", *Community Dent Oral Epidemiol.,* Vol. 24, pp. 21-4.

75. Silva Mendez L S, Allaker R P, Hardie J M and Benjamin N (1999), "Antimicrobial effect of acidified nitrite on cariogenic bacteria", *Oral Microbiol Immunol.,* Vol. 14, pp. 391-2.

76. Sirinian G, Shimizu T, Sugar C, Slots J and Chen C (2002), "Periodontopathic bacteria in young healthy subjects of different ethnic backgrounds in Los Angeles", *J Periodontol., Vol.* 73, pp. 283-8.

77. Socransky S S, Haffajee A D and Dzink J L (1988), "Relationship of subgingival microbial complexes to clinical features at the sampled sites", *J Clin Periodontol.,* Vol. 15, pp. 440-4.

78. Sowinski J A, Battista G W, Petrone D M, Petrone M E, DeVizio W and Volpe A R (2002), "A clinical study to assess the anticalculus efficacy of a new dentifrice containing a special grade of silica (Colgate Total Plus Whitening Toothpaste): a clinical trial on adults", *J Clin Dent.,* Vol. 13, pp. 65-8.

79. Sulaiman M I, Ajabnoor M A and Al Khateeb T (1986), "Effects of *Salvadora persica* extracts on mice exploratory locomotion activities", *J Ethnopharmacol.,* Vol. 17, pp. 263-8.

This article can be downloaded from http://www.ijlbpr.com/currentissue.php

80. Tenovuo J, Mansson-Raheamtulla B, Pruitt K M and Arnold R (1981), "Inhibition of dental plaque acid production by the salivary lactoperoxidase antimicrobial system", *Infect Immun.,* Vol. 34, pp. 208-12.

81. Trovato A, Galati E M, Rossitto A, Monforte M T, d´Aquino A and Forestieri A M (1998), "Hypoglycemic effects of *Salvadora persaica* L. in the rat", *Phytomed.,* Vol. 5, pp. 129-32.

82. van Palenstein Helderman WH, Munck L, Mushendwa S and Mrema F G (1992), "Cleaning effectiveness of chewing sticks among Tanzanian schoolchildren", *J Clin Periodontol.,* Vol. 19, pp. 460-3.

83. World Health Organization (1979), *Oral health surveys*: Basic Methods. Geneva: WHO.

84. World Health Organization (1987), *Prevention of oral diseases*, Geneva: WHO, p. 60-1.

85. Xu J, Xu X and Verstraete W (2001), "The antimicrobial effect and chemical reactions of acidified nitrite under conditions simulating the stomach", *J Applied Microbiol.,* Vol. 90, pp. 523-9.

86. Younes S A and El-Angbawi M F (1982), "Dental caries prevalence in intermediate Saudi schoolchildren in Riyad", *Community Dent Oral Epidemiol.,* Vol. 10, pp. 74-6.

This article can be downloaded from http://www.ijlbpr.com/currentissue.php

International Journal of Life Sciences Biotechnology and Pharma Research

Hyderabad, INDIA. Ph: +91-09441351700, 09059645577

E-mail: editorijlbpr@gmail.com or editor@ijlbpr.com

Website: www.ijlbpr.com

ISSN 2250-3137