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Effect of Water Temperature and Improper Storage on the Setting Time of Alginate Impression Material

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ABSTRACT

Background: Alginate is an irreversible hydrocolloid printed material containing various materials such as potassium alginate, calcium sulfate, sodium phosphate, potassium titanium fluoride, zinc oxide, and diatomaceous earth as filler. **Purpose**: The aim of this study was to know the effect of water temperature and improper storage on the setting time of alginate print material. **Methods**: This study consisted of 4 treatment groups, using Tulip brand alginate impression material (Cavex-Holland) exp 2018-04 and tap water. The time setting data were analyzed by One-Way ANOVA test and continued with Least Significant Different test (LSD). **Results**: A one-way ANOVA test was used to discover the significant differences between the four treatment groups. LSD test results show that there are significant differences between K-1 and other groups. **Conclusions**:that higher water temperatures and improper conditions in alginate printing material storage will accelerate the setting time.

Keywords: alginate, moisture, water temperature, setting time

INTRODUCTION

Case management in dentistry involves various steps, one of which is the taking oral cavity impression to obtain study models and work models. Oral cavity impression can be done by using various types of impression materials. One of the most widely used as impression materials is alginate.Alginate is an irreversible hydrocolloid printed material containing various materials such as potassium alginate, calcium sulfate[1], sodium phosphate[2–4], potassium titanium fluoride, zinc oxide, and diatomaceous earth as

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filler[5–7].Potassium alginate reacts with calcium ions of water-soluble calcium sulfate to form a gel and sodium phosphate consistency, which has an important role in controlling the setting time of alginate printing material[8].

Alginat impression material is being manipulated using water at room temperature[9]. But, alginate materials on the market comes from abroad (outside Indonesia) and room temperature water is recommended by the factory to have a temperature range of 20ºC, so there is a possibility of setting a time difference when manipulating alginate print material in the tropics. Meanwhile, Indonesia is a tropical country with temperatures ranging from a minimum of 180-260C and a maximum of 270-34ºC[10].

During the study, tap water temperature was measured, showing a result of around 27.20C with humidity around 72%.Alginate materials generally include the expired date on the packaging. However, the storage method for alginate materials can affect shelf life. Some things that can affect shelf life are temperature, humidity, duration of storage, and amount of material and type of storage[11,12][12].The two factors that had the most significant influence on the shelf life of alginate printing materials were the storage temperature and air humidity around the storage area[5].

At the Dentistry Laboratoryof Universitas Airlangga, alginate powder materials left after used for practicum were not stored properly. Often, the excess ingredients of alginate powder are stored only in a cupboard with folded packaging. The Alginate print material storage area must be a tightly closed place[12]. Based on the above, the researcher wants to know the effect of water temperature and improper storage on the setting time of alginate print material.

MATERIAL AND METHOD

This study consisted of 4 treatment groups, using Tulip brand alginate impression material (Cavex-Holland) exp 2018-04 and tap water. Open pack alginate is printed alginate material that has been stored in a cupboard for 5 months with the condition of the packaging folded and manipulated using water with a temperature of 27.20C (K 1) and 200C (K 3). Closed packing alginate is alginate printing material which is still in a tightly sealed condition from the factory and manipulated by using water with temperature of 27.20C (K 2) and 200C (K 4).

The alginate manipulation process is carried out with the same technique. As

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much as 16.67 ml of water and 7.67 grams of alginate powder are stirred using a spatula with movements resembling the number eight, forming 1800 intermittent turns, at a rate of 2 times / second. Alginate stirring is carried out while pressing the alginate mixture on the walls of the rubber bowl until smooth and homogeneous for 30 seconds. Alginate dough is put into a ring-shaped mold with a diameter of 3 cm and 16 mm then the tip of the time-setting bar-shaped test instrument is made of acrylic with a length of 10 cm and a diameter of 6 mm is touched on the surface of the alginate dough at intervals of 5 seconds[13].

The setting time is calculated from the beginning of mixing the alginate powder and water, so that no visible pressure marks from the tip of the acrylic bar on the alginate mixture. The time setting data were analyzed by One-Way ANOVA test and continued with Least SignificantDifferent test (LSD) to see the significance of the effect of water temperature and storage on the time setting of the alginate print material.

RESULT

Alginate impression material setting time test results showed that the treatment group of alginate in open packaging with water temperature of 27.20C (K 1) had the shortest average setting time, which was 156.43 seconds. Whereas the treatment group of alginate manipulation in a closed package with water with a temperature of 20°C (K4) had the longest average setting time, that is 184.29 seconds.

A one-way ANOVA test was used to discover the significant differences between the four treatment groups, p = 0,000 ($p<0.05$), suggesting that there were significant differences between the groups. To find groups that have a significant difference between the four treatment groups, the Least Significant Different (LSD) test with $\alpha = 0.05$ is used. The results can be seen in Table 2.

LSD test results show that there are significant differences between K-1 and other groups. K-2 also has a significant difference from K-4. K-3 is no different from K-4, while K 2 and K 3 also have no significant difference.

Tab1e 1. The mean value and standard deviation of the setting time of alginate

Group	n	X	SD
K 1	7	156,43	8,522
K 2	7	174,29	7,868
K 3	7	180	6,455

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K 4	7	184,29	7,868

Footnotes:

X : Mean

SD : Standarddeviastion

n : Number of sample

K 1 : open packaging + air 27,2^{0}C

K 2 : closed packaging + air 27,2^{0}C

K 3 : open packaging + air 20^{0}C

K 4 : closed packaging + air 20^{0}C

Table 2. Result of LSD Analysis of Alginate Setting Time

	K 1	K 2	K 3	K 4
K 1	-	0,00*	0,00*	0,00*
K 2		-	0,179	0,023*
K 3			-	0,309
K 4				-

* = Significant

DISCUSSION

The mechanical, physical, and chemical properties of alginate impression material are influenced by the mass and storage of the material[14].The setting reaction is a normal chemical reaction. The speed can be doubled with an increase in temperature of 100 C. However, the use of water with temperatures below 180 C or greater than 240 C is not recommended[4]. In Surabaya, however, the water temperature is around 27.2ºC.

The LSD test results showed that there were significant differences between groups using open pack alginate and water. This occurs because the condition of the open packaging does not provide good protection against the surrounding air. Alginate impression material powder reacts with water vapor in the air, causing a polymerization reaction that forms an early polymer structure in alginate powder. Polymer structure which has been formed earlier will cause shorter setting time[15].There is also the effect of higher water temperatures (27.2ºC), which will shorten the setting time.

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The alginate manipulation treatment group with a closed package using water with a temperature of 27.2ºC (K 2) also had a significant difference compared to the alginate manipulation treatment group with a closed package using water with a temperature of 20ºC. (K-4). The setting reaction is a normal chemical reaction. The speed can be doubled with an increase in temperature of 10ºC[16]. Using water that has a higher temperature will cause a shorter setting time by accelerating the rate of reaction of sodium phosphate with calcium sulfate and accelerating the reaction between calcium sulfate and potassium alginate[8].

During the setting process, water temperature affects the efficiency of bonds between molecules in chemical reactions through kinetic effectiveness[17]. Higher water temperatures will add to the collision effect of each molecule that reacts, causing a faster reaction. Otherwise water temperatures lower than normal use will cause the polymerization reaction to occur more slowly[18].

The alginate group with the open package (K 3) compared to the closed package (K 4), when using water with a temperature of 20ºC did not have a significant difference. This can be due to the alginate group with the open package used in the study is still not expired. Although there is an influence of humidity during storage that is less dense, changes in conditions that occur in alginate powder are still quite small, while the water used at 20ºC is the recommended temperature by so the factory setting time is still within the normal range. Other research states that alginates that have exceeded the expiration date have a shorter setting time compared to alginates that are still in sealed packages[19].

The alginate group closed with water at 27.2ºC (K 2) and the open alginate group with water at. The 20ºC (K-3) also did not have a significant difference. The higher temperature should cause shorter setting time, but due to the condition of the alginate package which has been opened for five months, it is contaminated with air humidity. The result is the same as alginate whose packaging is still closed with 27.2ºC water which should be set faster.

CONCLUSIONS

Based on the results of this study, it can be concluded that higher water temperatures and improper conditions in alginate printing material storage will accelerate the setting time.

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