



Antibacterial activity of Miswak (*Salvadora persica* L.) extracts on oral hygiene

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Received 8 June 2015; received in revised form 11 September 2015; accepted 14 September 2015

Available online 29 December 2015

Abstract

Salvadora persica L., also known as the toothbrush tree (Miswak), has been used since ancient times as a chewing stick for oral hygiene. Miswak is a natural source of many unique phytochemicals, which are described by traditional medicine as a remedy for various disease symptoms with beneficial properties. The availability and richness of biologically active compounds and minerals, related to oral and dental health, in Miswak makes it a superior tool for oral hygiene and a barrier against general pathogens that enter the human body through the mouth. This study investigates the presence of antimicrobial agents in Miswak extracts based on their polarity in different solvents. The results show that Miswak contains more than one type of antimicrobial agent that inhibits the growth of both gram positive and negative bacteria. The zone of inhibition for three different extracts was measured in *Escherichia coli*, *Staphylococcus aureus*, *Lactobacillus acidophilus*, *Streptococcus mutans* and *Pseudomonas aeruginosa*; the results show a strong antimicrobial activity in the aqueous extract and less activity in alcoholic and nonpolar extracts.

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Keywords: *Salvadora persica*; Miswak; Chewing sticks; Oral hygiene; Saliva; Antibacterial activity

1. Introduction

Oral hygiene is one of the most important daily routine practices and keeps the mouth and teeth clean and prevents many health problems [1]. Modern dental care

tools are designed to provide both a mechanical and chemical means of removing plaque and food residues from the surface and spaces between the teeth. Throughout history, people have been using different tools and chemicals to maintain their oral health, such as chewing sticks, tooth brushes, gum, mouth wash, toothpaste and floss, which are all believed to evolve from botanical origins [2,3]. Chewing sticks are considered the most popular among all of the dental care tools for their simplicity, availability, low cost and their traditional and/or religious value [1,3]. Chewing-sticks were used by the Babylonians more than 7000 years ago [2]. Currently, in the Muslim world, the use of Miswak as a chewing stick is highly recommended as a Sunnah practiced by the prophet Mohammad (peace be upon him) and his

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Peer review under responsibility of Taibah University.



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Table 1
Phyto-chemicals found in *S. persica* and their benefits for oral and dental health.

#	Chemical	Benefit to oral health	Reference
1	Sulphur	Antibacterial effect	[5]
2	Chlorides, fluorides	Enamel remineralization	
3	Vitamin C	Tissue healing and repair	
4	Tannins,	Reduce plaque and gingivitis	[28]
5	Silica	Removing stains	
6	Alkaloids	Antibacterial activity	
7	Benzyl isothiocyanate	Prevent cariogenic and genotoxic compounds	[13]
9	Essential oils	Flow of saliva and buffering pH	
10	Butanediamide	Antimicrobial agent	[29]
11	N-benzyl-2-phenylacetamide	Antimicrobial agent	

companions to achieve daily dental care, and the prophet emphasised the importance of using Miswak for oral hygiene [3].

Salvadora persica Linn. (Miswak) is a small ever-green tree that belongs to the Salvadoraceae family [4]. The *S. persica* tree can reach up to 3 m tall and has thick succulent small leaves [5]; new stem branches are green to greyish in colour while old branches are dark brown [6]. The scientific name of *S. persica* was given to the tree after classifying the first sample in 1598 by the Spanish botanist, Dr. Laurent Garcin, who collected the specimen from the middle-east [4]. The tree is globally known as the toothbrush tree or chewing-sticks; it has many local names in different geographical regions such as Miswak or Arak in the Arab world, Koyoji in Japan, Qesam in Hebrew, and Mastic in Latin [7].

The suitability of Miswak chewing sticks as a dental care tool is achieved mechanically by the ability of its fibres to reach in between teeth and also chemically by the richness of its phyto-constituents, which are unique in their complexity and biological activity. Previous studies have demonstrated the richness of *S. persica* Miswak for the minerals and phytochemical components related to dental care, which is shown in Table 1. Many studies focus on extracted chemicals, such as β -sitosterol [8], glycosides [9] and organic compounds like pyrrolidine, pyrrole and piperidine derivatives [10], which are biologically active and described as remedies for joint pain, spleen troubles, gonorrhoea, skin diseases and stomach ulcers [6,11]. Chlorides and fluorides in Miswak extracts were also shown to be important elements to remineralize teeth enamel along and showed antimicrobial activity [12]. The Miswak sap is reported as a stimulant of saliva production with a pH buffering capacity [13], the ability to remove the dental plaque layer [14], remineralization of the enamel layer [12] and shows a strong antimicrobial activity [1].

Exploring the antimicrobial activity of *S. persica* is still in its early stages, where crude and alcoholic extracts have shown general effectiveness against some pathogenic bacteria and fungi [2,11,15] such as *Bacillus subtilis*, *Escherichia coli*, *Lactobacillus brevis*, *Proteus vulgaris*, *Staphylococcus aureus*, *Streptococcus mutans*, *Lactobacillus acidophilus*, *Pseudomonas aeruginosa*, *Aspergillus niger*, and *Candida albicans* [11,15,16]. The biological activity of a few of *S. persica*'s fractionated phytochemicals were investigated and reported, such as benzyl isothiocyanate [17] and β -sitosterol [8], which inhibit the cariogenic and genotoxic compounds accumulated on the surface of the teeth. The toxicity of *S. persica* extracts was reported in high concentrations and exceeded 5 g/kg of the mammal's body weight [18].

The polar nature of chemical compounds and the choice of solvents are major factors in determining the solutes and their activity in the performed extracts [19]. Nevertheless, it has been reported that a high mineral content, dissolved inorganic compounds and anionic components in the extract, such as chlorides, fluorides, sulphur, cyanides, and heavy metals, possess a broad antimicrobial activity [20,21] by disrupting the bacterial cell wall, disrupting the transport system, inhibiting oxygen uptake, and leading to oxidative stress in bacteria or causing immediate toxicity and death [21,22]. The phytochemical constituents in *S. persica* were shown in an earlier study to be selective in their polarity, where alkaloids, flavonoids, quinones, and glycosides were more soluble in fresh samples with a higher water content [16] than alcoholic extracts. However, nonpolar compounds in *S. persica*, such as essential and volatile oils, were reported to possess antimicrobial activity against human pathogenic bacteria and fungi [23,24], in addition to its role in buffering the pH of saliva and removing the plaque layer [13].

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