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(REVIEW ARTICLE)



## THE MISWAK (SALVADORA PERSICA) AS A MODERN ALTERNATIVE IN ORAL HYGIENE: A NARRATIVE REVIEW

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### ABSTRACT

**Background:** Effective plaque control remains the cornerstone of preventing dental caries and periodontal disease. While the fluoridated nylon-bristle toothbrush and paste is the conventional standard of care, the miswak (*Salvadora persica*) — a chewing stick with a documented history spanning millennia and continued daily use by hundreds of millions of people — has attracted renewed scientific interest as a natural, low-cost oral hygiene device.

**Objective:** This narrative review synthesises the available evidence on the composition, mechanism of action, and clinical efficacy of miswak, and evaluates its standing as a modern alternative or adjunct to conventional oral hygiene. **Methods:** A non-systematic narrative review of peer-reviewed literature — including systematic reviews, meta-analyses, and randomised controlled trials indexed in PubMed, Scopus, and the Cochrane Library — was undertaken, focusing on chemical composition, antimicrobial and antiplaque activity, and comparative clinical trials of miswak versus toothbrushing and chlorhexidine.

**Results:** Miswak contains a broad range of bioactive constituents — including fluoride, silica, tannins, alkaloids (salvadorine), and benzyl isothiocyanate — that confer mechanical cleansing and antimicrobial, astringent, and remineralising properties. Meta-analytic evidence indicates that miswak reduces plaque and gingivitis scores to a degree statistically comparable with manual toothbrushing, and that *Salvadora persica* mouthrinse significantly reduces plaque and cariogenic bacterial counts relative to placebo, although its antiplaque effect remains modestly inferior to chlorhexidine. Adjunctive use of miswak alongside toothbrushing appears to confer additional benefit. Reported disadvantages include a risk of gingival recession with vigorous or improper use and inconsistency in reporting of technique across trials.

**Conclusion:** The evidence supports miswak as a safe, effective, and accessible oral hygiene tool, particularly suited to resource-limited and rural settings, and as a complementary adjunct to conventional oral hygiene practice. Larger, longer-term, well-standardised trials are required to establish optimal technique and frequency of use.

**Keywords:** Miswak; *Salvadora Persica*; Chewing Stick; Oral Hygiene; Dental Plaque; Gingivitis.

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## 1 INTRODUCTION

Dental caries and periodontal disease remain among the most prevalent chronic diseases worldwide, and both are preventable through regular, effective mechanical removal of dental plaque.

The nylon-bristle toothbrush used in combination with fluoridated dentifrice is internationally regarded as the conventional standard for personal oral hygiene, and powered toothbrushes with a rotation-oscillation action have been shown to remove plaque and reduce gingivitis more effectively than manual brushing in the short and long term<sup>13</sup>. However, across large parts of Africa, the Middle East, and South and Southeast Asia, chewing sticks — most commonly derived from the root, stem, or twig of the *Salvadora persica* ("arak" or "toothbrush") tree and known as the miswak or siwak — continue to be used as the primary or adjunctive means of oral hygiene by an estimated several hundred million people<sup>1,2</sup>. The practice has a documented history stretching back at least seven thousand years to the Babylonians, and was subsequently adopted by the Greeks, Romans, Jews, Egyptians, and, notably, within Islamic tradition, where its use is explicitly encouraged in prophetic teaching and remains a widespread daily religious and cultural practice<sup>1</sup>.

In recent decades, the miswak has attracted renewed scientific attention not merely as a traditional or religious artefact but as a candidate "modern alternative" in preventive dentistry: a low-cost, biodegradable, portable device requiring no water, toothpaste, or electricity, with a growing evidence base describing its phytochemical constituents and clinical effects on plaque, gingivitis, and cariogenic bacterial load<sup>2,3</sup>. The World Health Organization has formally recommended the use of *Salvadora persica* chewing sticks as an effective oral hygiene tool in populations where the practice is customary<sup>4</sup>, and miswak-derived extracts have since been incorporated into a range of commercially available toothpastes and mouthrinses marketed globally.

Despite this long history of use and a substantial and growing body of clinical research, miswak remains comparatively under-examined in mainstream restorative and preventive dental curricula, and questions remain regarding its comparative efficacy against the conventional toothbrush, its role as an adjunct rather than a substitute, and the safety of its long-term or improper use. The objective of this narrative review is therefore to synthesise the current evidence on the chemical composition, proposed mechanisms of action, and comparative clinical efficacy of the miswak, in order to critically evaluate its position as a viable modern alternative or adjunct within contemporary oral hygiene practice.

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## 2 MATERIALS AND METHODS

This paper is presented as a narrative review rather than a *de novo* systematic review or clinical trial, and therefore did not require institutional ethical approval or informed consent from human subjects; no primary human or animal data were generated. A structured literature search was conducted using the PubMed/MEDLINE, Scopus, ScienceDirect, and Cochrane Library databases, supplemented by manual screening of reference lists of retrieved articles, using combinations of the search terms "miswak", "siwak", "*Salvadora persica*", "chewing stick", "oral hygiene", "dental plaque", "gingivitis", and "toothbrush".

Priority was given to peer-reviewed systematic reviews and meta-analyses of randomised controlled trials, and to individual randomised controlled trials directly comparing miswak with manual toothbrushing or chlorhexidine mouthrinse, published in the English-language dental and biomedical literature. Foundational reviews describing the phytochemistry and constituent bioactive compounds of *Salvadora persica* were also included to provide mechanistic context. Studies were synthesised narratively under thematic headings (composition and mechanism of action; antimicrobial and antiplaque efficacy; comparative clinical effectiveness; safety and limitations) rather than pooled quantitatively, consistent with the scope of a narrative rather than systematic review.

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## 3 RESULTS AND DISCUSSION

### 3.1 Botanical origin, chemical composition, and mechanism of action

*Salvadora persica* L. (family Salvadoraceae), also known by the synonyms arak, peelu, pilu, and the "mustard" or "toothbrush" tree, is a small evergreen shrub or tree with a crooked trunk that rarely exceeds three metres in height, native to Saudi Arabia, Sudan, southern Egypt, Chad, Pakistan, and parts of India<sup>1</sup>. Chewing sticks are traditionally cut from the root, stem, or twig; when the fibrous end is chewed or crushed, it frays into a natural, brush-like bundle of bristles that can be used to mechanically debride tooth surfaces in a manner broadly analogous to a conventional toothbrush.

Phytochemical analyses have identified more than ten distinct bioactive constituents in miswak extracts, including fluoride, silica, tannic acid, resins, the alkaloid salvadorine, volatile sulphur-containing compounds (including benzyl

isothiocyanate and mustard-oil derivatives), vitamin C, sodium bicarbonate, chlorides, calcium, salicylic acids, sterols, trimethylamine, saponins, and flavonoids<sup>1,2</sup>. These constituents are understood to act synergistically to confer the plant's reported oral health effects. Silica functions as a mild mechanical abrasive that assists in the removal of extrinsic staining; sodium bicarbonate likewise contributes mild abrasive cleansing action<sup>1</sup>. Tannins exert an astringent effect on the oral mucosa, are associated with a reduction in clinically detectable gingivitis, and have been shown in vitro to inhibit glucosyltransferase activity, thereby reducing bacterial adherence and plaque formation<sup>1</sup>. The alkaloid salvadorine is reported to exert a bactericidal effect and a stimulatory action on gingival tissue, while the sulphur-containing compounds — most notably benzyl isothiocyanate, the major steam-distillable constituent of the root — possess broad-spectrum bactericidal activity, inhibiting both the growth and acid production of *Streptococcus mutans*, together with virucidal activity against herpes simplex virus<sup>1</sup>. Calcium and fluoride release from the chewing stick is thought to contribute to salivary calcium saturation, thereby inhibiting demineralisation and promoting remineralisation of enamel, while chloride ions have been associated with inhibition of calculus formation<sup>1</sup>.

The overall oral health effect of miswak use is therefore generally understood to result from a dual mechanism: a purely mechanical, brush-like debridement action, analogous in principle to toothbrushing, combined with a pharmacological or chemical action arising from the release of antibacterial, astringent, and remineralising compounds directly at the site of application<sup>2</sup>. This combined mechanism has been proposed as the rationale underlying the World Health Organization's endorsement of the chewing stick as a legitimate oral hygiene device in settings where it is the customary practice<sup>4</sup>.

### 3.2 Antimicrobial and antiplaque efficacy

A substantial in vitro and clinical literature supports the antimicrobial activity of *Salvadora persica* against organisms implicated in caries and periodontal disease. Sofrata and colleagues demonstrated that both fresh miswak pieces and their essential oil extract exerted a strong antibacterial effect against Gram-negative periodontal pathogens, with the most pronounced inhibitory effect observed against *Porphyromonas gingivalis* and *Aggregatibacter actinomycetemcomitans*, a lesser effect against *Streptococcus mutans*, and the least effect against *Lactobacillus acidophilus*<sup>7</sup>, implicating volatile antibacterial compounds released from the fresh plant material as the likely active agents.

At the level of aggregated clinical evidence, a systematic review and meta-analysis of nineteen clinical trials by Jassoma and colleagues found that *Salvadora persica* mouthrinse produced a statistically significant reduction in plaque scores and cariogenic streptococcal and lactobacillus counts when compared with placebo rinse<sup>4</sup>. However, when compared directly with chlorhexidine — widely regarded as the pharmacological gold standard for chemical plaque control — *Salvadora persica* rinse was found to be significantly, though modestly, less effective (mean difference in plaque score of 0.19 favouring chlorhexidine)<sup>4</sup>. Notably, this inferiority narrowed and lost statistical significance when the comparison was restricted to trials of three weeks' duration or longer, suggesting that miswak's relative disadvantage may be most pronounced in short-term use and may diminish with sustained, longer-term application<sup>4</sup>. A more recent systematic review of antibiofilm properties similarly concluded that miswak exerts a consistent antibacterial and antiplaque effect, with a corresponding reduction in cariogenic bacterial load and gingival inflammation across the trials reviewed<sup>3</sup>.

### 3.3 Comparative clinical effectiveness against conventional toothbrushing

The comparison most directly relevant to miswak's candidacy as a "modern alternative" in oral hygiene is its head-to-head clinical performance against the conventional manual toothbrush. A systematic review and meta-analysis by Ramli and colleagues, pooling nine randomised controlled trials in adults, found no statistically significant difference between miswak and toothbrush use in either mean plaque score reduction (standardised mean difference 0.39, 95% CI -0.05 to 0.83) or mean gingivitis score reduction (standardised mean difference 0.13, 95% CI -0.16 to 0.43), indicating broadly comparable efficacy between the two modalities when used exclusively<sup>5</sup>. This finding held across subgroups of patients with a healthy periodontium and those with pre-existing gingivitis, and was corroborated by a recent two-week single-blind randomised controlled trial by Abdellatif and colleagues, which likewise reported comparable reductions in plaque and gingival indices between miswak and toothbrush groups over the trial period<sup>6</sup>.

Of particular clinical relevance, the meta-analysis by Ramli and colleagues further reported that adjunctive use of miswak alongside conventional toothbrushing produced a significantly greater reduction in both plaque (standardised mean difference 0.68, 95% CI 0.14 to 1.22) and gingivitis scores (standardised mean difference 0.66, 95% CI 0.03 to 1.29) compared with toothbrushing alone<sup>5</sup>, suggesting that the two modalities may act complementarily rather than purely as substitutes, and that miswak may hold particular value as an adjunct — for example, for interim or additional cleaning between conventional brushing episodes — rather than solely as a stand-alone replacement.

Fluoride availability has been a further focus of comparative research, given the well-established caries-preventive role of topical fluoride. Miswak sticks impregnated with sodium fluoride have been shown to release fluoride both in vitro

and in vivo and to exert a remineralising effect on white-spot lesions in orthodontic patients<sup>8,9</sup>, while a randomised trial comparing fluoridated and plain miswak against fluoridated toothpaste and toothbrushing found the fluoridated chewing stick capable of comparable fluoride release and plaque removal<sup>10</sup>, and fluoride-impregnated miswak has additionally demonstrated superior antibacterial efficacy against *Streptococcus mutans* relative to the plain stick<sup>11</sup>. These findings suggest that deliberate fluoride supplementation of manufactured miswak products may further narrow the gap with conventional fluoridated toothpaste.

### 3.4 Safety, limitations, and considerations for clinical practice

Despite generally favourable efficacy and safety data, several limitations warrant consideration before miswak can be unreservedly recommended as a universal substitute for the toothbrush. First, the miswak's bristle-like fibres lie in the long axis of the stick, in contrast to the perpendicular bristle orientation of a conventional toothbrush, which may limit access to the lingual and interproximal surfaces of posterior teeth; anecdotal and clinical observation suggests that miswak users may over-clean the more accessible anterior labial surfaces while under-cleaning posterior and lingual surfaces.

Second, vigorous, prolonged, or improper use has been associated with an increased prevalence and severity of gingival recession. A study of adult Tanzanian miswak users found gingival recession to be significantly more pronounced among habitual miswak users than among toothbrush users<sup>14</sup>, underscoring the importance of correct, non-traumatic technique and of professional instruction analogous to that given for conventional toothbrushing.

Third, the existing randomised controlled trial literature — while growing — remains characterised by considerable methodological heterogeneity, including inconsistent reporting of miswak preparation, cutting method, frequency and duration of use, and inconsistent standardisation of brushing technique across trials, which limits the precision of pooled effect estimates and complicates the formulation of definitive, standardised clinical guidance<sup>3,5</sup>. Most trials to date have also been of relatively short duration (one to eight weeks), such that longer-term comparative data on caries incidence, periodontal attachment loss, and patient-reported outcomes remain comparatively sparse.

Finally, while chlorhexidine remains the pharmacological benchmark for chemical plaque control, its long-term use is associated with recognised adverse effects, including tooth and restoration discoloration, taste alteration, mucosal irritation, and increased supragingival calculus formation, such that regulatory guidance typically limits continuous chlorhexidine use to defined periods<sup>12</sup>. Miswak's comparatively favourable safety profile, low cost, and ready availability — combined with meta-analytic evidence of antiplaque efficacy approaching that of chlorhexidine with prolonged use<sup>4</sup> — support its consideration as a viable long-term alternative, particularly for children, individuals with special needs at risk of inadvertently ingesting chemical mouthrinse, and patients of lower socioeconomic status for whom commercial oral hygiene products may be less accessible.

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## 4 CONCLUSION

The accumulated clinical and phytochemical evidence indicates that the miswak (*Salvadora persica*) is a safe, effective, and readily accessible oral hygiene device whose combined mechanical and pharmacological actions produce reductions in dental plaque and gingival inflammation that are statistically comparable to those achieved by conventional manual toothbrushing, and that its adjunctive use alongside toothbrushing may confer additional periodontal benefit beyond either modality used alone. Although *Salvadora persica* extracts remain modestly less effective than chlorhexidine as a chemical antiplaque agent in the short term, this gap narrows substantially with prolonged use, and miswak's favourable long-term safety profile makes it a reasonable alternative where continuous chlorhexidine use is undesirable. Clinicians should nonetheless remain mindful of the risk of gingival recession associated with improper technique and should consider providing patients who choose to use miswak with clear guidance on correct preparation and non-traumatic application. Given the substantial global population for whom miswak is already a customary daily practice, it represents a genuinely practical, low-cost, and culturally embedded "modern alternative" in preventive oral health care, though larger, longer-term, and methodologically standardised randomised controlled trials are needed to refine recommendations on optimal technique, frequency of use, and fluoride supplementation.

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### *Disclosure of conflict of interest*

The author declares that there is no conflict of interest, financial, professional, institutional, or personal, that could be perceived to influence the research presented in this manuscript.

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