

# Miswak (chewing Stick): A Cultural And Scientific Heritage

Ra'ed I. Al Sadhan, *BDS*, Khalid Almas, *BDS, MSC, DDPH.RCS, FRACDS, FDS RCSED, FICD*  
College of Dentistry, King Saud University, P.O. Box 60169, Riyadh 11545, K.S.A.

Saudi Dental Journal 1999/Volume 11 Number 2; 80-88

## Abstract

Miswak (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. Chewing sticks are used for oral hygiene, religious and social purposes. This article presents some of the different types of chewing sticks used around the world with special emphasis on the most commonly used plant in the Middle East, the Arak (*Salvadora persica*). The Pharmacological and therapeutic aspects of Miswak and its role in plaque control, gingival recession, tooth wear, bleeding gums and periodontal health is discussed with reference to current literature. Finally, this review concludes with how to select and use the Miswak.

## Introduction

Dental caries and periodontal diseases are the two main afflictions to mankind. Bacterial plaque is solely responsible for the initiation and progression of periodontal diseases. The methods available for the maintenance of oral health are mainly mechanical and chemical. Toothbrushes and dentifrices are widely used for cleaning teeth. The traditional toothbrush or chewing stick is deeply rooted in Islamic culture. This article gives a brief cultural and historical background of the subject and review current literature on Miswak.

### Definitions

Pencil-sized sticks of various plants are fashioned from certain plant - parts and are chewed on one end until they become frayed into a brush. The brush-end is used to clean the teeth in a manner similar to the use of a toothbrush. When used in this manner, they are commonly referred to as chewing sticks or Miswak.

The conventional meaning of Miswak is 'stick used on teeth and gums to clean them.' Its various names are Miswak and Siwak as used in the Middle East, Mswaki in Tanzania, Mefaka in Ethiopia and Datun in India and Pakistan.<sup>1</sup> Although Siwak or Miswak is used to describe Arak (*Salvadora persica*), the stick which the Prophet Muhammad - Peace and Blessings of Allah be upon Him (PBUH) - used to clean his mouth with, miswak is a more general term which includes all types of sticks used as tooth-cleaning aids.

### Types of Miswak

In the Middle East, the most common source of chewing sticks is Arak (*Salvadora persica*). In West Africa, the lime tree (*Citrus aurantifolia*) and the orange tree (*Citrus sinensis*) are used. The roots of senna (*Cassia vinnea*) were used by

Black Americans, and those of African laburnum (*Cassia sieberiana*) were used in Sierra Leone. Neem (*Azadirachta indica*) is widely used in the Indian subcontinent.<sup>2</sup>

Arak, a tree used for Miswak, is also known as "tooth brush tree" and "mustard plant". Although the Miswak is usually obtained from the roots of the Arak tree, some sticks are made from its branches and bark.<sup>3</sup>

*Salvadora persica* is an upright evergreen small tree or shrub, seldom more than one foot in diameter reaching maximum height of three meters. The leaves are small, oval, thick and succulent with a strong smell of cress or mustard. The fresh leaves are eaten as salad and are 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.<sup>4</sup>

#### *Historical and Cultural Background of Miswak*

The use of Miswak is a pre-Islamic custom, which was adhered to by the ancient Arabs to get their teeth white and shiny. It also contributed to ritual purity. This custom was adopted and Islamized by Prophet Muhammad (PBUH) around 543 AD. This kind of toothbrushing has been used by the Arabs, the Babylonians some 7000 years ago,<sup>2</sup> the Japanese called it Koyoji, while the Romans used mastic to rub their teeth and as a toothpick. Ancient Egyptians and the Jews also used it.<sup>3</sup> It is in use throughout the Islamic countries.

#### *Religious Background*

Islam introduced basic oral hygiene by 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 Miswak in oral hygiene. For example: *Prophet Muhammad (PBUH), said: "Siwak purifies the mouth and pleases Allah'and said: Were it not to be a hardship on my community, I would have ordered them to use Siwak for every ablution.'*

#### *Chemical Composition of Miswak (Salvadora persica)*

The beneficial effects of Miswak in respect of oral hygiene and dental health are partly due to its mechanical action and partly due to pharmacological actions.

Farooqi et al<sup>4</sup> isolated benzy-lisothiocyanate from *Salvadora persica* root, they claimed to have found saponins along with tannins, silica, a small amount of resin, trimethylamine and a fairly large amount of alkaloidal constituents. Ray et al<sup>5</sup> found B-sitosterol, m-anisic acid, and salvadorea [1,3-Bis-(3-methoxy-benzyl)-urea]. Lewis and Elvin-lewis<sup>6</sup> report a high content of minerals in the root: 27.06%.

Ezmirly et al<sup>7</sup> also found B-sitosterol, together with elemental sulfur (S<sub>8</sub> a monoclinic form) in the root of *Salvadora persica*. They also found sulfur-containing mustard oil with the content of sulfur in the ash of the roots as high as 4.73%. Attar<sup>8</sup> indicates that plant fibers contain sodium bicarbonate. El-Mostehy et al<sup>9</sup> reported finding the following chemical substances: Trime- thylamine, an alkaloid, chlorides, high amounts of fluoride, silica (SiO<sub>2</sub>), sulfur, vitamin C, and small amounts of tannins, saponins, flavenoids and sterols. Akhtar and Ajmal<sup>10</sup> mentioned resin and large amounts of salts containing chlorine. A study by Chawla<sup>11</sup> reported that some types of chewing sticks such as Neem (*Azadirachta indica*), *Salvadora persica* and *Acacca/ arabica* contain a reasonable amount of fluoride.

#### *The Effects of Different Components*

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. The repeated process of using chewing sticks releases fresh sap, which seems to fulfill the above criteria.<sup>2</sup>

*Silica* in Miswak acts as an abrasive material to remove stains giving the teeth whiteness.<sup>102</sup>

*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. Its topical use is now restricted to the treatment of bedsores, minor ulcerations and the likes.<sup>13</sup> Tannic acid shows anti-tumor effect on animals and *in vitro*.<sup>14</sup> When denture bases were treated with tannic acid there were reduced *Candida* <3/Mv?/75 attachments to these surfaces.<sup>15</sup> It exerts an astringent effect on the mucous membrane, thus reducing the clinically detectable gingivitis.<sup>12</sup> Tannins also inhibit the action of

glucosyl transferase thus reducing plaque and gingivitis.<sup>16</sup>

*Resins* are amorphous products with a complex chemical composition. They are end products of metabolism. Physically, they are usually hard, transparent, or translucent and, when heated, soften and finally melt. Chemically, they are complex mixtures of resin acids, resin alcohols (resinols), resin phenols (resinotannols), esters, and chemically inert compounds.<sup>131712</sup> 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. They are usually derivatives of Nitrogen ring compounds, presenting colorless crystals that are bitter in taste, soluble in alcohol, and slightly soluble in water, their names end in -ines. Examples are atropine, caffeine, coniine, morphine, nicotine, quinine, and strychnine. The term is also applied to synthetic substances such as procaine.<sup>1819</sup> The alkaloid present in *Salvadora persica* is Salvadorine, which yields trimethylamine on hydrolytical cleavage.<sup>20</sup> It exerts a bacteriocidal effect and stimulatory action on the gingiva.<sup>1</sup>

*Essential (volatile) oils* possess characteristic aroma and exert carminative, antiseptic action.<sup>10</sup> The mild bitter taste stimulates the flow of saliva, which is antiseptic.<sup>21</sup>

The *sulfur* compounds present in Miswak as shown by their pungent taste and smell have a bactericidal effect.<sup>22</sup>

*Vitamin C* helps in the healing and repair of tissues.

*Sodium bicarbonate* (baking soda)  $\text{NaHCO}_3$  has mild abrasive properties and is, thus, used as a dentifrice.<sup>18</sup> In addition to having a mild germicidal action.<sup>23</sup>

High concentrations of *chloride* inhibit calculus formation<sup>4</sup> and help in removing stains from the teeth.<sup>1</sup>

*Calcium* saturation of saliva inhibits demineralization and promotes remineralization of tooth enamel.<sup>16</sup>

The root of *Salvadora persica* contains a steam-distillable oil composed of 10% benzyl nitrate and 90% *Benzylisothiocyanate* (BIT).<sup>24</sup> BIT is classified as one of the chemo-preventive agents that are thought to prevent carcinogenic and other genotoxic compounds from reaching or reacting with the target sites on the treated tissue.<sup>25</sup> Al Dosari et al<sup>26</sup> studied the effect of BIT on epithelial changes induced by trauma and Dimethylbenzanthracin (DMBA) in the hamster tongue. Their results indicate that BIT retarded 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.<sup>27</sup> In addition, it is reported to have a broad-spectrum bacteriocidal activity.<sup>28</sup> Al-Bagieh et al reported that BIT inhibits the growth and acid production of *streptococcus mutans*.<sup>29</sup>

### *Pharmacological Properties*

#### 1. Antibacterial properties

Studies have indicated that *Salvadora persica* contain substances that possess plaque inhibiting and antibacterial properties against several types of cariogenic bacteria which are frequently found in the oral cavity. The growth and acid production of these bacteria is thus inhibited.<sup>7, 23, 29, 30</sup>

Al Lafi and Ababneh<sup>31</sup> tested the antibacterial activity of *Salvadora persica* against some oral aerobic and anaerobic bacteria and reported that the extract of these sticks had a drastic effect on the growth of *Staphylococcus aureus*, and a variable effect on other bacterial species. They commented that the chewing sticks they used were harvested one month earlier, and suggested that using more fresh sticks will give better result. Almas et al<sup>32</sup> tested fresh vs. one-month-old Miswak extracts for antibacterial activity and found no difference. A comparison of alcohol and aqueous extract of Miswak was also made. It was found that alcoholic extract is more effective than aqueous extract for antibacterial activity.<sup>33</sup>

#### 2. Antimycotic activity

Results of the investigation carried by Al- Bagieh et al<sup>14</sup> suggest that aqueous extracts of Miswak could be used to reduce growth of *Candida albicans*. Such inhibition lasts for up to 36/h at concentrations of 15% and above.

3. Release of calcium and chloride into saliva Gazi et al<sup>16</sup> investigated the immediate and medium-term effect of Miswak on the composition of mixed saliva. They reported that Miswak produced significant increases in calcium (22-fold) and chloride (6-fold), and significant decreases in phosphate and pH. Calcium saturation of saliva inhibits demineralization and promotes remineralization of tooth enamel whereas high concentrations of chloride inhibit calculus formation.<sup>4</sup>

#### 4. Analgesic effect

Mansour et al<sup>35</sup> studied the analgesic effect of Miswak decoction when injected to mice. They found that Miswak was more effective against thermal stimuli than against chemical stimuli. Should the analgesic effect of Miswak be confirmed in clinical dental pain, e.g. superficial pain due to dental hypersensitivity to thermal, tactile, or to chemical stimuli, Miswak will be of practical value.

#### 5. Cytotoxicity

Mohammad et al<sup>23</sup> investigated the cytotoxic potential of *Salvadora persica* on gingiva and other periodontal structures using the agar overlay method. Results showed no cytotoxic effect by a freshly cut and freshly used Miswak. However, the same plant used for after 24 hours does contain harmful components. Based on these findings they recommend cutting the used portion of the Miswak after it has been used for one day and preparing a fresh part. The cytotoxicity in this study became evident only after 24 hours because the agar overlay method depends on the diffusion of the medicament through the agar material. In addition, it did not provide direct contact between the cells and the tested solution.<sup>23</sup>

#### 6. Other pharmacological properties

Miswak was reported to have anti-inflammatory, hypoglycemic activities<sup>723</sup> beside the astringent and detergent effect.<sup>9</sup>

#### *Uses of Miswak for Therapeutic Purposes*

Whenever Miswak is used, both the teeth and the tongue are cleaned. It has also been used to treat toothache. Miswak has various therapeutic uses, such as reputed benefits from the juice of the stick extracted on chewing (antibacterial extracts) and its functional aspects of chewing as a jaw exerciser following traumatic injuries to the jaw and temporomandibular joint, as well as a Sialogogue - a reflex induction of copious saliva - which is beneficial to the oral hygiene and general health. Miswak is often used to prevent oral habits such as smoking in adults and thumb sucking in children. It can also be used in the development of dentition during eruption.<sup>1</sup> It may improve appetite and regulate peristaltic movements of the gastro-intestinal tract.<sup>12</sup>

#### *Therapeutic applications of Miswak*

##### 1. Toothpaste

Some of the known commercial toothpaste produced from *Salvadora persica* plant are: Sarkan toothpaste®, UK, Quali-Meswak tooth-paste®, Switzerland, Epi-dent toothpaste®, Egypt, Siwak-F®toothpaste, Indonesia. Fluoroswak,® Miswak,® Pakistan.<sup>1</sup> Dentacare Miswak Plus,® Saudi Arabia.

##### 2. Mouthwashes

Mostafa et al<sup>36</sup> found a reduction in plaque formation by Miswak-based mouthwash. But no such preparation presently exists in the market.

##### 3. Endodontic irrigation solution

Although the antimicrobial activity of Miswak has been reported,<sup>7,22,23-29,31,34</sup> its toxicity must be considered. In addition, no report has been yet made on the utilization of the extract as an irrigant solution in endodontic practice. Abo Al Samh, et al<sup>37</sup> evaluated, *in vitro*, the effect of different concentrations of Miswak extract on L929 cell-line in tissue culture and compared the results with sodium hypochlorite (NaOCl). They found a concentration dependent morphological change of L929 cell-line when exposed to Miswak extract and NaOCl. They suspect recovery of the cells after a 4-hour exposure period to different Miswak extract concentrations.

### *Studies showing Relationship of Miswak to Oral Hygiene*

#### 1. Plaque reduction

Few studies have reported on the cleaning effectiveness of chewing sticks. Cross-sectional studies show conflicting results. A cross-sectional study in Ghana<sup>38</sup> among adults revealed higher plaque and gingival bleeding in chewing stick users as compared with toothbrush users. Another retrospective study showed that Miswak users had deeper pockets and more prevalence of periodontal diseases.<sup>39</sup>

In contrast, no differences in plaque and gingival bleeding were found between toothbrush and chewing stick users among 7-15 years old children in Tanzania.<sup>40</sup> It is reported that patients using Miswak regularly show decreased gingival bleeding on probing compared with non-Miswak users.<sup>41</sup> Thus, poor oral hygiene with those using chewing sticks may be a reflection of poor techniques.<sup>42</sup>

On the other hand, controlled longitudinal studies were more consistent. A clinical trial study on Ethiopian schoolchildren comparing mefaka (Miswak) with conventional toothbrush, found Miswak to be as effective as the toothbrush in removing oral deposits. The study also found instruction and supervision to be important since the children in the sample were found not to be familiar with Miswak techniques. The study further concluded that Miswak should be used in preventive dental programs, as it was economical and familiar to the older people.<sup>43</sup> In a clinical trial among adolescents in Nigeria, the results showed that the *Massularia acuminata* chewing stick was as effective in controlling and removing dental plaque as the toothbrush and paste.<sup>42</sup>

Al-Lafi<sup>44</sup> reports reduction in plaque in Miswak users. Danielsons, et al-showed that there was a reduction of plaque on the front teeth more than the posterior teeth and recommended Miswak as a tool for oral hygiene.<sup>45</sup> Mustafa et al<sup>36</sup> found 75 per cent plaque reduction after eight days of Miswak use.

Rinsing with a slurry of Miswak toothpaste reduces gingival inflammation and bleeding on probing.<sup>46</sup> Chlorhexidine and Miswak were compared and Chlorhexidine (CHX) was found to be more effective than, Miswak in plaque reduction.<sup>47</sup> It was found that *streptococcus mutans* were eliminated in the Miswak group and were less in CHX.

Gazi et al<sup>41</sup> reported that plaque and gingivitis were significantly reduced when Miswak was used 5 times a day compared with conventional toothbrush. Another study suggested that the frequent use of the Miswak was associated with a reduced need for periodontal care among Saudi Arabian adults.<sup>48</sup> It has demonstrated that Miswak may be of potential value in reducing plaque and gingival inflammation.<sup>49</sup>

In a controlled study,<sup>9</sup> it was reported that powdered Miswak if used with a mechanically proper device i.e. toothbrush, will give better results than Miswak sticks alone or commercial toothpowder in term of plaque percentage. Guile et al<sup>50,51</sup> concluded from a survey of Saudi school children that the low incidence of periodontal disease was attributable to the practice of using Miswak for teeth cleaning. Similar results and conclusions were reported in another study regarding dental caries in Saudi children.

In general, it is concluded from the above- mentioned studies that reduction in plaque leads to a decrease in gingivitis and ultimately a reduction in bleeding gums.

#### 2. Gingival recession

A relatively high prevalence of gingival recession among adults in Tanzania has been reported.<sup>52</sup> Gingival recession on buccal surfaces has been ascribed to brushing habits.<sup>53,54</sup> Since the lingual

surfaces in the Tanzanian population exhibits gingival recession to the same extent as the buccal surfaces, as has been reported,<sup>52</sup> then it is doubtful that the Miswak is the cause of high prevalence of gingival recession.<sup>55</sup>

Younes and El-Angbawi<sup>56</sup> reported that about 22% of the Saudi schoolchildren with gingival recession used Miswak. The low percentage of calculus deposits found in the group affected by gingival recession may be due to the common use of Miswak.

It has been reported that Miswak users had significantly more sites of gingival recession than did the toothbrush users. Furthermore, the severity of the recession was significantly more pronounced in the Miswak users than that in the toothbrush users.<sup>57</sup> However, the gingival recession reported in Miswak users may be a reflection of poor techniques.

### 3. Occlusal wear

A study by Johansson et al<sup>58</sup> analyzed the possible factors influencing the occurrence of occlusal tooth wear in a young Saudi population, factors found to correlate significantly with increased occlusal wear were bruxism, and the use of Miswak.

#### *How to use Miswak*

Miswak is available in various diameters and lengths and can be further cut into suitable lengths by the user. A length of 20 cm for adults and 15 cm for children is recommended for convenience of grip and ease of manipulation in a confined space.<sup>2</sup> An excessively long stick may result in serious traumatic injuries, from the intra-oral end. This is possible because most people habitually carry out their oral hygiene whilst continuing with other domestic duties.<sup>59</sup> The diameter is normally 1 centimeter. This gives a supple stick which is firm enough to transmit the pressure of the cleansing action to the teeth without breaking off.<sup>59</sup> The thicker sticks tend to be older and difficult to chew.<sup>60</sup>

Miswak should be freshly cut so that it is supple, easily chewed, and still rich in active constituents.<sup>2</sup> The root should be whitish-brown in color; a dark brown color indicates that the Miswak is no longer fresh.<sup>23</sup> A very dry Miswak can be expected to damage the gums and other oral tissues. If a stick is dry, the end for chewing should initially be soaked in fresh water for 24 hours. It should be noted that soaking for unduly long periods causes loss of active constituents and diminishes the therapeutic properties, although the mechanical effects on the teeth can still be expected to occur.<sup>2</sup> Before Miswak is used, the end should be washed with water. It is then chewed repeatedly until the fibers stand out like the bristles of a toothbrush. These fibers should be clipped of every 24 hours. If possible the Miswak should be kept in a moist place when not in use.<sup>2</sup>

Miswak is very similar to the toothbrush in that both have bristles and are used to remove plaque from the tooth surfaces mechanically. However, Miswak may also have a chemical action and may be chewed or sucked for several hours daily by some people.<sup>2</sup> But unlike a conventional toothbrush, the bristles' of the Miswak lie in the same long axis as its handle. The angulation in the toothbrush enables it to adapt more easily to the distal tooth surfaces particularly on the posterior teeth.<sup>42</sup>

The techniques employed for removing plaque mechanically are similar with the toothbrush and the chewing stick, e.g., vertical and horizontal brushing. However, these techniques are less important than people's attitudes, knowledge and manual dexterity.<sup>2</sup>

There are two basic holds, Pen-grip (three- finger grip) or palm-grip (five-finger grip).<sup>2</sup> In each case the aim is to ensure:

- a) Firm but controlled movement of the brush end of the Miswak within the oral cavity.
- b) That every area of the mouth is reached with relative ease and convenience.<sup>59</sup>

The cleaning movement should always be directed away from the gingival margin of the teeth on both the buccal and lingual surfaces. An anterior-to-posterior scrubbing movement is used on the occlusal surfaces. Care should be taken to avoid damaging the soft tissues of the mouth. Satisfactory cleaning

can be achieved if this procedure is followed for five minutes.<sup>2</sup>

The tongue is commonly cleaned by users of chewing sticks, the objective being to control bad breath and remove the white coating that develops on the dorsum of the tongue. This surface is usually cleaned by means of the brush end of the chewing stick, but better results are obtained by breaking the stick into a V-shape and scraping the resulting blade several times across the tongue.<sup>2,12</sup>

#### *When to Use Miswak*

Ideally, Miswak should be used before meals to remove the bacteria that convert sugar into acid, or immediately after meals. However, the latter is impractical, since the fall in pH and the associated damage occur within a few minutes, and 20 minutes later the saliva performs the buffering action itself. It does not seem that the use of Miswak occurs regularly after meals. In general it is recommended to use Miswak five times a day.<sup>2</sup>

The use of the Miswak alone can be satisfying if enough time is devoted to its application during the period it is kept in the mouth. A common fault is the habit of keeping it in the mouth while domestic duties are carried on, with the complete neglect of the stick. A definite time should be set aside for the use of the chewing stick; five minutes of complete devotion to this function is deemed sufficient to ensure good cleansing. The resulting smooth feel of the teeth with the tongue gives a critical measure of the efficiency and effectiveness of the chewing stick.<sup>59</sup>

#### **Conclusions and Recommendations**

- The use of Miswak might have evolved in various cultures independent of each other. The influence of Islam on the use and spread of it in the world is significant. The concept of Miswak in Islam includes all oral hygiene aids and is not restricted to the use of Arak "*Salvadora persica*" sticks.
- A traditional practice so common in large percentage of our population should be further thoroughly investigated on modern scientific lines.
- Miswak can be a good alternative to the toothbrush since it is inexpensive, and readily available. Miswak contains many medicinal properties, and is available in most rural areas of the poor countries. It does not need expertise or any extra resources to manufacture it. Thus it is recommended as an important and effective tool for oral hygiene.
- Dentists who practice in areas where chewing sticks are commonly used should realize that their patients might need specific instructions on proper ways to use the chewing sticks.

#### **References**

1. Almas K. Miswak (chewing stick) and its role in oral health. *Postgraduate Dentist* 1993; 3: 214-18.
2. Almas K and Al - Lafi T. The natural toothbrush. *World Health Forum* 1995; 16:206-10.
3. Gerrit Bos. The Miswak, an aspect of dental care in Islam. *Medical History* 1993; 37:68-79.
4. Farooqi MIH and Srivastava JG. The toothbrush tree (*Salvadora persica*). *Quart. J. Crude Drug Res.* 1968;8:1297-99.
5. Farooqi MIH and Srivastava JG. The toothbrush tree (*Salvadora persica*), *Quart. J. Crude Drug Res.* 1968; 8: 1297-99.
6. Ray AB, Lai Chand and Dutta SC. *Chemistry and Industry.* 1975;15 : 517.
7. Lewis WH and Elvin-Lewis MPF. *Oral Hygiene, Medical Botany,* John Wiley & Sons, New York, 1977:226-270.
8. Ezmirly ST, Cheng JC and Wilson SR. Saudi Arabian Medicinal plants: *Salvadora persica.* *Planta Medica.* 1978; 35:191-192.
9. Attar ZA. The Miswak, Nature's toothbrush. *Bull. History of Dentistry* 1979; 27: 39- 40.
10. El Mostehy MR, Al-Jassem AA, Al-Yassin IA, et al. Miswak as an oral health device. Preliminary chemical and clinical evaluation. *Hamdard* 1983; 26:41-50.

11. Akhtar M and AJmal M. Significance of chewing sticks (Miswak) in oral hygiene from a pharmacological viewpoint. J. Pak. Med. Assoc. 1981; 4:89-95.11 Chawla HS. A new natural source for topical fluoride. J Indian Dent Assoc 1983;55:419-422.
12. Chawla Hs. A new natural source for topical fluoride. J Indian Dent Assoc 1983; 55: 419-422.
13. Khoory T. The use of chewing sticks in preventive oral hygiene. Clinical Preventive Dentistry. 1983; 5:11-14.
14. Tyler VE, Bradley LR Robebers JE. "Pharma- cognosy" 9th Ed. Lea & Febiger 1988; 80-106.
15. Gali HU, Perchellet EM and Perchellet JP. "Inhabition of turner promoter-induced ornithine decar-boxylase activity by tannic acid and other poly-phenols in mouse epi- dermis in vivo". Cancer-Res. 1991; 51 : 2820-5.
16. Kubota K, Tanaka T, Murata Y and Hirasawa M. Effect of tannic acid on adherence of Candida to denture base. J of Dental Research 1988; 67: abstract 183.
17. Gazi MI, Davies TJ, Al-Bagieh N and Cox SW. The immediate and medium- term effects of Meswak on the composition of mixed saliva. J Clin Perio- dontol 1992; 19: 113-117.
18. George ET and William CE Pharmacognosy. 12th ed. Bailliere Tindall 1985; 95.
19. Jablonski S. Illustrated Dictionary of Dentistry. Philadelphia: W. B. Saunders Comp., 1982.
20. Dorland W. A. Newman. Dorland's Illustrated Medical Dictionary. 27th ed. Philadelphia: W. B. Saunders Co., 1988.
21. Dorner WG. Active substances from African and Asian natural toothbrushes Chemische Rundschau 1981; 34: 19-23.
22. Grant J. Miswak- toothbrushes that grow on trees. Todays - FDA. 1990; 2: 60.
23. Abo Al-Samh D. and Al-Bagieh N. A study of antibacterial activity of the miswak extract in vitro. Biomedical Letters. 1996; 53: 225-238.
24. Mohammad A and Turner JE. In vitro evaluation of Saudi Arabian toothbrush tree (*Salvadora persica*). Odontostomatol Trop 1983; 3:145-148.
25. Ezmirly ST and El-Nasr MS. Isolation of gluco- tropaeolin from *Salvadora persica*. J Chem Soc Pak 1981; 3: 9-12.
26. Wattenberg LW. Inhibition of carcinogenic effects of polycyclic hydrocarbons by benzyliothio- cyanate and related compounds. J Natl Cancer Inst. 1977;58:395-8.
27. Al-Bagieh NH and Weinberg ED. Benzyliothiocya- nate: a possible agent for controlling dental caries. Microbios. 1988; 39: 143-151.
28. Brown JM and Jacobs JW. An investigation into antibacterial activity in chewing sticks against oral streptococci. Odontostomatol Trop. 1979; 2 :25-30.
29. Al-LafiTand 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.
30. Almas K, Al-Bagieh N, and Akpata ES. In Vitro antibacterial effect of freshly cut and 1-month-old Miswak extracts. Biomedical letters. 1997;56:145- 149.
31. Al - Bagieh N. and Almas K. In-vitro antibacterial effects of aqueous and alcohol extracts of Miswak (chewing sticks). Cairo Dental Journal. 1997; 13:221-24.
32. Al-Bagieh NH, Idowu A and Salako O. Effect of aqueous extract of Miswak on the in vitro growth of *Candida albicans* Microbios 1994; 80:107-113.
33. Mansour MI, Al-Khateeb TL and Al -Mazraoo AA. The analgesic effect of Miswak. SDJ 1996; 8: 87-91.
34. Mustafa MH, Abd-el Al MM and Abo-el Fadl-KM. Reduced plaque formation by Miswak - based mouthwash. Egypt Dent J 1987; 33: 375-84.
35. Abo Al-Samh D., and Al-Nazhan S. In vitro study of the cytotoxicity of the miswak ethanolic extract. Saudi Dental Journal. 1997; 9 :125-30.
36. Norton MR and Addy M. Chewing sticks versus tooth brushes in West Africa. Clin Preventive Dent 1989; 11:11-13.
37. Eid MA and Selim HA. Retrospective study on the relationship between Miswak chewing stick and periodontal health. Egyptian Dent J 1994; 40:589- 92.
38. Norman S and Mosha HJ. Relationship between habits and dental health among rural Tanzanian children. Comm Dent Oral Epidemiol 1989; 17:317-21.
39. Gazi M, Saini T, Ashri N and Lambourne A. Meswak chewing stick versus conventional tooth- brush as an oral hygiene aid. Clin Preventive Dent 1990; 12: 19-23.



40. Sote EO. The relative effectiveness of chewing sticks and toothbrush on plaque removal. *African Dent J* 1987; 1:48-53.
41. Olsson B. Efficiency of traditional chewing sticks in oral hygiene programs among Ethiopian school children. *Comm Dent Oral Epidemiol* 1978; 6:105-9.
42. Al-Lafi T. Effectiveness of Miswak as a tool for oral hygiene. M Sc. Thesis 1988. University of London.
43. Danielsons B, Baelum V, Manji F and Fejerskov O. Chewing stick, toothpaste and plaque removal. *Acta Odontol Scand* 1989; 47:121-25.
44. Gazi M, Lambourne A and Chagla A. The anti- plaque effect of toothpaste containing *Salvadora persica* compared with chlorhexidine gluconate. *Clin Preventive Dent* 1987;9:3-8.
45. Gazi M. Photographic plaque assessment of the antiplaque properties of Sanguinarine and chlor- hexidine. *J Clin Periodontol* 1988; 15:106-9.
46. Al - Khateeb TL, OMullane DM, Whelton H and Sulaiman MI. Periodontal treatment needs among Saudi Arabian adults and their relation- ship to the use of the Miswak. *Comm Dent Health* 1991;8:323-28.
47. Eid MA, Al - Shammery AR and Selim HA. The relation-ship between chewing sticks (Miswak) and periodontal health. II. Relationship to plaque, gingivitis, pocket depth, and attachment loss. *Quint Int* 1990;21:1019-22.
48. Guile E, Al-Shammery A, Backly M and Lambourne A. Periodontal status of school attenders in Saudi Arabia. *J of Dent Res* 1988; 67: Abstr no. 1456.
49. Younes SA and El - Angbawi MF. Dental caries prevalence in intermediate Saudi schoolchildren in Riyadh. *Community Dent Oral Epidemiol* 1982; 10:74-76.
50. Baelum V. Pattern of periodontal breakdown in adult Tanzanians. *Scand J Dent Res* 1987; 95:221-28.
51. O'Leary TJ, Drake RB, Jividen GF and Allen MF. The incidence of recession in young males; Relationship to gingival and plaque scores. *Periodontics* 1968; 6:109-11. Sangnes G and Gjermo P. Prevalence of oral soft and hard tissue lesions related to mechanical tooth cleaning procedures. *Community Dent Oral Epidemiol* 1976;4:77-83.
52. Van Palenstein Helderman WH, Munck L, Mushendwa S and Mrema FG. Cleaning effectiveness of chewing sticks among Tanzanian schoolchildren. *J Cli Periodontol* 1992; 19:460-63.
53. Younes SA and El Engebawi MF. Gingival recession in mandibular central incisor region of Saudi schoolchildren aged 10-15 years. *Community Dent Oral Epidemiol* 1983; 4:246-49.
54. Eid MA, Selim HA and Al-Shammery AR. The relationship between chewing sticks (Miswak) and periodontal health. III. Relationship to gingival recession. *Quint Int* 1991; 22:61-4.