

# Study of the effects of natural toothbrush (*Salvadora persica*) in prevention of dental caries and plaque index

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## ABSTRACT

**Background:** Nowadays, though more attention is being paid to oral and dental hygiene all over the world, dental caries and periodontal diseases are increasing daily. We decided to study the effectiveness of natural toothbrush in prevention of dental caries and plaque formation. **Methods:** This analytic, semi-experimental clinical trial included 390 individuals. Subjects were divided into 3 groups: using natural toothbrush, using artificial toothbrush and using both natural and artificial toothbrush. The plaque index and DMFT was assessed at the beginning of the study until 1 year. ANOVA, Kruskal Wallis, LSD, Paired t-test, chi square, Fisher exact and Mc-Nemar tests were used for data analysis. **Results:** The plaque index in all three groups showed a mean reduction of 0.71. The mean DMFT in the samples before intervention was  $8.38 \pm 4.14$  and increased to  $9.1 \pm 4.56$ . At the end of the study, the lowest plaque index was observed in the group using both the natural and artificial methods. During one year follow-up, the plaque index decreased 1.16, 0.83, and 0.21 degrees in the first, second and third groups. **Conclusion:** The increase in DMFT in the group that used artificial toothbrush was more than other groups. Thus, use of natural toothbrush leads to a decrease in growth rate of DMFT. Therefore natural toothbrush can be used for the cleaning of teeth and prevention of dental caries.

**Keywords:** *Salvadora persica*; Natural Toothbrush;

Toothbrush and Tooth Paste; Caries; Plaque Index

## 1. INTRODUCTION

*Salvadora persica* (SP) is a wild plant that grows in the region extending from north western India to Africa. This plant is also known as natural Arak tree, chewing stick, toothbrush and Meswak [1]. Some other applications have been reported for this plant. SP is used for controlling blood sugar level, splenic disorders, deep wounds, and gingival and gastric problems. The extract of the plant boiled in oil is an appropriate ointment for treatment of crush injuries. Its leaves, branches and roots contain a kind of oil with diuretic effects. Its bark is used against stings of poisonous animals and its branches are used for treatment of cough, asthma, scurvy, rheumatism, leprosy, gonorrhoea, headache, hepatic problems and various other disorders. Its boiled extract has shown protective effects against ethanol intoxication and stress-related peptic ulcer in rats and regulating effects on blood sugar levels as well. This plant contains such chemicals as trimethyl amine, organic sulfur compounds and B-sitosterol and small amounts of saponin and lignane glycosides.

Dental plaques are the leading cause of oral diseases and dental caries; so elimination or reduction of plaques is necessary for prevention of these diseases. This plant has been used in Saudi Arabia as a toothbrush since 1400 years ago [1]. It has anti-microbial, anti-inflammatory and hypoglycemic properties. Toothpastes containing the extract of this plant protect gums and teeth. The plant is also used for various other purposes [2]. Chewing sticks are traditionally used for cleaning the teeth [3,4]. Although new artificial toothbrushes are considerably used

in Asian and African countries, chewing sticks are still used for cleaning the teeth [3,5]. The benefits of these sticks are due to their constituents and mechanism of action [6]. Recently WHO has proposed the use of these sticks as an effective tool for oral hygiene and their effect against certain aerobic and anaerobic bacteria has been studied [7].

Primary analysis of SP showed that it contains trimethyl amines, salvadorin, chloride, fluoride, silica, sulfur, mustard oil, vitamin C, resin and small amounts of tannin and saponine. These ingredients have anti-bacterial and anti-febrile properties and protect gums against irritation. Fluoride has anti-caries properties; Silica is abrasive and removes plaques and stains, and mustard oil and sulfur show anti-bacterial effects. In addition, the resin creates a protective layer on the surface of the enamel and tannin has a contractive effect on the mucous membranes thus inhibits the transfer of glycosyl. Some chewing sticks contain such alkaline compounds as anthraquinones (*Acacia Arabica*), fagaronine and benzophenathridine with anti-bacterial properties [8,9].

Recent *in vitro* studies on the microbiological effects of Miswak on oral bacteria have shown that its raw extract has a bacteriostatic effect on *Bacteriodes Gingivalis*. Other studies regarding its chemical compounds and pharmaceutical effects have proved that the high fluoride content in Miswak is responsible for its strong anti-caries effect [10,11].

Many researchers have paid attention to the mechanical cleaning effect of Miswak stick and the anti-microbial activity of its extract. The mechanical cleaning effects of the chewing sticks have been reported as the mechanism of the reduction of plaques and gum inflammation [12].

Nowadays, although more attention is paid to oral and dental hygiene all over the world, the frequency of dental caries and periodontal diseases is increasing which is probably due to increased consumption of carbohydrates, and deficiency of fluoride and calcium in diet and improper oral hygiene [12,13].

Natural toothbrush that was initially proposed by the Holly Prophet, Hazrat Mohammad (SAW), for cleaning and strengthening of teeth and prevention of dental caries more than 1400 years ago is now used in many countries and the significant effects of brushing for prevention of dental caries and oral diseases have been determined. The anti-bacterial, and anti-fungal effects of this natural product and its effect against caries, and plaque formation have been studied and it is proposed that these effects are due to both mechanical and chemical effects [12,14].

Studies have shown that 90% of rural population of Nigeria and Tanzania (10% of urban children), 50% of Saudi Arabians and Indians (65% rural and 43% urban

population) use Miswak [15-17].

These sticks are effective, inexpensive, abundant, and available and have both mechanical and chemical effects. In the study by Khalid Almas, two types of Miswak sticks were studied and their anti-bacterial effect on streptococcus mutans and fecalis was significant [18].

In the present study, the effects of Miswak on oral and dental hygiene, DMF (decayed, missed, filled), and prevention of caries and dental plaque was studied and compared with common toothpastes and toothbrushes.

## 2. METHODS

This was a semi-experimental clinical trial which was conducted by parallel plan. In a 1 year period (from March 2010 till March 2011) subjects referred to dentistry clinics of health centers in Shahid Sadoughi University of Medical Sciences, Yazd, Iran with following criteria entered the study: Age between 18 and 50 years, living in Yazd, and having at least 20 permanent teeth. Smokers, orthodontic patients, and those with dental anomalies or acute periodontal disease were excluded from the study.

A total of 12 health centers were randomly selected and divided into 3 groups (4 clinics in each group). The groups were randomly assigned to one of the methods of tooth brushing. The methods included: group 1: natural toothbrush (*Salvadora persica*), group 2: artificial toothbrush and toothpaste, and group 3: both artificial and natural toothbrush.

One hundred and thirty cases in each group were included in the study. Then a questionnaire including name, home address and telephone number for follow up, demographic features, and state of teeth before intervention was filled for each participant. All subjects were similarly trained for oral and dental health and care. Miswak toothbrush (**Figure 1**) was given to the natural toothbrush group and they were trained for its use. The second group received artificial toothbrush and toothpaste and was trained for its use, while the third group received both natural and artificial toothbrush and toothpaste. All participants were asked to brush their teeth 3 times a day and to refer every three months until 1 year and the state of their oral and dental care was recorded. The subjects in the third group were asked to brush their teeth two times with one method and one time with another and change this arrangement every other day. They were provided by new toothpaste and toothbrushes as necessary in each visit. At the end of one year, the plaque index and number of decayed, filled and extracted teeth (due to caries) was evaluated.

The manager of the dentistry clinic and a dentist in each center attended a 2-day workshop about the method of teaching tooth brushing with SP at the deputy of health



**Figure 1.** Natural toothbrush.

of the university. They were also trained how to determine the plaque index and state of tooth caries. On the basis of standard references of reconstructive dentistry, tooth caries was classified into 6 caries levels (CL):

CL I: Occlusal surface of the posterior teeth, palatal surface of the anterior teeth, and buccal and lingual surfaces of the upper contour of the teeth.

CL II: Mesial and distal surfaces of the posterior teeth.

CL III: Mesial and distal surfaces of the anterior teeth, incisal border not involved.

CL IV: Mesial and distal surfaces of the anterior teeth with involvement of the incisal border CL V: Buccal and lingual surfaces in the one third of gingival area.

CL VI: Tip of cusp.

Plaque index was graded 0 - 3 as follows:

0: Plaque not visible and not observed even on rubbing the probe.

1: Plaque not visible but observed after rubbing the probe or using the tablet.

2: Plaque visible and observed after rubbing the probe against the gum margins as well.

3: Plaque visible and covering the dental margins and even extending to the teeth surface.

The data was analyzed by SPSS (ver. 17) using ANOVA, Kruskal Wallis, paired—t-test, chi square, Fisher exact and Mc-Nemar tests. LSD method was used for double comparisons.

No expenses were incurred upon the cases and they were explained in detail about the study at the beginning. After explaining the research protocol, an informed consent was obtained from each subject. The proposal of this study was approved by the ethics committee of Shahid Sadoughi University of Medical Sciences.

### 3. RESULTS

A total of 390 subjects were divided into 3 groups: natural toothbrush (*Salvadora persica*), artificial toothbrush and toothpaste and both methods. Ultimately, 35 subjects failed to continue to the end and 355 cases were evaluated.

The mean age of the population under study was  $28.98 \pm 6.08$  years (range: 18 - 50 years). The mean age was not significantly different among 3 groups (ANOVA test, P value = 0.435). Ninety eight (27.6%) and 253 (72.4%) subjects were males and females, respectively. This ratio was not significantly different among three groups (Chi square test, P value = 0.083). On follow-up evaluations, the mean number of tooth brushings increased from 1.11 to 1.54 times per day and the use of dental floss increased from 26.8% at the beginning of the study to 36.6% at the end of the study. The mean decrease in the plaque index was 0.71 degrees in all subjects.

**Table 1** compares the educational state of subjects in 3 groups. Educational state was not significantly different among 3 groups (P value = 0.256).

**Table 2** shows the trend of the mean number of tooth brushings per day in follow-up evaluations. The difference became significant after a period of 3 months with a P value of 0.004. LSD test showed that the mean number of tooth brushings in the first group was significantly lower than the other groups after 3 months (P value = 0.046 and 0.001 in comparison with second and third groups, respectively); although the comparison between second and third groups failed to show a significant difference (P value = 0.137). The difference between first group and the other groups was significant at 6, 9, and 12 months follow-up evaluations as well (P value = 0.019

**Table 1.** Comparison of educational state among 3 groups.

Educational state	Group						Total	
	Natural toothbrush		Artificial toothbrush		Both methods		Number	Percent
	Number	Percent	Number	Percent	Number	Percent		
Primary school	11	10.9	22	16.5	12	9.9	45	12.7
Guidance school	16	15.8	32	24.1	23	19	71	20
High school	31	30.7	40	30.1	39	32.2	110	31
University	43	42.6	39	29.3	47	38.8	129	36.3
Total	101	100	133	100	121	100	355	100

**Table 2.** The mean ( $\pm$ SD) frequency of tooth brushings per day in the three groups during follow-up.

Follow-up period	Group			Total (N = 355)	P value
	Natural toothbrush (N = 101)	Artificial toothbrush (N = 133)	Both methods (N = 121)		
Before intervention	1.17 (0.75)	1.02 (0.61)	1.15 (0.62)	1.11 (0.66)	0.155
After 3 months	1.12 (0.69)	1.29 (0.60)	1.41 (0.65)	1.28 (0.65)	0.004
After 6 months	1.24 (0.71)	1.45 (0.68)	1.69 (0.66)	1.47 (0.7)	0.000
After 9 months	1.32 (0.67)	1.43 (0.65)	1.68 (0.66)	1.48 (0.67)	0.000
After 1 year	1.48 (0.72)	1.43 (0.65)	1.7 (0.66)	1.54 (0.68)	0.003

and 0.0001 after 6 months for 2nd and 3rd groups, respectively). **Figure 2** compares the use of dental floss before and after intervention. Mc-Nemar test showed a significant difference among groups (P value < 0.001).

Plaque index directly determines the effectiveness of tooth brushing. At the beginning of the study, only 12.1% of subjects were free from plaques on their teeth surfaces (similar in 3 groups). After one year, the lowest plaque index was observed in the group using both the natural and artificial methods. **Table 3** compares the plaque index among 3 groups. During one year follow-up, the plaque index decreased 1.16, 0.83, and 0.21 degrees in the first, second and third groups, respectively. Kruskal Wallis test showed a significant difference among 3 groups (P value < 0.001).

**Table 4** compares DMF variables at the beginning and end of the study. LSD test showed a significant difference between the 1st and 2nd group (P value < 0.001) and between 2nd and 3rd group (P value < 0.001), but it failed to show a significant difference between 1st and 3rd group (P value = 0.565). The changes in DMF in the three groups after one year is depicted in **Table 5**.

It was observed that the increase in DMF in the natural toothbrush group was 1.18 fold of the control group using artificial toothbrush and toothpaste and this increase in the group using both methods was half of the natural toothbrush group. This relationship was analyzed by ANOVA test and the observed difference was significant (P value < 0.001).

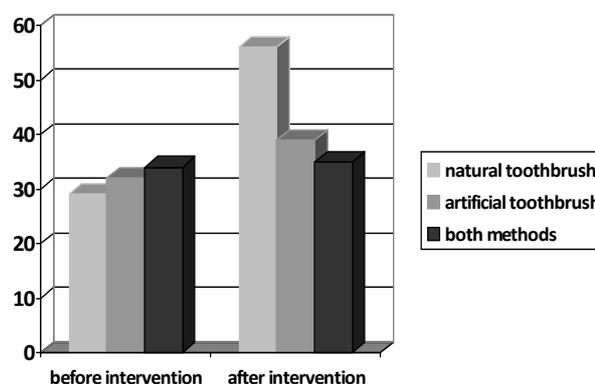
#### 4. DISCUSSION

In the present study, a total of 355 cases were followed every 3 months for a period of one year. The plaque index and the number of decayed, filled and extracted (due to caries) teeth were evaluated.

The efficacy of chewing sticks in oral hygiene has been evaluated by various studies [17,19-21]. Al-Lafi and Kh. Almas *et al.* showed that streptococcus fecalis is the most susceptible microorganism to *Salvadora persica* [7,22]. In the present study the incidence and progression of dental caries decreased after natural toothbrush use

that is probably due to its anti-microbial properties. Kh. Almas reported that streptococci decreased significantly in the group using natural toothbrush compared to the group using artificial toothbrush and toothpaste (P = 0.013), but the difference in lactobacilli was not significant (P = 0.147) [23]. In the present study, dental caries was reduced. Wolinsky and coworkers [24] showed that *Salvadora persica* reduces the colonization power of certain streptococci on the teeth surface. The state of the teeth health regarding the number of decayed, filled and extracted teeth was similar in all groups at the beginning of the study and there was significant reduction in DMF at the end of the study (P value = 0.0001), along with the reduction in caries that could be due to the anti-microbial properties of natural toothbrush [10]. Almas and Me-hanna in their studies stated that the antibiotics existing in *Salvadora persica* could interfere with the bacteria and prevent their aggregation [18,25].

Fluoride is another compound that could affect the glycolytic enzymes of bacteria. Benzilisoithiocyanate (BIT) that is naturally present in *Salvadora persica*, prevents the growth of bacteria and their acid production [26]. In addition to the anti-bacterial effects, chewing sticks remove the plaques physically and this is very effective in prevention of caries. Reduction of caries during one year of the study proves this claim.

**Figure 2.** Comparison of the frequency of dental floss use before and after intervention in the groups under study.

**Table 3.** Comparison of plaque index at the beginning of the study and after one year intervention in the groups under study.

Time period	Plaque index	Group						Total		P value
		Natural toothbrush		Artificial toothpaste		Both methods		Number	Percent	
		Number	Percent	Number	Percent	Number	Percent			
Beginning of the study	0	10	9.9	14	10.5	19	15.7	43	12.1	C 0.608
	1	43	42.6	67	50.4	56	46.3	166	46.8	
	2	28	27.7	33	24.8	29	24.0	90	25.4	
	3	20	19.8	19	14.3	17	14.00	56	15.8	
One year after intervention	0	43	42.6	17	12.8	96	79.3	156	43.9	F 0.000
	1	41	40.6	79	59.4	25	20.7	145	40.8	
	2	17	16.8	29	21.8	0	0	46	13.00	
	3	0	0	8	6.00	0	0	8	2.3	

C: Chi square test; F: Fisher Exact test.

**Table 4.** The mean DMF of the three groups before and after the intervention.

Group	Number of samples	Before study				After study			
		Mean DMF	SD	Minimum	Maximum	Mean DMF	SD	Minimum	Maximum
Artificial toothpaste and toothbrush	133	9.00	3.96	0	17	10.81	4.64	0	21
Natural toothbrush	101	7.79	3.69	1	22	7.89	3.72	1	22
Both methods	121	8.18	4.62	0	20	8.23	4.58	0	20
Total	355	8.38	4.14	0	22	9.1	4.56	0	22
P value				0.071				<0.001	

**Table 5.** Mean increase in DMF over a period of one year in the three groups.

Group	Number of samples	Mean	SD	Minimum	Maximum	P value**
Artificial toothpaste and toothbrush	133	1.81	1.63	0	8	0.000
Natural toothbrush	101	0.1	0.33	0	2	0.002
Both methods	21	0.05	0.28	0	2	0.029
Total	355	0.72	1.33	0	8	--
P value*				<0.001		

\*ANOVA; \*\*Paired test.

In the study of M.A. Eid *et al.* [6], the capabilities of artificial and natural toothbrushes in plaque removal and the relationship between Miswak and periodontal health were studied. The results showed that natural toothbrush use results in more accurate and better removal of plaques. Thus Miswak ensures periodontal health by reducing plaque formation. It seems that the combination of chemical and physical properties of Miswak provides this effect. In the present study, the number of decayed and filled teeth was less in the group using natural tooth-

brush as well.

Similarly, Mosadomi [27] and Farah [28] reported that *Salvadora persica* has anti-microbial effects and a substantial amount of fluoride. In the present study it was concluded that sticks of *Salvadora persica* have substantial anti-microbial effects.

The use of natural toothbrush not only removes plaques better than artificial toothbrush but also it possibly prevents its formation and fights against oral microorganisms. In the present study, the increase in DMF was

small in the study group that could be due to the antimicrobial properties and fluoride content of natural toothbrush. Darout and coworkers [29] concluded that the dental and periodontal condition of those using natural toothbrush was better than those using artificial toothbrush and toothpaste consistent with the present study.

In the study by Norton in Ghana, it was shown that the rate of plaque formation, and creation and progression of tooth caries was less in natural toothbrush users than those using artificial toothbrush and tooth paste which was in agreement with our study [30].

In the study in Ethiopia, Nigeria and Saudi Arabia wherein natural and artificial toothbrushes were compared, it was shown that natural toothbrush is more effective than artificial toothbrush in removal of dental plaque [31-33].

The total fluoride content of Miswak sticks is approximately 1.02 µg/g. Farah [28] realized that SP chewable sticks, Neem-kikar, walnut and Pekujebu contain 2.8, 1.0, 0.5 and 0.2 µg/ml fluoride, respectively. Crystallographic assessment with fluorescence and microanalysis with X ray showed that *Salvadora persica* contains more calcium and phosphorous [34]. It was also observed the hot taste and chewing of the stick result in increased flow of saliva and its buffering effect [9]. This could be one of the explanations of decreased caries in the present study.

In the study of Ezoddini *et al.* on 337 high school students, DMFT was significantly higher in the control group using artificial toothbrush and toothpaste than those using natural toothbrush [35].

Firas *et al.* studied the effects of the water/alcohol extract of *Salvadora persica* on oral health. The alcoholic extract was more effective on streptococci, and the strongest effect of the water extract was against streptococcus fecalis. Both extracts had sufficient anti-fungal effects against candida albicans according to the turbidity test [36].

In the present study, there was a slight decrease in the frequency of tooth brushing after three months which is probably due to the more time spent for brushing with natural toothbrush than artificial one.

## 5. CONCLUSION

It can be concluded that *Salvadora persica* (natural toothbrush) can be used for the cleaning of teeth and prevention of dental caries. Considering the advertisements by the toothpaste manufacturing companies and new products being introduced everyday in the international markets, even if the chewing sticks are not available, toothpastes containing its extract can be used in

developing countries.

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