



# Dimensional Accuracy and Tearing Strength of Alginate Impression Material Containing Different Concentrations of Natural Miswak Powder: An In-Vitro Study

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## دقة الأبعاد وقوة التمزق لمادة انطباع الجينات المحتوية على تركيزات مختلفة من مسحوق المسواك الطبيعي: دراسة مخبرية

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### ABSTRACT

#### Background:

Alginate impression material is an irreversible hydrocolloid due to its chemical setting reaction. Hydrocolloids dimensional stability depends on the presence of water, as water makes up around 70% of dental alginate. One of the Salvadoraceae families, *Salvadora persica*, is the source of miswak. The Arak tree, or *Salvadora persica*, is often referred to as the "toothbrush tree" as it is known in English. It is evergreen form develops like a shrub or small tree with a twisted trunk. The researchers mixed miswak powder with the alginate to examine the dimensional accuracy and tearing strength.

#### Materials and Methods:

Sixty alginate specimens were prepared. 30 specimens for dimensional accuracy and 30 specimens for tearing strength, each of them is divided into three groups: The control group, Group A % 17 miswak powder, and Group B % 34 miswak powder. The dimensional stability and tearing strength were tested.

#### Results:

There is no dimensional change in group B, lesser dimensional change was revealed in group A, according to control group. Group B is more resistant to tearing strength when compared with the control group and group A, and group A is more resistant than the control group.

#### Conclusion:

Adding a suitable amount of miswak powder to alginate is beneficial for reducing and preventing shrinkage, as well as improving tearing strength.

#### Key words:

Alginate, impression materials, dimensional stability, tearing strength, miswak



## INTRODUCTION

Dental cements and impression materials are two materials that are commonly used for polyelectrolytes in dentistry. When making diagnostic imprints, an irreversible hydrocolloid (alginate) has been used because of its inexpensive cost, hydrophilicity, and precision. [1],[2].

Fillers like diatomaceous earth and binder like  $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$  are components of alginate impression materials [3], [4]. Using diatomaceous earth increases the final combination's stiffness and eases the process of alginate mixture mixing [4]. One of the most critical features of an impression material is its dimensional change [5], [6]. Accuracy typically ranges between 0.1% and 0.27% [5], [7], [8]. Hydrocolloid materials have poor tear strength [10], so it is necessary to focus on tear strength. Dental impression materials must also be able to reproduce little details accurately [11]. It is not clear how manipulating factors affect alginate's qualities, despite several studies comparing various commercial alginate products for tearing strength and detail reproduction [10], [12]. However, the influence of manipulating factors on alginate's characteristics is not well understood [13], [14].

In an in vitro study, increasing the ratio of powder to water in the mixed alginate resulted in higher viscosity and tear strength, but no significant clinical difference in tearing was seen. More importantly than the difference in powder/water, the thickness of the alginate impression between adjacent teeth affected tearing [15].

Alginates with a lower calcium to sodium ratio lose less water and have superior dimensional stability than alginates with a higher calcium to sodium ratio [16]. Alginates with larger filler to alginic polymer ratios and lighter molecular polymer chains displayed improved dimensional stability [17].

According to S.Y. Chen et al. and W. Wulandari, some of the materials that have been added to alginate to improve its tear strength and dimensional stability are silica and hydroxyapatite. [18], [19].

One of the Salvadoraceae families, *Salvadora persica*, is the source of miswak. Table 1 provides the whole *Salvadora persica* taxonomic categorization. The Arak tree, or *Salvadora persica*, is often referred to as the "toothbrush tree" in English. Its evergreen form develops like a shrub or small tree with a twisted trunk. [20],[21].

**Table 1: Classification of Salvadorans**

Classification of <i>Salvadora persica</i>	
Kingdom	Plantae
Division	Magnoliophyta
Class	Magnoliopsida
Order	Brassicales
Family	Salvadoraceae
Genus	Salvadora
Species	Persica oleoides
Binomial name	Salvadora persic

Organic and inorganic substances are found in miswak's chemical content. The saponin, flavonoid, alkaloid, and herbal steroid benzyl 2–4 isothiocyanate are among the organic components. [22-24] Silica, fluoride (in the form of chlorine), and oxalate (in the form of chromium chloride) are among the inorganic compounds. [25], [26]

The aim of this research is to determine how miswak powder affects the alginate impression material's accuracy and tearing strength.

## **MATERIALS AND METHODS**

Sixty samples of alginate impression materials were prepared with various amounts of miswak powder. 30 samples for dimensional accuracy and 30 samples for tearing strength. Miswak from the *Salvadora persica* tree was chosen since it is widely available in the Middle East, then dried at room temperature for 10 days, cut into small pieces, and powdered by using a commercially available food mixer [27]. Trituration was employed to make 50 gram alginate impression material (Alginplus, Italy) with miswak powder in two different concentrations: (50 gram alginate = control group), (50 gram alginate + 8.5 gram miswak powder = 17% group A) and (50 gram alginate + 17 gram miswak powder = 34% group B) [40]. On a sensitive digital scale

(Sartorius, Germany), alginate impression material and miswak powder were correctly weighed and homogeneously mixed [28]. All of the samples used in this study were mixed with tap water using auto-mix devices as directed by the manufacturer, then put in a humidifier to prevent any dimensional change.

## 2.1 Dimensional Stability Test

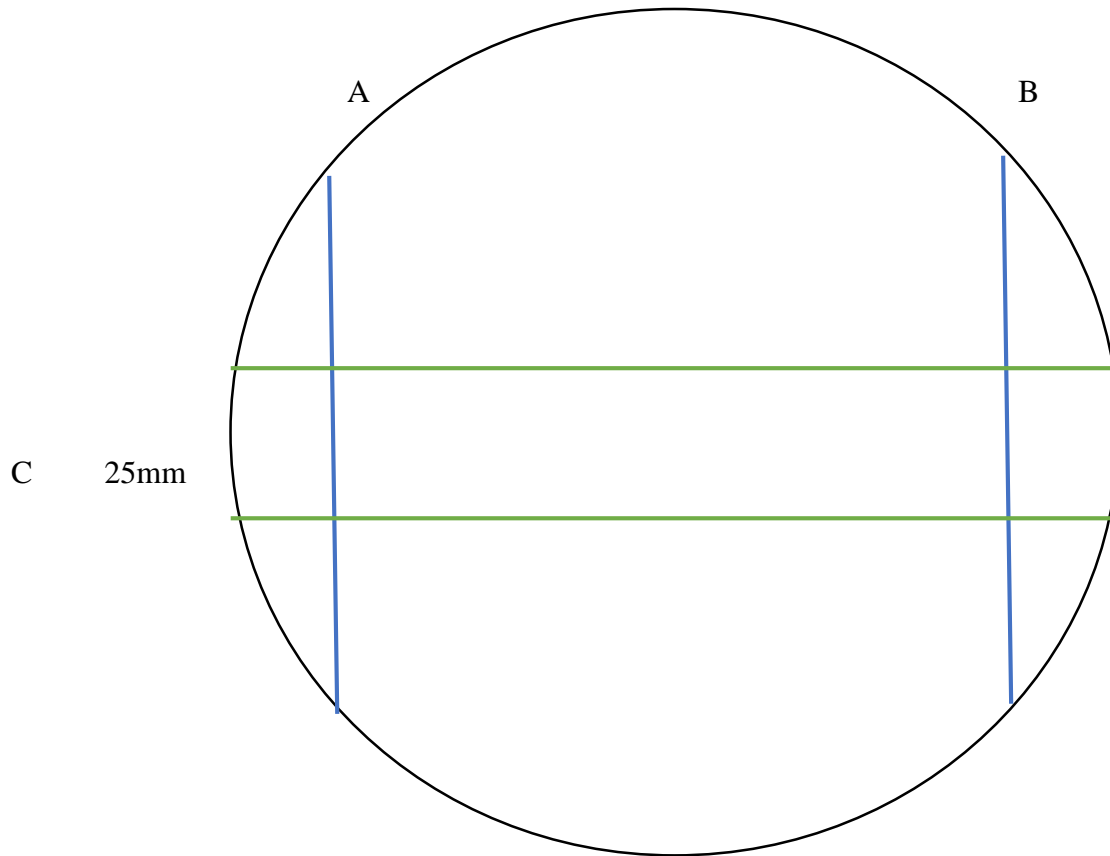
Dimensional stability was measured immediately after setting time, then 15 minutes later, followed by 30 minutes later for each group. According to the American Dental Association (ADA) standard code Nineteen for alginate materials, the samples were put in a humidifier then examined. A stainless-steel device with a metal plate etched with x and y direction lines and a metallic ring was used as a mold for a dental impression (Figure 1).



**Figure 1. American Dental Association Specification Code Nineteen**

The total number of specimens was 30. These 30 were divided into three subgroups, each with ten samples for the control group and 10 samples for each different concentration of miswak powder with the alginate (Alginplus, Italy), as seen in Figure 3. Before applying the alginate to the metal block, a separating medium was applied to the metal plate edges to aid separation.

Using a one-kilogram weight on the glass lab that was placed on the specimens to a mimic hand pressure.[24] For the alginate impression materials utilized in this study, the manufacturer advised a three-minute setting time. Under a special USB microscope, a ruler was used to measure how stable the dimensions were after setting time, 15 minutes after setting time, and 30 minutes after setting time.



**Figure 2: Line C, which measured 25mm between A and B, is shown in this diagram of the metal plate apparatus used in this investigation.**



**Figure 3: Samples for Each Group**

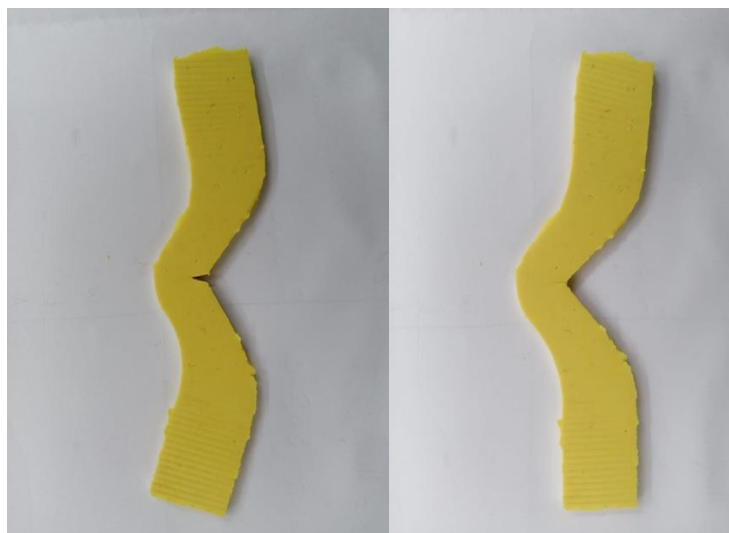
## 2.2 Tearing Strength Test

A V-shaped mold was employed in this study. Using a V-shaped Teflon mold, the mixed alginate was placed into a test chamber that had been specifically prepared to assess tear strength in accordance with American Society for Testing and Materials D 1004-94a. The mold's length, width, and thickness total was  $98 * 20 * 4$ . (Figure 4).

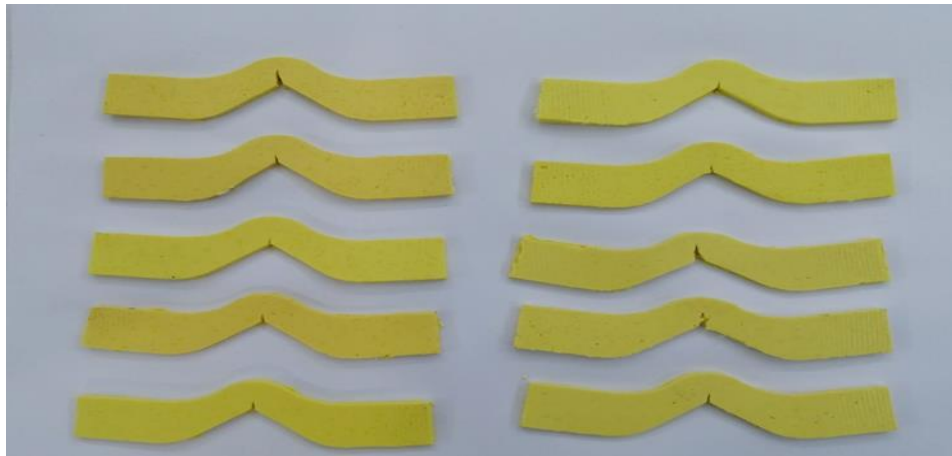


**Figure 4: Mold Used in the Study**

The total number of specimens was 30. These 30 were divided into three subgroups, each with 10 samples for the control group (figure 5) and a different concentration of miswak powder (groups A and B) with alginate impression material (Alginplus, Italy) (figure 6). Each group had 10 specimens for tearing strength. Separating media was added to the mold to aid separation, and the alginate impression material was placed in the mold. A glass lab was put on it, and a one-kilogram weight was placed on this assembly to simulate the pressure of a hand on the tray [29]. For the alginate impression materials utilized in this study, the manufacturer advised a three-minute setting time.



**Figure 5: One sample for the control group**



**Figure 6: Samples for Group A**

Tearing strength was measured immediately after setting time directly for each group by using a pneumatic clamp, then inserted into a universal testing machine (Gotech, Taiwan) as shown in figure 7. The sample was not under compressive stress, the fixture was adjusted before the test. The load was applied at pressure until failure at a cross-head speed of 5 micrometers. [38].



**Figure 7: Universal Testing Machine Used in the Study with Sample**



## **RESULTS AND DISCUSSION**

### **3.1 Dimensional accuracy**

According to the study, more accurate samples were produced by adding Miswak extract because Miswak extract significantly decreased the number of bubbles and voids in the alginate impression material. After 15 minutes, There is no difference between the control group and group A in this experiment. However, after 30 minutes, the control group exhibited higher shrinkage than group A. SPSS statistical analysis was used to examine the statistical data. The findings of this investigation also revealed a significant difference between group B with the control group and group A, as explained in tables 2, 3, and 4.

**Table 2. Control Group (50 grams of alginate)**

Sample	Length after setting time / mm	After 15 minutes	After 30 minutes
1	25	24.5	<b>24.25</b>
2	25	24.5	<b>24.25</b>
3	25	24.5	<b>24.25</b>
4	25	24.5	<b>24.25</b>
5	25	24.5	<b>24.25</b>
6	25	24.5	<b>24.25</b>
7	25	24.5	<b>24.25</b>
8	25	24.5	<b>24.25</b>
9	25	24.5	<b>24.25</b>
10	25	24.5	<b>24.25</b>





**Table 3. Group A: 17% (50 grams of alginate impression material and 8.5 grams of miswak powder)**

Sample	Length after setting time / mm	After 15 minutes	After 30 minutes
1	25	24.5	<b>24.5</b>
2	25	24.5	<b>24.5</b>
3	25	24.5	<b>24.5</b>
4	25	24.5	<b>24.5</b>
5	25	24.5	<b>24.5</b>
6	25	24.5	<b>24.5</b>
7	25	24.5	<b>24.5</b>
8	25	24.5	<b>24.5</b>
9	25	24.5	<b>24.5</b>
10	25	24.5	<b>24.5</b>

**Table 4. Group B: 34% (50 grams of alginate impression material and 17 grams of miswak powder)**

Sample	Length after setting time / mm	After 15 minutes	After 30 minutes
1	25	25	<b>25</b>
2	25	25	<b>25</b>
3	25	25	<b>25</b>
4	25	25	<b>25</b>
5	25	25	<b>25</b>
6	25	25	<b>25</b>
7	25	25	<b>25</b>
8	25	25	<b>25</b>
9	25	25	<b>25</b>
10	25	25	<b>25</b>



### 3.2 Tearing Strength

According to the study, adding Miswak extract to alginate greatly enhanced the material's tear strength, reducing its likelihood of tearing or breaking while in use. The findings of this study revealed that each group differs, group B was the best, followed by group A after the control group. Overall tearing force for the control group was (1.2 N = 0.0296 MPa), for group A it was (1.3 N = 0.032 MPa) and for group B it was (1.4 N = 0.035 MPa). Tables 5, 6 and 7.

**Table 5. Control Group (50 gram of alginate)**

Sample	Tearing force / N	Tearing force / MPa
1	1.26	<b>0.031</b>
2	1.1	<b>0.027</b>
3	1.12	<b>0.027</b>
4	1.2	<b>0.029</b>
5	1.24	<b>0.03</b>
6	1.2	<b>0.029</b>
7	1.28	<b>0.031</b>
8	1.29	<b>0.031</b>
9	1.05	<b>0.025</b>
10	1.28	<b>0.031</b>

**Table 6. Group A: 17% (50 grams of alginate impression material and 8.5 grams of miswak powder)**

Sample	Tearing force / N	Tearing force / MPa
1	1.27	<b>0.031</b>
2	1.31	<b>0.032</b>
3	1.28	<b>0.031</b>
4	1.35	<b>0.033</b>
5	1.29	<b>0.031</b>
6	1.26	<b>0.031</b>
7	1.33	<b>0.032</b>
8	1.29	<b>0.031</b>
9	1.28	<b>0.031</b>
10	1.34	<b>0.033</b>



**Table 7. Group B: 34% (50 grams of alginate impression material and 17 grams of miswak powder)**

Sample	Tearing force / N	Tearing force / MPa
1	1.45	<b>0.0358</b>
2	1.43	<b>0.0353</b>
3	1.41	<b>0.034</b>
4	1.41	<b>0.034</b>
5	1.4	<b>0.034</b>
6	1.45	<b>0.0358</b>
7	1.46	<b>0.036</b>
8	1.43	<b>0.0353</b>
9	1.41	<b>0.034</b>
10	1.42	<b>0.035</b>

#### 4. DISCUSSION

Alginate impression material is an irreversible hydrocolloid due to its chemical setting reaction. It may be used in dentistry and orthodontics for diagnostic castings as well as working castings for the production of orthodontic devices [35]. Hydrocolloids dimensional stability depends on the presence of water. Water makes up around 70% of dental alginate [36]. Alginate impression material is protected against shrinking by miswak, and one of the components of miswak is resin. It was also discovered that miswak had protective action by producing a layer [41]. It is revealed that the control group had more dimensional change compared with group A and group B because it didn't have any miswak powder Group A had less dimensional change because of a small amount of miswak powder, but group B had more resistance to shrinkage because of a larger amount of miswak.

It is usual in dentistry to use alginate impressions [30]. Furthermore, the dentist may modify the powder-water ratio at the dental clinic to suit his or her own preferences [33]. It has been reported that prosthodontists have come up with their own ideal viscosity for alginate, departing from the manufacturer's instructions. As a result, different viscosities emerged, which could have an impact on characteristics like tear strength and detail reproduction [31], [32]. The standard powder-liquid ratios specified by the manufacturer were utilized in this study by adding miswak powder to alginate, which was then mixed with tap water.



According to Almas k. et al. and Tubaishat Sh. et al., one of the components of miswak is fluoride [42], [43], and according to Alaa M. and Raghdaa K., fluoride can increase the tearing strength, as the researchers revealed that the control group had less tearing strength compared with groups A and B because they didn't have any amount of miswak, but group B needed more force for tearing because it had a higher amount of miswak [44].

According to Hilal A. and Rajagopal K., due to its moderate effectiveness and long history of daily use without notable side effects [39], The researcher added miswak powder to alginate.

## 5. CONCLUSIONS

Within the constraints of this study, It is concluded that mixing appropriate miswak powder at about 34% (50 grams of alginate impression material + 17 grams of miswak powder) with the alginate impression material is beneficial for reducing and preventing shrinkage, as well as improving tearing strength.

### Conflict of interests

There are non-conflicts of interest.

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## الخلاصة

### مقدمة:

مادة الانطباع الجينات هي غرواني مائي لا رجوع فيه بسبب تفاعلها الكيميائي. يعتمد ثبات أبعاد الغروانيات المائية على وجود الماء الذي يشكل حوالي 70% من ألبينات الأسنان. واحدة من عائلة *Salvadora persica*, *Salvadoraceae*. هي مصدر السواك والتي غالباً ما يشار إلى شجرة الأراك أو سالفادورا بيرسيكا في اللغة الإنجليزية باسم "شجرة فرشاة الأسنان". دائمة الخضرة تنمو مثل شجيرة أو شجرة صغيرة ذات جذع ملتوي. استخدم الباحثون مسحوق السواك مع الجينات لفحص دقة الأبعاد وقوة التمزق.

### طرق العمل:

تم تحضير ستين عينة ألبينات. 30 عينة لدقة الأبعاد و30 عينة لمقاومة حيث التمزق، كل منها مقسمة إلى ثلاث مجموعات: مجموعة التحكم، المجموعة A %17 مسحوق سواك، المجموعة B %34 مسحوق سواك. تم اختبار ثبات الأبعاد وقوة التمزق.

### الاستنتاجات:

لا يوجد تغيير في الأبعاد في المجموعة B ، بينما ظهر تغير أقل في الأبعاد في المجموعة A حسب المجموعة الضابطة. المجموعة B أكثر مقاومة للتمزق عند مقارنتها بمجموعة التحكم والمجموعة A ، وكانت المجموعة A أكثر مقاومة من المجموعة الضابطة.

### الكلمات المفتاحية:

الجينات، مواد الانطباع، ثبات الأبعاد، قوة التمزق، السواك