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### The Miracle Twig -Miswak

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#### Abstract

Chewing sticks are being used as oral hygiene aid since 3500 BC. There are more than 180 plant species from which chewing sticks are being prepared, among which Miswak (tooth cleaning stick) which is harvested from *Salvadora persica* is used most extensively. It is popularly known as "Tooth brush tree". Geographic distribution of *Salvadora persica* includes Africa, Egypt, Saudi Arabia, Iran, Iraq, Afghanistan, Pakistan and India. Miswak has many chemical components which makes it a good oral hygiene aid. It acts as a combination of tooth brush and paste. Using Miswak is a religious practice in Islam. The aim of this review article is to high light the miraculous properties of Miswak as an oral hygiene aid.

**Keywords:** *Salvadora persica*, Miswak, Chewing stick

#### 1. Introduction

Nowadays people turn back to nature for their ailments. Herbal products are gaining immense popularity. Toothpaste is not an exception. Most of the brands claim one or more herbal ingredients in them. Modern tooth brush is evolved from chewing sticks which were used by Arabs, Greeks and Romans since 3500 BC [1]. Chewing sticks are still being used by many people in rural areas for cleaning their teeth. They are said to have systemic benefits too when they are chewed and sucked.

Miswak is a stick which is not much familiar to us but shares its origin from India too. It has different names in different languages. Miswak or Siwak in Arabic, Peelu in Urdu and Ugaai in Tamil. The botanical name of Miswak is *Salvadora Persica*. *Salvadora Persica* is well known as "Tooth brush tree". "Miswak," is an Arabic word which means tooth-cleaning stick [2]. Among 180 plant species suitable for preparing toothbrushing sticks, Miswak harvested from *Salvadora persica*, is used most extensively [3].

World Health Organization (WHO) has recommended and encouraged the use of chewing sticks as an effective oral hygiene tool (WHO 1984). According to the consensus statement on oral hygiene (2000) by WHO, chewing sticks may play an important role in the promotion of oral hygiene. Further research in the evaluation of the effectiveness of chewing sticks would be highly beneficial [4].

#### 2. Origin and appearance

*S. persica* has a wide geographic distribution ranging from India, Nepal, Malaysia, Pakistan, Iran, Iraq, Saudi Arabia, Egypt, and Africa [5]. The term *Salvadora*, (from Juan Salvatory Bosca, 1598–1681) was proposed by Dr. Laurent Garcin while *persica*, term indicates Persia and L is used to indicate Carl Linnaeus (1707–1778), the father of modern taxonomy. *S. persica* L. belongs to family *Salvadoraceae* and Class *Magnoliopsida* [6].

*Salvadora persica* is an evergreen small tree or shrub, reaching maximum height of three meters. The leaves are 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 asthma, cough, piles, rheumatism, scurvy and other diseases. The flowers are small and fragrant and are used as a stimulant and are mildly purgative. The berries are small. They are eaten both fresh and dried [6]. Although Miswak is usually obtained from the roots of the Arak tree, some sticks are made from its branches [7]. The root bark of the tree is similar to sand in colour and the inner surfaces are an even lighter shade of brown. It has a warm and pungent taste.

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### 3. Chemical composition

The use of miswak for oral hygiene serves dual function i.e. mechanical plaque control by friction between plant fibres and tooth surfaces and chemical plaque control due to its chemical composition which includes<sup>[8]</sup>

- Benzyl iso thiocyanate - a major component of Miswak, has strong bactericidal effect against oral pathogens involved in periodontal disease.
- Alkaloids (SALVODARINE) - bactericidal effect and stimulates gingiva
- Silica - acts as abrasive material that removes stains and deposits from the tooth surface
- Calcium and fluoride (1 microgram/gm) ions – promote re-mineralization.
- Sodium bicarbonate - mild abrasive and germicidal effect
- Tannic acid – astringent effect, good anti-plaque and anti-gingivitis agent
- Resins – physical function, forms a layer over enamel protecting it from microbial action
- Essential oils – antiseptic effect and stimulates the flow of saliva.
- Vitamin C – healing and repair

#### 3.1 Benzyl iso thiocyanate

The root of *Salvadora persica* contains a steam-distillable oil composed of 90% Benzyl iso thiocyanate (BIT) and 10% benzyl nitrate<sup>[9]</sup>. BIT is classified as one of the chemopreventive agents that are thought to prevent carcinogenic and other genotoxic compounds from reaching or reacting with the target sites on the treated tissue<sup>[10]</sup>. The effect of BIT on epithelial changes induced by trauma and Dimethylbenzanthracin (DMBA) was studied by Dosari *et al* in the hamster tongue. Their results indicate that BIT retarded the development of neoplastic changes induced by trauma or trauma plus DMBA<sup>[11]</sup>. BIT is reported to have an anti-viral activity against Herpes simplex virus 1 (HSV-1) at a concentration of 133.3 mg/ml<sup>[12]</sup>. It is also reported to have a broad-spectrum bacteriocidal activity<sup>[13]</sup>. Al-Bagieh *et al* reported that BIT inhibits the growth and acid production of *Streptococcus mutans*<sup>[14]</sup>.

#### 3.2 Salvodarine

The alkaloid present in *Salvadora persica* is Salvadorine, which yields tri methylamine on hydrolytical cleavage<sup>[15]</sup>. It is bactericidal and stimulates gingiva<sup>[16]</sup>.

### 4 Miswak on oral health

#### 4.1 Analgesic effects

Miswak has analgesic, astringent and anti-inflammatory properties, making it an effective treatment for primary periodontal diseases<sup>[17]</sup>. Evidences suggested Miswak being effective against thermal stimuli compared to chemical ones. Focusing on the physiology, the responses of the thermal stimuli are via skin pain receptors whereas the chemical stimulus has its response via the visceral receptors. Thus it was found that Miswak responds to the peripheral pain and not the visceral. Hence, if applied to the oral mucosa it sets a relief in the oral pain<sup>[18]</sup>. Experiments on mice in a laboratory proved Miswak has a moderate analgesic effect that is related to interaction with the peripheral opiate system<sup>[19]</sup>. In addition, it has been noted that patients practicing Miswak regularly had a low incidence of toothache compared to toothbrush users<sup>[20]</sup>.

#### 4.2 Anti plaque

Miswak inhibits the formation of dental plaque chemically

and the value of Miswak is due primarily to its mechanical cleaning action<sup>[21]</sup>. Lower plaque scores were reported following the proper use of Miswak as an oral hygiene aid in comparison with the use of conventional tooth brushes.<sup>[22]</sup> Lower gingival bleeding was seen in habitual Miswak users<sup>[23]</sup>.

#### 4.3 Release of calcium and chloride in to saliva

Gazi *et al* investigated the effect of Miswak on the composition of mixed saliva. They found that Miswak produced significant increase in calcium (22-fold) and chloride (6-fold), and significant decrease in phosphate. Calcium saturation of saliva inhibits demineralization and promotes re-mineralization of tooth enamel whereas high concentrations of chloride inhibit calculus formation<sup>[24]</sup>.

#### 4.4 Anti- carious

Many epidemiological studies revealed that Miswak had strong anti-carious effects. In a dental health survey conducted in Sudan, a lower caries prevalence was reported among Miswak users than among toothbrush users<sup>[25]</sup>. Subsequent studies (Baghdady and Ghose, 1979<sup>[26]</sup>; Sathanathan *et al*, 1996<sup>[27]</sup>; Younes and El-Angbawi, 1982<sup>[28]</sup>) found similar lower caries incidences among school children using Miswak. Dental loss in adult is very low in adults where Miswak is used widely<sup>[29]</sup>

#### 4.5 Antibacterial properties

Studies have indicated that Miswak contain substances that possess plaque inhibiting and antibacterial properties against several types of cariogenic bacteria and periodontopathogens which are frequently found in the oral cavity<sup>[30]</sup>. Al-Otaibi M *et al* (2004) observed that the use of miswak, in contrast to toothbrush, significantly reduced the amount of *A. actinomycetemcomitans* in the subgingival plaque, which indicated that extracts from *Salvadora persica* might interfere with the growth and leukotoxicity of *A. actinomycetemcomitans*<sup>[31]</sup>. Almas, 1999 showed that miswak extracts had antimicrobial effects on *Streptococcus mutans* and *E. faecalis*. Elvin-Lewis *et al*. (1980) and Almas (1999) suggested that this effect may be due to the interaction with bacteria, which prevents their attachment on the tooth surface<sup>[32]</sup>.

#### 4.6 Antimycotic activity

Al- Bagieh *et al* suggested that aqueous extracts of Miswak could be used to reduce growth of *Candida albicans*. Such inhibition lasted for up to 36/h at concentrations of 15% and above<sup>[33]</sup>.

#### 4.7 Halitosis

Miswak is also used to clean the tongue. It helps in fighting halitosis and effectively removes the white coat that develops on the dorsum of the tongue. This is usually done by the brush end of the Miswak<sup>[34]</sup>.

#### 4.8 Removal of smear layer

Soaking the healthy and periodontally diseased root dentine in Miswak extract resulted in partial removal of smear layer, and occlusion of dentinal tubules was observed in dentine specimens brushed with Miswak solution<sup>[35]</sup>.

### 5 Milestone studies

Miswak exhibits high antioxidant activity due to the presence of antioxidant enzymes such as peroxidase, catalase,

polyphenoloxidase [36]. In a study it was found that mints with miswak extracts were 20 times more effective in killing bacteria than ordinary mints, which was published in 2007 by Journal of Agriculture and Food Chemistry. It showed that in 30 min 60% of bacteria was killed by mints with miswak extracts when compared to a meagre 3.4% by ordinary mints [37]. Miswak, Neem, Banyan and Mango sticks are among the popular oral hygiene aids that are used in India and a study was done in South India comparing these four sticks, which concluded stating Miswak being the more superior in antimicrobial activity among these chewing sticks [38]. Strong anti-bacterial effect of Miswak against oral pathogens was proved when an invitro study showed both Miswak pieces embedded in the agar plate and suspended above the agar plate at a distance of 3mm showed a zone of inhibition around the stick for *Aggregatibacter actinomycetemcomitans*, *Porphyromonas gingivalis*, *Lactobacillus acidophilus* and *Haemophilus influenza*. This suggested the volatile antibacterial agents present in the Miswak [39].

## 6. Traditional Uses of Miswak for Therapeutic Purposes

Miswak is used as a jaw exerciser following traumatic injuries to the jaw and temporomandibular joint. It acts as a Sialogogue - a reflex induction of copious saliva - which is beneficial to the oral hygiene and general health. It may improve appetite and regulate peristaltic movements of the gastro-intestinal tract. [40] Miswak is being used as an ingredient in tooth paste, mouthwash, and endodontic irrigation solution [41].

## 7. Systemic effects

### 7.1 Anti diabetic potential

Aqueous extract of Miswak at 500mg/kg dose level in comparison to other extracts was reported to have significant hypoglycemic and hypo lipedemic effects and regenerated pancreatic beta cells in streptozocin treated diabetic rats. [42]

### 7.2 Anti hyperlipidemic activity

The effects of long term administration of a lyophilized stem decoction of *S. persica* have also been investigated in diet induced rat hypercholesterolemia. The results showed that the miswak decoction significantly lowered cholesterol and LDL plasma levels in rats [43].

### 7.3 Anticonvulsant and sedative

Monforte *et al* observed the effect of Miswak stem extracts on sodium pentobarbital activity and on generalized tonic-clonic seizure produced by pentylenetetrazol on the rats. It was found that, extracts of *S. persica* extended sleeping time and decreased induction time induced by sodium pentobarbital. It attenuated pentylenetetrazol-induced convulsion by increasing the latency period and diminishing the death rate [44].

### 7.4 Antiulcer activity

The antiulcer activity of decoction of Miswak has been reported in rats. The ulcer index significantly decreased after the treatment with a lyophilized decoction of miswak (500 mg/kg, os), once daily for 7 days, with respect to controls [45]. Moreover, *S. persica* decoction possesses significant anti-inflammatory activity. The other study was designed to confirm the antiulcer activity of Miswak decoction using optical microscopy. The elements of gastric mucosa tended to be re-established normally in treated rats [46].

## 8. Method of use

Miswak has its own unique aspects which should be adapted prior to use for the best results. The functional end of a thin bark piece is striped off followed by chewing. Chewing of Miswak separates fibers and giving it a brush like appearance that helps in cleaning the teeth and massaging the gums. The recommended length for a stick is about 15 cm so that it can easily be grasped along with ease to carry around, whereas, the diameter is preferred to be less than 1 cm [47].

There are two methods documented to hold the Miswak. One is the three finger grip technique and the other is five finger grip technique. The aim of both techniques is to make sure that all surfaces of the teeth are accessible and cleaned with convenience and controlled movements of the stick in the oral cavity. In order to clean the tooth surfaces, the fibers of Miswak should be held perpendicular to the tooth surface and gently moved in vertical strokes, directed away from the gingival margins on both the buccal and lingual surfaces [47]. Miswak should be freshly cut so that it is supple, easily chewed, and still rich in active constituents. Fresh miswak is light brown in colour where as dry Miswak is dark brown in colour. [48] A very dry Miswak can damage the gums and other oral tissues. If a stick is dry, chewing end should be soaked in fresh water for 24 hours. However soaking for unduly long periods causes loss of active constituents and diminishes the therapeutic properties. If possible the Miswak should be kept in a moist place when not in use [49]

## 9. Tooth brush and Miswak

Miswak is very similar to the toothbrush in that both have bristles and are used to remove plaque from the tooth surfaces mechanically. 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 especially on the posterior teeth [50]. Removing plaque mechanically is similar with the toothbrush and the chewing stick, e.g. vertical and horizontal brushing. However, techniques are less important than people's attitudes, knowledge and manual dexterity.

Miswak is organic and totally biodegradable whereas plastic tooth brushes causes tonnes and tonnes of landfills every year. Tooth brush is usually used along with tooth paste for brushing. Finally the paste is spitted out considering the systemic toxicity of the ingredients, but the juice of the Miswak stick is sucked during brushing and also habitually which has systemic effects.

In a study which compared the efficacy of Miswak and use of tooth brush and they found that the use of Miswak was associated with a significant reduction of dental plaque and gingivitis along with comparable or superior oral hygiene effect [51]. It was also reported that the habitual Miswak users had lower gingival bleeding, [52].

A study was conducted among 213 males, aged 20 to 65 years, to evaluate the periodontal status of Miswak and toothbrush users. They reported that periodontal status of Miswak users in Sudanese population is better than that of toothbrush [53]. In a single-blind cross-over clinical study, after professional instruction of the proper use of Miswak and toothbrush, Miswak was found to be more effective than use of tooth brush for reducing plaque and gingivitis in a sample of male Saudi Arabians [54].

A study reported that about 22% of the Saudi school children with gingival recession used Miswak [55]. This group had minimal calculus deposits which may be attributed to the use of Miswak. It has been reported that Miswak users had

significantly more sites of gingival recession than did the toothbrush users. In addition, the severity of the recession was significantly more pronounced in the Miswak users than that in the toothbrush users [56]. However, the gingival recession reported in Miswak users may be due to poor techniques.

## 10. Conclusion

Natural medicine like herbal chewing sticks (Miswak) has been popular since ancient times; further long-term clinical trials are needed to evaluate the therapeutic and pharmacological effects of various chemical components of Miswak. More and more studies should focus on clinical effectiveness of Miswak as compared with the toothbrush and with various fluoridated and non-fluoridated dentifrices. The results from these studies would definitely open new outlook in the field of dentistry in providing a foundation for various preventive oral health programs for rural and urban society.

## 11. References

- Almas K, Al - Lafi T. The natural toothbrush. World Health Forum. 1995; 16:206-10.
- Wu C, Darout I, Skaug N. Chewing sticks: timeless natural toothbrushes for oral cleansing. J. Periodontal. Res. 2001; 36(5):275-284.
- Hattab F. Meswak: the natural toothbrush. J. Clin. Dent. 1997; 8(5):125-129.
- Hassan suliman halawany. A review on miswak (*salvadora persica*) and its effect on various aspects of oral health. The Saudi dental journal. 2012; 24:63-69.
- Elvin-Lewis M. The therapeutic potential of plants used in dental folk medicine. Odontostomatol. Trop. 1982; 5(3):107-117.
- Farooqi MIH, Srivastava JG. The toothbrush tree (*Salvadora persica*). Quart. J. Crude Drug Res. 1968; 8:1297-99.
- Gerrit Bos. The Miswak, an aspect of dental care in Islam. Medical History. 1993; 37:68-79.
- Miswak (chewing Stick). A Cultural and Scientific Heritage, Saudi dental journal 1999; 11(2):80-88.
- Mohammad A, Turner JE. *In vitro* evaluation of Saudi Arabian toothbrush tree (*Salvadora persica*). Odontostomatol Trop. 1983; 3:145-148.
- Ezmirly ST, El-Nasr MS. Isolation of gluco- tropaeolin from *Salvadora persica*. J Chem Soc Pak. 1981; 3:9-12.
- Wattenberg LW. Inhibition of carcinogenic effects of polycyclic hydrocarbons by benzylisothio- cyanate and related compounds. J Natl Cancer Inst. 1977; 58:395-8.
- Al-Bagieh NH, Weinberg ED. Benzylisothiocyanate: a possible agent for controlling dental caries. Microbios. 1988; 39:143-151.
- Brown JM, Jacobs JW. An investigation into antibacterial activity in chewing sticks against oral streptococci. Odontostomatol Trop. 1979; 2:25-30.
- 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.
- Dorland WA. Newman. Dorland's Illustrated Medical Dictionary. 27th ed. Philadelphia: W. B. Saunders Co, 1988.
- Almas K. Miswak (chewing stick) and its role in oral health. Postgraduate Dentist. 1993; 3:214-18.
- Eid MA, Selim HA. A retrospective study on the relationship between miswak chewing stick and periodontal health. Egypt Dent J. 1994; 40:589-92.
- Sulaiman M, Al-Khateeb T, Al-Mazraoo A. Analgesic effects of miswak. The Saudi Dental Journal. 1996; 8:140-4.
- Hayes AG, Tyers MB. Determination of receptors that mediate opiate side effects in the mouse. Br J Pharmacol 1983; 79:731-6.
- Wu CD, Darout IA, Skaug N. Chewing sticks: Timeless natural toothbrushes for oral cleansing. J Periodontal Res. 2001; 36:275-84.
- Akpata E, Akinrimisi E. Antibacterial activity of extracts from some African chewing sticks. Oral Surg. Oral Med. Oral Pathol. 1977; 44(5):717-722.
- Gazi M. Photographic plaque assessment of the antiplaque properties of Sanguinarine and chlorhexidine. J Clin Periodontol. 1988; 15:106-9.
- Olsson B. Efficiency of traditional chewing sticks in oral hygiene programs among Ethiopian school children. Comm Dent Oral Epidemiol. 1978; 6:105-9.
- Kubota K, Tanaka T, Murata Y, Hirasawa M. Effect of tannic acid on adherence of *Candida* to denture base. J of Dental Research. 1988; 67:183.
- Emslie, R. A dental health survey in the Republic of the Sudan. Br. Dent. J. 1966; 120(4):167-178.
- Baghdady V, Ghose L. Comparison of the severity of caries attack in permanent first molars in Iraqi and Sudanese school children. Community Dent. Oral Epidemiol. 1979; 7(6):346-348.
- Sathananthan K, Vos T, Bango G. Dental caries, fluoride levels and oral hygiene practices of school children in Matebeleland South, Zimbabwe. Community Dent. Oral Epidemiol. 1996; 24(1):21-24.
- Younes S, El-Angbawi M. Dental caries prevalence in intermediate Saudi schoolchildren in Riyadh. Community Dent. Oral Epidemiol. 1982; 10(2):74-76.
- Lewis WH, Elvin-Lewis MPF. Oral Hygiene, Medical Botany, John Wiley & Sons, New York. 1977, 226-270.
- Almas, K. The antimicrobial effects of extracts of *Azadirachta indica* (Neem) and *Salvadora persica* (Arak) chewing sticks. Indian J. Dent. Res. 1999; 10 (1):23-26.
- Al-Otaibi M, Al-Harthy M, Gustafsson A, Johansson A, Claesson R, Angmar-Mansson B. Subgingival plaque microbiota in Saudi Arabians after use of miswak chewing stick and toothbrush. J Clin Periodontol. 2004; 31:1048-53.
- Elvin-Lewis M. Plants used for teeth cleaning throughout the world. J. Prev. Dent. 1980; 6:61-70.
- Tyler VE, Bradley LR Robebers JE. "Pharma- cognosy" 9th Ed. Lea & Febiger. 1988; 80-106.
- Chawla Hs. A new natural source for topical fluoride. J Indian Dent Assoc. 1983; 55:419-422.
- Almas K. The effects of extracts of chewing sticks (*Salvadora persica*) on healthy and periodontally involved human dentine: A SEM study. Indian J Dent Res 2001; 12:127-32.
- Mohamed SA, Khan JA. Antioxidant capacity of chewing stick miswak *Salvadora persica*. BMC Complement Altern Med 2013; 13:40.
- Husain A, Khan S. Miswak: The miracle twig. Arch Med Health Sci. 2015; 3:152-4.
- Elangovan A, Muranga J, Joseph E. Comparative evaluation of the antimicrobial efficacy of four chewing sticks commonly used in South India: An in vitro study. Indian J Dent Res. 2012; 23:840.
- Sofrata A, Claesson R, Lingstrom P, Gustafsson A. Strong antibacterial effect of miswak against oral micro-organisms associ-ated with periodontitis and caries. J.

- Periodontol. 2008; 79(8):1474-1479.
40. Al-Khateeb TL, O'Mullane DM, Whelton H, Sulaiman MI. Periodontal treatment needs among Saudi Arabian adults and their relationship to the use of the Miswak. *Community Dent Health*. 1991; 8:323.
  41. Ra'ed I, Al Sadhan, Khalid Almas, Miswak (chewing stick). A cultural and scientific heritage. *The Saudi dental journal*. 1999, 11(2).
  42. Trovato A, Galati EM, Rossitto A, Monforte MT, Aquino A, Forestieri AM. Hypoglycemic effect of *Salvadora Persica* in the rat. *Phytomedicine*. 1998; 5:129-32
  43. Galati EM, Monforte MT, Forestieri AM, Miceli N, Bader A, Trovato A. *Salvadora persica* L. hypolipidemic activity on experimental hypercholesterolemia in rat. *Phyto Med*. 1997; 63:27-30.
  44. Monforte MT, Trovato A, Rossitto A, Forestieri AM, Daquino A, Miceli N, *et al*. Anticonvulsant and sedative effects of *Salvadora persica* L. stem extracts. *Phytother Res* 2002; 16:395-7.
  45. Monforte MT, Miceli N, Mondello MR, Sanogo R, Rossitto A, Galati EM. Antiulcer activity of *Salvadora persica* on experimental ASA induced ulcer in rats: Ultrastructural modifications. *Pharma Biol*. 2001; 39:289-92.
  46. Sanogo R, Monforte MT, Daquino A, Rossitto A, Maur DD, Galati EM. Antiulcer activity of *Salvadora persica* L. structural modifications. *Phytomedicine*. 1999; 6:363-6.
  47. Almas K, Al-Lafi T. The natural toothbrush. *World Health Forum*. 1995; 16:206-10.
  48. Abo Al-Samh D, Al-Bagieh N. A study of antibacterial activity of the miswak extract in vitro. *Biomedical Letters*. 1996; 53:225-238.
  49. Almas K, Al-Lafi TR. The natural toothbrush. *World Health Forum* 1995; 16:206-10.
  50. Al-Lafi T. Effectiveness of Miswak as a tool for oral hygiene. M Sc. Thesis. University of London, 1988.
  51. Danielsons B, Baelum V, Manji F, Fejerskov O. Chewing stick, toothpaste and plaque removal. *Acta Odontol Scand*. 1989; 47:121-25.
  52. Gazi M, Saini T, Ashri N, Lambourne A. Meswak chewing stick versus conventional toothbrush as an oral hygiene aid. *Clin Prev Dent*. 1990; 12:19-23.
  53. Darout IA, Albandar JM, Skaug N. Periodontal status of adult Sudanese habitual users of miswak chewing sticks or toothbrushes. *Acta Odontol Scand*. 2000; 58:25-30.
  54. Al-Otaibi M, Al-Harthy M, Soder B, Gustafsson A, Angmar Mansson B. Comparative effect of chewing sticks and toothbrushing on plaque removal and gingival health. *Oral Health Prev Dent*. 2003; 1:301-7.
  55. Younes SA, 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.
  56. Eid MA, Selim HA, Al-Shammery AR. The relationship between chewing sticks (Miswak) and periodontal health. III. Relationship to gingival recession. *Quint Int*. 1991; 22:61-4.