TRISODIUM PHOSPHATE 2% EFFECT ON SETTING TIME ALGINAT MATERIALS

(PENGARUH TRISODIUM PHOSPHATE 2% TERHADAP SETTING TIME BAHAN CETAK ALIGINAT)

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ABSTRACT

Alginate is widely used in dentistry as an impression material. Manipulation of commercial alginate impression materials with the addition of Trisodium Phosphate (TSP). It is known to prolong the setting time of alginate by reacting it first with calcium sulfate. Dental students in their first grade sometimes have difficulty manipulating alginate so they need-a longer manipulation time. There is no alginate product with a longer setting time in the market. From this study, we added 2% TSP to add setting time for dental education. The purpose of this study to characterize was to determine the compressive strength of alginate molding materials that have been added with TSP to commercial alginate products with factory standards. Setting time, compressive strength, EDS, and SEM was used as a characterization. This research was true experimental research. It was conducted using normal type printed materials with one of the brands available in the market. The results of this study were then analyzed using paired T-

test, the compressive strength of alginate without and without TSP 2% was a significant difference. The addition of 2% TSP affected the compressive strength of the alginate impression material.

Keywords: alginate, irreversible hydrocolloid; trisodium phosphate

ABSTRAK

Bahan cetak alginat berfungsi sebagai cetakan negatif dari gigi dan jaringan rongga mulut. Bahan cetak alginat bersifat hidrofilik dan digunakan sebagai cetakan pre-eliminasi untuk custom tray sebagai cetakan kedua yang lebih akurat. Stabilitas dimensi pada hasil cetakan alginat merupakan hal penting untuk keberhasilan pembuatan model cetakan yanh akurat. Perubahan dimensi alginat berhubungan dengan kontraksi selama proses pengerasan bahan cetak alginat atau setting time dari bahan cetak alginat. Penambahan Trisodium Fosfat (TSP) diketahui bisa memperpanjang waktu pengerasan alginat dengan memperlambat reaksi garam alginat dan kalsium sulfat. Tujuan penelitian ini untuk mengetahui perbandingan antara uji stabilitas dimensi pada bahan cetak alginat dengan penambahan trisodium fosfat 2% dengan yang tidak ditambahkan trisodium fosfat 2% setelah terjadi pengerasan. Penelitian ini merupakan penelitian eksperimental murni laboratorik. Setting time, compressive strength, EDS, and SEM digunakan untuk karakterisasi bahan cetak alginat. Alginat dibagi menjadi 2 kelompok, yaitu kelompok sesuai ketentuan pabrik dan kelompok yang ditambahkan trisodium fosfat 2%. Hasil penelitian ini kemudian dianalisis dengan menggunakan uji T test tidak berpasangan, hasil menunjukan terdapat perbedaan yang signifikan pada stabilitas dimensi alginat tanpa TSP 2% dengan penambahan TSP 2%. Penelitian ini menunjukkan bahwa penambahan TSP 2% menghasilkan stabilitas dimensi yang lebih baik pada kelompok dengan penambahan TSP 2%.

Kata kunci: *alginate; irreversible hydrocolloid; trisodium fosfat*

INTRODUCTION

Alginate is widely used in dentistry as an impression material. Alginate composition of: potassium alginate 15%, potassium titanium fluoride 3%, Diatomaceous earth 60%, calcium sulfate 16%, zinc oxide 4% and Sodium phosphate 2%.[1–3] Alginate powder after mixing water will harden according to the shape of the mold, and cannot change to its original shape so that it is included in the material of irreversible hydrochloric impression.[4,5] Alginate impression material has the criteria of adapting to the tissues in the mouth, the material while in the mouth must be able to become a solid object, alginate which has hardened no longer changes when coming out of the mouth.[1,4,6] Alginate has the advantages of being easy to mix and manipulate, simply used equipment, elastic molds, and quite accurate and relatively cheap prices.[1,3,7]

The type of alginate found in the market is divided into two related to the time of its hardening. Type I alginate with a normal set (working time is around 2 minutes and hardening time 2-4.5 minutes and type II fast set (working time is more than 1 minute 15 seconds and hardening time 12 minutes). Conditions that require adjustment of the hardening time such as students who are still studying are needed the type of alginate whose hardening time is slower, but this type of alginate is not on the market.[8,9] Dental students who are currently in education sometimes have difficulty in manipulating alginate and require a longer manipulation time. However, there is no alginate product with a longer setting time in the market. From this study, we added 2% TSP to add setting time for dental education. There are several ways to prolong the setting time of alginates such as temperature and the addition of a retarder such as Trisodium Phosphate (TSP).[2,5] Buchan & Peggie's study concluded that the more TSP added to the alginate, the longer it takes for the alginate to harden. In the other study added 2% TSP to the normal alginate powder set, and obtained the setting time before adding TSP which is 2.24 minutes. After adding TSP 2% is 4.47 minutes, there is an increase in setting time of 99.5%. The study found that the alginate printed material added to TSP 2% appeared to have side effects against excessive attachment to the mold and glass lab after hardening. However, there has been no quantitative analysis and measurement of the nature of alginate impression materials added TSP 2%.[10,11] In Hummudi's study, which added a retarder to the alginate impression material, the results showed that the addition of a retarder to the alginate impression material delayed the setting reaction and had lower compressive

strength.[12] Compressive strength is the capacity of a material or structure to withstand loads that reduce its size. The function of the compressive strength of alginate clinically is to keep the mold-resistant to pressure when it is released into the mouth and to prevent the tearing of the mold.[12–15]

Seeing the effect of adding a retarder in previous studies on the adhesion and compressive strength of the alginate impression material, the authors would like to conduct a deeper analysis and measurement of the compressive strength properties of the added alginate impression material.

TSP as much as 2%. The compressive strength of the alginate is required to prevent the mold from tearing or cracking and the mold is sufficiently elastic when it is removed from the mouth,[12,14,15] while the addition of TSP as a retarder is widely used in dentistry.

METHOD

This research method was experimental laboratories which were to find out the characteristics of alginate impression materials that had been added TSP 2%.

The tools used were a rubber bowl, spatula, measuring glass, stopwatch, glass lab, special cylindrical mold made of stainless steel with a diameter of 1 cm and a height of 3 cm (Figure 3.1), funnel term, digital analytical scales, compressive strength testing machine using a universal testing machine (UTM).

The materials used in this study were normal alginate set with GC aroma fine DF III normal set, room temperature aquadest, powder-shaped TSP. The object of this research was the normal type of alginate impression material set which had been added TSP as much as 2%. Number of Samples

There were 2 groups, they were in the study sample this time, the control group was an alginate print material without the addition of TSP 2% and the treatment group was an alginate print material that was added TSP as much as 2%. Determination of the number of samples using the Federer formula. Based on calculations using the Federer formula obtained a minimum of 16 group samples.

Procedure of Research

Alginate powder was divided into 2 groups, one control group according to the provisions of the factory without the addition of TSP. One group was added with TSP powder as much as 2% of the total amount of alginate powder that had been divided, then the sampling of

alginate powder following the instructions of the factory brand GC Aroma Fine DF III normal set as much as 8.4gr, then put into a rubber bowl (rubber bowl). Add 20 ml of water according to factory instructions then mix alginate powder with water using a spatula. Mixing the alginate powder with the spatula water pressed against the rubber bowl wall and spun like a twisting number until the dough becomes homogeneous for 30 seconds. Alginate dough that had been homogeneous was partially stored in a cylindrical sample mold 1 cm in diameter and 3 cm high. Hardened alginate molds were left in moisture-resistant containers, conditioned at room temperature of 23-25ºC, after which each group was divided into 4 groups with time differences that were waited for 1 hour, 2 hours, 3 hours, and 4 hours. After being left for the specified time then removing the alginate in the container and testing the compressive strength testing machine the sample was placed at the place of the sample under-emphasis. It was then the load cell dropped at a predetermined speed and press the sample until it was destroyed.

The magnitude of the force that occurs during the test, and the compressive strength can be calculated

= compressive strength (MPa) F = applied force or load (N)

A = cross-sectional area imposed by the load (mm)

using equality = (MPa)

RESULT

The effect of the addition of TSP on commercial alginate on the setting time shows in (Table 2)

Table 1 Descriptive results of the setting time of the two treatment groups

	N	X	±	SD
A Without TSP2%	16	2.24	±	0.03
B With TSP2%	16	4.47	±	0.03

The compressive strength of the alginate impression material was measured by applying a compressive force to the object or objects being tested until the object was torn or destroyed, using a universal testing machine (UTM). The compressive strength associated with the presence of stress (stress) and strain (strain) is shown in Figure 1.

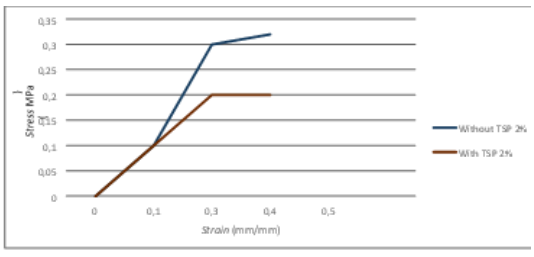

Figure 1. Graph of Stress and Strain

with and without TSP Addition of 2%.

Figure 1. showed a graph of the relationship between stress and strain. The stress strength of alginate without the addition of 2% TSP was greater than the compressive strength of alginate with 2% TSP added. The greater the value of the strain, the greater the stress. The comparison of the results of the compressive strength of alginate impression materials with and without the addition of 2% TSP was shown in figure 2.

The result of pressure strength with the addition of TSP 2% each time fluctuated. There was an increase in the average value of pressure within 4 hours and a decrease in the average value of pressure at 3 hours. Data in table 4.1 showed a decrease for each time between no TSP2% and after using TSP 2%.

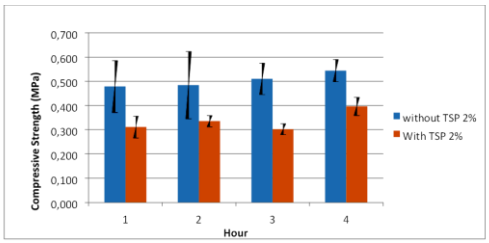

Figure 2. Graph of Compressive Strength Results with and without the addition of 2% TSP.

Figure 2. showed the graph of the average compressive strength of alginate without the addition of 2% TSP which was greater than the compressive strength of alginate with 2% TSP added.

The results of the compressive strength data without TSP 2% and with TSP 2% were first tested for normality and homogeneity using the Shapiro Wilk test and Levene test. The results can be seen in table 2.

Table 2 Normality and homogeneity test

	Normality test		Homogeneity test	
	P-Value	Interpretasi	P-Value	Interpretation
Without TSP2%	0.35	Normal		
With TSP2%	0.139	Normal	0.055	Homogeneous

Based on table 2. showed that the compressive strength data were normally distributed ($p > 0.05$) for the group without TSP 2% and with TSP 2%. The homogeneity test was obtained at $p>0.05$, so the data was homogeneous. The statistical test used was the parametric test, and it was the paired T-test.

Table 3 Paired T-test compressive strength

Group	Mean	Mean differences	T count	*P-Value
Without TSP2%	0.5039	0.1679		
With TSP2%	0.336		7.47	0.00

* *paired t-test*

Based on the calculation results showed that the probability value (p-value) between the compressive strength without TSP 2% compared to the strength with TSP 2% was 0.00 because of the p-value <0.05 i.e. (0.00<0.05). It means that there was a significant difference in strength between no TSP 2% and TSP 2%. This could be seen from the value of the difference in compressive strength of 0.1679. The compressive strength of alginate without TSP of 2% was higher than that of alginate with the addition of 2% TSP.

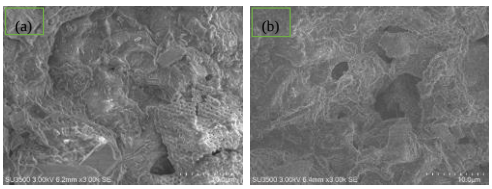

Figure 3.

(a) Scanning Electron Microscopy Alginate Impression Material without TSP 2% .

(b) Scanning Electron Microscopy Alginate Impression Material with TSP 2%

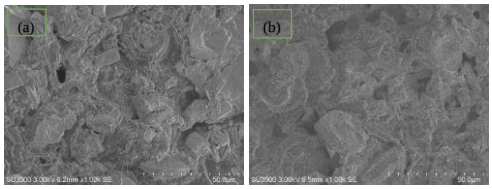

Figure 4.

(a) Scanning Electron Microscopy Alginate Impression Material without TSP 2%

(b) Scanning Electron Microscopy Alginate Impression Material with TSP 2%

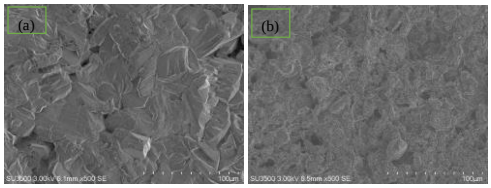

Figure 5.

(a) Scanning Electron Microscopy Alginate Impression Material without TSP 2% .

(b) Scanning Electron Microscopy Alginate Impression Material with TSP 2%

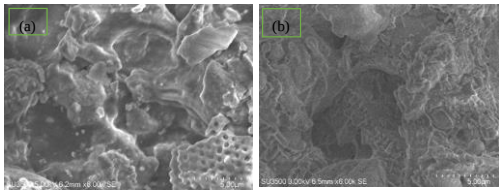

Figure 6.

(a) Scanning Electron Microscopy Alginate Impression Material without TSP 2%.

(b) Scanning Electron Microscopy Alginate Impression Material with TSP 2%

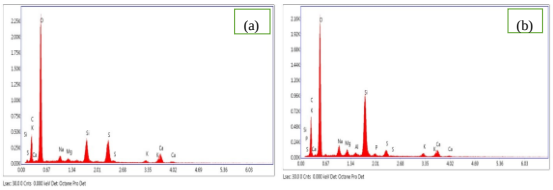

Figure 5.

(a) Energy Dispersive X – Ray Spectroscopy Alginate Impression Material without TSP 2% .

(b) Energy Dispersive X – Ray Spectroscopy Alginate Impression Material with TSP 2%

DISCUSSION

This study compared the compressive strength of alginate impression materials with 2% TSP added with 2% TSP not added. TSP was a material that slowed down the hardening reaction. TSP had properties that were easily soluble in water in alginate as in the following reaction: [5,16.]

Na_nAlg + n/2 $CaSO_4$ ↔ *n/2* Na_2SO_4 + $Ca_{n/2}$ Alg [4]

TSP slowed down the reaction of alginate salts and calcium sulfate. When manipulating the alginate, we could see a change in shape into a gel shape. TSP plays a role in holding the dough which did not directly turn into solid. TSP blocked the above reaction by reacting first with calcium sulfate before with alginate salts.[17,18] Thus, the glassing process which occurred in alginate added TSP as much as 2% becomes longer with the process of glassing which was not added TSP as much as 2%.

The compressive strength of alginates was related to the concentration of the polysaccharide molecules and the presence of crosslinking ions. Compressive strength was related to the presence of stress (stress) and strain (strain).[12,17,18] The addition of retarder to alginate can affect calcium chloride which acts as a reactor and diatomaceous earth as a filler. The addition of TSP material affects the elasticity of the alginate impression material,[10] because the activity of calcium chloride and diatomaceous earth will be inhibited. The

addition of TSP could affect the structure of the intercellular matrix gel in the alginate which made the gel strength of alginate impression material weak, they could weaken the compressive strength of alginate impression materials.

The compressive strength of alginates was related to the concentration of the polysaccharide molecules and the presence of crosslinking ions. Compressive strength was related to the presence of stress (stress) and strain (strain).[12,17,18] The addition of retarder to alginate can affect calcium chloride which acts as a reactor and diatomaceous earth as a filler. The addition of TSP material affects the elasticity of the alginate impression material,[10] caused by the activity of calcium chloride and diatomaceous earth will be inhibited. The addition of TSP could affect the structure of the intercellular matrix gel in the alginate which made the gel strength of the alginate impression material weak. They could weaken the compressive strength of alginate impression materials. The strength of the alginate was important, according to the ANSI-ADA specification, the compressive strength of the alginate required a minimum of 0.37Mpa. Alginate compressive strength without the addition of TSP 2% had a higher average value than alginate which was added to TSP 2% in table 1 and figure 2. The value of alginate pressure strength with the addition of TSP 2% which is 0.336 Mpa was found in table 3. Based on the sem description, alginate without TSP 2% is more structured and the bond is clearer. This SEM picture is related to its compressive strength below the minimum compressive strength required for alginate. Compressive strength was related to the capacity of the material or structure to withstand loads which reduced its size.[12,15] In table 1. The difference in testing time also affects the pressing strength of alginate impression materials, the longer the time, the greater the value of the compressive power. Within 4 hours the pressure strength value of alginate is closer to the standard of 0.36 Mpa, so it could be considered the use of TSP 2% in the clinic. The difference in the value of alginate compressive strength over the testing time related to crosslinking that occurs within alginate polymers, contractions, and other causes might have an effect on the dredging or shrinkage of the cause of water components disappearing. [12,13,17,18]

The use of alginate for students who were still learning in addition to adding retarders several factors could control the hardening time, among others, by manipulating the ratio of powder and

water, adding a little more water than the dose of powder. How manipulating alginate by adding water could also affect the impression process. The more water added made the alginate impression material more dilute and could be at risk of swallowing at the time of impression. The alginate mold could be imported indicating its pressure strength was lower. The use of TSP as a retarder had an exception in controlling the ratio of alginate powder to water, due to the nature of TSP that easily reacted with water. The compressive force of the alginate greatly affected the impression process. By the time the alginate impression material was removed from the mouth, the alginate was strong enough to withstand pressure and prevent the mold from tearing. Alginate impression material added TSP 2% affects the compressive strength. Thus, alginate impression materials added TSP 2% could affect the impression process, alginate prints were easily torn which resulted in less accurate prints.[8,17,19,20]

Limitations in this study were during the difficult impression process because alginate impression materials were not too dilute. It was difficult to fit into small prints measuring 1 x 3 cm. Thus, special ways are needed such as using perforated plastic, so all molds are filled with alginate and not inporus.

CONCLUSION

This study concludes that 2% TSP can affect the compressive strength of alginate impression materials. The compressive strength of alginate without the addition of 2% TSP with a TSP of 2%, has a compressive strength difference of 0.1679. This shows that the alginate impression material added with 2% TSP has a lower compressive strength than the alginate impression material without the addition of 2% TSP. The alginate impression material added with 2% TSP can affect the impression process, and the alginate mold is easily torn which results in less accurate printouts.

CONFLICT OF INTEREST

We hereby declare that there is no conflict of interest in the scientific articles that we write.

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