



# Effect of adding durian seed flour (*Durio zibethinus* Murr.) on the setting time of alginate impression material: an experimental laboratory study

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## ABSTRACT

**Introduction:** Alginate is one of the most commonly used impression materials in dentistry to obtain a negative reproduction of teeth and surrounding tissues. To achieve an accurate impression, alginate must have an adequate setting time. However, its tendency to set too quickly is one of the material's main weaknesses in clinical use. Modification of alginate with durian seed flour (*Durio zibethinus* Murr.), which contains amylose and amylopectin, may alter its setting time. This study aimed to analyze the effect of adding durian seed flour on the setting time of alginate impression material. **Methods:** This was an experimental laboratory study using a post-test only control group design. The samples consisted of pure alginate and alginate mixed with 20% and 40% durian seed flour, for a total of 30 samples. The setting time was measured using a cylinder rod tip and recorded with a stopwatch. Data were analyzed using One-way ANOVA followed by Post Hoc LSD tests. **Results:** The mean setting times of pure alginate, alginate 80% + durian seed flour 20%, and alginate 60% + durian seed flour 40% were  $132.2 \pm 3.495$  s;  $212.3 \pm 3.742$  s; and  $266.8 \pm 3.369$  s, respectively. The addition of durian seed flour significantly affected the setting time of alginate impression material ( $p < 0.05$ ). **Conclusion:** Alginate with 40% durian seed flour addition exhibited the longest setting time compared with other sample groups. However, alginate with 20% and 40% durian seed flour additions still met the American Dental Association (ADA) Specification No. 18 for acceptable setting time.

## Keywords

Alginate, amylopectin, amylose, durian seed flour, setting time

## *Pengaruh penambahan tepung biji durian (*Durio zibethinus* Murr.) terhadap setting time bahan cetak alginat: eksperimental laboratoris*

## ABSTRAK

**Pendahuluan:** Bahan cetak alginat merupakan bahan cetak yang paling sering digunakan di kedokteran gigi untuk mendapatkan reproduksi negatif gigi dan jaringan disekitarnya. Alginat harus memiliki setting time yang cukup agar dapat menghasilkan cetakan yang baik. Setting time yang cenderung terlalu cepat menjadi salah satu kelemahan alginat dalam keadaan klinis. Modifikasi alginat dengan penambahan tepung biji durian yang memiliki kandungan amilosa dan amilopektin dapat mempengaruhi setting time alginat. Tujuan menganalisis pengaruh penambahan tepung biji durian (*Durio zibethinus* Murr.) terhadap setting time bahan cetak alginat. **Metode:** Penelitian ini menggunakan jenis penelitian experimental laboratory dengan desain penelitian post-test only control group design. Sampel yang digunakan dalam penelitian ini adalah bahan cetak alginat murni serta alginat dengan penambahan tepung biji durian 20% dan 40%. Total sampel keseluruhan sebanyak 30 sampel. Setting time diukur dengan ujung batang silinder dan dihitung menggunakan stopwatch. Data hasil penelitian dianalisis menggunakan uji One Way ANOVA dan Post Hoc LSD. **Hasil:** Rata-rata hasil pengukuran setting time alginat murni, alginat 80%+tepung biji durian 20%, alginat 60%+tepung biji durian 40% berturut-turut adalah:  $132,2 \pm 3,495$ ;  $212,3 \pm 3,742$ ;  $266,8 \pm 3,369$ . Penelitian ini menunjukkan bahwa penambahan tepung biji durian berpengaruh terhadap setting time bahan cetak alginat ( $p < 0,05$ ). **Kesimpulan:** Alginat dengan penambahan tepung biji durian 40% memiliki setting time yang paling lama dibandingkan dengan kelompok sampel lainnya pada penelitian ini. Alginat dengan penambahan tepung biji durian 20% dan 40% memiliki setting time yang masih sesuai dengan standar American Dental Association (ADA) No. 18.

## Kata kunci

Alginat, amilopektin, amilosa, tepung biji durian, setting time

## INTRODUCTION

Alginate impression material is the most commonly used impression materials in dentistry to obtain a negative reproduction of teeth and surrounding tissues, such as for study models, impressions for removable dentures, orthodontic impressions, and primary impressions for complete dentures.<sup>1-4</sup> Alginate impression materials belong to the group of irreversible elastic hydrocolloids.<sup>3</sup>

They are easy to manipulate with simple equipment and are comfortable for patients.<sup>(5)</sup> Alginate impression materials must comply with ideal biological and mechanical property standards. The biological properties of alginate include a pleasant aroma, taste, color, being non-irritating to oral tissues, and demonstrating good biocompatibility.<sup>6</sup> The mechanical properties include working time, setting time, dimensional stability, elastic recovery and permanent deformation, flexibility, compressive strength, and tear strength. The standardization of alginate impression material properties is regulated in ANSI/ADA specification No. 18.<sup>7-9</sup>

Alginate impression material must have sufficient setting time to make good impressions.<sup>2</sup> The setting time is measured from the beginning of the mixing process until the alginate is no longer sticky when touched with a clean, dry finger.<sup>6</sup> The setting time can be influenced by several factors, such as the alginate composition, water temperature, room temperature, mixing technique, mixing time, and the powder-to-water ratio (w/p ratio).<sup>10,11</sup> An excessively fast setting time is one of the limitations of alginate impression materials in clinical conditions; therefore, modifications have been developed to improve alginate properties.<sup>12</sup>

Alginate can be modified by adding natural flour or starch to the alginate powder before manipulation.<sup>13</sup> Research by Dewi et al., reported that sweet corn flour can be used as an alternative ingredient in alginate modification, producing a longer setting time than pure alginate while still meeting ADA specification standards.<sup>3</sup> Similarly, Utami et al. reported that the addition of rice flour to alginate impression materials can extend their setting time while remaining compliant with ADA specifications.<sup>2</sup>

The basis for alginate modification using natural flour or starch lies in its polysaccharide content.<sup>13</sup> Polysaccharides in natural starches or flours consist of amylose and amylopectin chains.<sup>14</sup> Amylose and amylopectin have similar characteristics to one of the constituent components of alginate, namely alginic acid, which functions as a thickening agent and plays a role in gel formation.<sup>2,6</sup> A natural material containing starch in the form of amylose and amylopectin is durian seed flour.<sup>15</sup> Durian seed flour has a starch content of 88.68%, comprising 22.35% amylose and 66.33% amylopectin.<sup>16-18</sup> The quality testing of durian seed flour as an alternative food ingredient has also met the requirements of SNI No. 3751-2009.<sup>19</sup>

Durian (*Durio zibethinus* Murr.) is a tropical fruit native to Southeast Asia, including Indonesia, and is known locally as the King of Fruits.<sup>20</sup> Durian seeds are a by-product of durian fruit and agricultural waste material that contributes to environmental pollution.<sup>21</sup> Durian seeds contain two main components: starch and gum, which contain carbohydrates and proteins.<sup>17</sup> They also contain water-soluble polysaccharides, which are hydrocolloids.<sup>15</sup> Processing durian seeds into flour increases their potential utilization as a versatile, semi-finished product that is easier to use.<sup>22,23</sup> Isnaini et al.<sup>24</sup> reported that the addition of durian seed flour affects the dimensional stability of alginate impression materials.<sup>24</sup> Therefore, this study aims to analyze the effect of adding durian seed flour (*Durio zibethinus* Murr.) on the setting time of alginate impression materials.

## METHODS

This study employed an experimental laboratory design using a post-test only control group. The study was conducted in the Skills Laboratory, Faculty of Dentistry, Andalas University. The research samples were divided into three treatment groups: pure alginate (Group A), alginate with 20% durian seed flour (Group B), and alginate with 40% durian seed flour (Group C). Each group consisted of 10 samples, giving a total 30 samples. The materials used included normal set type alginate Aroma Fine Plus (*GC Co, Tokyo, Japan*), durian seed flour Hasil Bumiku (*Kusuka Ubiku, Indonesia*), and distilled water. The instruments used were 50 mL plastic pots, setting time indicators in the form of acrylic cylindrical rods, digital scales (*i-2000, J&R Electronic, China*) with 0.01-gram precision, and a stopwatch.

The water to powder ratio followed the manufacturer's instructions for the alginate, specifically 16.8 grams of powder and 40 mL of water. Group A (control) consists of 16.8 grams of alginate powder, Group B consists of 13.44 grams of alginate powder and 3.36 grams of durian seed flour, and Group C consists of 10.08 grams of alginate and 6.72 grams of durian seed flour. All materials were measured accurately using the digital scales.

Alginate and durian seed flour were first mixed with a shaker, then manipulated manually with distilled water using a spatula and rubber bowl for 30 seconds. The spatula movements followed a figure-eight pattern while pressing the mixture against the bowl wall. The mixture was then poured into a plastic pot. Setting time was measured by gently touching the surface of the mixture with the tip of the cylindrical rod and lifting it.

Measurements were repeated every 5 seconds until the alginate mixture no longer adhered to the rod, which was recorded as the final setting time.<sup>3</sup> After each contact, any residue on the rod was wiped clean with tissue before reinsertion. All procedures, including setting time measurement, were conducted by a qualified operator under controlled conditions: distilled water temperature at 23°C and room temperature of 26°C. The collected data were analyzed using a computer assisted statistical program.

## RESULTS

The setting time was recorded from the start of mixing until the alginate had set, characterized by the absence of adherence of the material to the indicator rod. The time was measured using a stopwatch and expressed in seconds.

**Table 1. Setting time measurement**

Groups	n	Setting time (seconds)	
		Mean ± SD	Min - Max
Pure Alginate (100%)	10	132.2 ± 3.495	120 - 148
Alginate 80% + durian seed flour 20%	10	212.3 ± 3.742	194 - 224
Alginate 60% + durian seed flour 40%	10	266.8 ± 3.369	253 - 280

Table 1 shows that the longest mean setting time occurred in the group containing 40% durian seed flour, and while the shortest was observed in the pure alginate group. The shortest recorded setting time was 120s (pure alginate), and the longest was 280s (alginate + 40% durian seed flour).

A statistical analysis was then performed to compare the setting times between groups. The Shapiro Wilk normality test produced  $p > 0.05$  for all treatment groups, indicating normal distribution. The Levene's test for homogeneity showed  $p = 0.978$ , ( $p > 0.05$ ), confirming data homogeneity. Therefore, a One-Way ANOVA test was applied.

**Table 2. One-Way ANOVA for setting time**

Groups	n	Setting Time (second)	p
		Mean ± SD	
Pure Alginate 100%	10	132.2 ± 3.495	0,000
Alginate 80% + durian seed flour 20%	10	212.3 ± 3.742	
Alginate 60% + durian seed flour 40%	10	266.8 ± 3.369	

The One-way ANOVA results showed  $p < 0.05$ , indicating that the addition of durian seed flour significantly affected the setting time of alginate impression materials. A post hoc LSD test was then conducted to determine the significance level between sample groups.

**Table 3. Post Hoc LSD test for setting time**

Groups	Pure Alginate 100%	Alginate 80% + durian seed flour 20%	Alginate 60% + durian seed flour 40%
Pure Alginate 100%		0.000*	0.000*
Alginate 80% + durian seed flour 20%			0.000*
Alginate 60% + durian seed flour 40%			

Note: \* $p < 0.05$  = significant

The LSD post hoc test revealed significant differences among all groups, including between pure alginate and alginate + 20% durian seed flour, pure alginate and alginate + 40% durian seed flour, and between the two durian seed flour formulation.

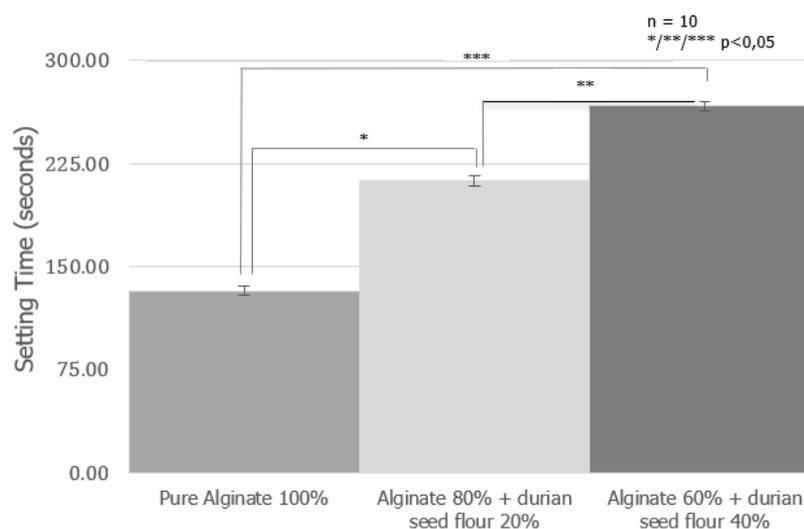
**Figure 1. Setting time of alginate with durian seed flour addition**

Figure 1 illustrates the comparative setting times of all study groups. Statistically significant differences ( $p < 0.05$ ) were observed, and the relatively low standard deviation values indicate consistent results within each group ( $n = 10$ ).

## DISCUSSION

Setting time is defined as the time required for an impression material to harden, measured from the start of mixing.<sup>2</sup> According to ADA Specification No. 18, a normal setting alginate should set within 3-4.5 minutes (180-270 seconds).<sup>7,9</sup> The manufacturer's

recommended setting time is 180 seconds. In this study, the fastest setting time was recorded for pure alginate with an average of 132.2 seconds, followed by alginate containing 20% durian seed flour with an average of 212.3 seconds, and the longest for alginate containing 40% durian seed flour with an average of 266.8 seconds. The average setting time of the pure alginate group was shorter than both the ADA and manufacturer standards, which may be due to the manual mixing technique. Increased mixing intensity accelerates the chemical reaction, thereby shortening the setting time.<sup>2</sup>

The results in Table 1 show that addition of durian seed flour prolonged the setting time compared with pure alginate. This is attributed to polysaccharide content of durian flour, which likely interferes with alginate hydration and slows its setting time.<sup>1</sup> Durian seed flour contains 338 kcal of energy, 8.97 g protein, 1.14 g fat, 85.4 g carbohydrate, 98 mg calcium, and 13 mg phosphorus.<sup>25,26</sup> The polysaccharides, starch, and protein components may hinder alginate hydration because alginate is less soluble in water containing sugars, flour, or proteins.<sup>3</sup> These findings are consistent with Dewi et al., who reported that the addition of corn starch to alginate increased setting time, as higher polysaccharide content produces a moister, stickier gel that absorbs less water.<sup>3</sup>

The One-way ANOVA results in Table 2 confirmed that the addition of 20% and 40% durian seed flour significantly affected the setting time of alginate impression materials. This is consistent with the study of Utami et al., who found that adding rice flour extended alginate setting time, because calcium ions preferentially react with starch molecules. Amylose in starch contains hydroxyl groups with hydrophilic properties that readily react with water.<sup>2</sup>

Durian seed flour contains polysaccharides such as starch, composed of amylose and amylopectin, while alginate primarily consists of alginic acid, a carbohydrate of the polysaccharide type.<sup>14,27–29</sup> Durian seed flour has an amylose content of around 22.35% and amylopectin of around 66.33%.<sup>15,16</sup> Polysaccharides play an essential role in gel formation because they serve as sites for cross-link formation. The longer the polymer chain, the greater the number of chemical reactions and cross-links formed, resulting in a longer gel formation time.<sup>12</sup>

Table 3 shows that the significant differences among all sample groups were due to the different concentrations of durian seed flour mixed into the alginate impression material. Adding durian seed flour reduces the relative concentration of alginate powder, thereby slowing down the setting time of the impression material. This is similar to the research of Ningsih et al., who reported that the alginate group with 45% corn flour addition showed significant differences from the pure alginate group and the alginate group with higher corn flour addition, owing to differences in the alginate-to-flour ratio.<sup>1</sup> Fransiska *et al.* also reported that the addition of 40% cassava starch and modified cassava starch to alginate impression material significantly prolonged the setting time due to alterations in gelation kinetics caused by reduced alginate concentration and interference with calcium–alginate cross-linking.<sup>30</sup>

Figure 1 shows that the alginate setting time increased with the addition of durian seed flour. Pure alginate exhibited the shortest setting time, whereas the incorporation of 20% and 40% durian seed flour resulted in a progressive prolongation of the setting time. These findings are consistent with the study conducted by Isnaini *et al.*, which reported that alginate impressions containing 40% durian seed flour demonstrated superior dimensional stability compared with those containing 20% durian seed flour and pure alginate formulations. This effect can be attributed to the presence of amylose and amylopectin in durian seed flour, which play critical roles in starch gel formation when mixed with water. Amylose contributes to the formation of a viscous gel, while amylopectin exhibits a high water-retention capacity, thereby enhancing gel consistency and improving dimensional stability.<sup>24,31</sup>

This study was limited to evaluating setting time under controlled laboratory conditions and a fixed water-to-powder ratio, while other clinically relevant properties of

alginate impression materials were not assessed. Additionally, only two concentrations of durian seed flour were investigated. Future studies should evaluate a wider range of concentrations, include comprehensive mechanical and dimensional property testing, and assess the clinical performance of the modified alginate to determine its practical applicability.

## CONCLUSION

Adding durian seed flour significantly affects the setting time of alginate impression materials. The longest setting time was observed in alginate with 40% durian seed flour, followed by alginate with 20% durian seed flour, and the shortest in the pure alginate group. Alginate with 20% and 40% durian seed flour had setting times that remained within the American Dental Association (ADA) No. 18 standard. These findings suggest that durian seed flour has potential as a natural modifier to control alginate setting behavior and improve handling characteristics in clinical practice. The use of durian seed flour may also contribute to the sustainable utilization of agricultural by-products as value-added dental materials. However, further studies are required to evaluate other physical and mechanical properties, optimize formulation concentrations, and assess clinical performance before this modification can be recommended for routine dental use.

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