EFFECT OF ADDITIONAL TRISODIUM PHOSPHATE 2% AS A RETARDER TO DIMENSIONAL STABILITY TESTS DENTAL MATERIAL ALGINATE AFTER HARDENING

(PENGARUH PENAMBAHAN TRISODIUM FOSFAT 2% SEBAGAI RETARDER TERHADAP UJI STABILITAS DIMENSI BAHAN CETAK ALGINAT SETELAH MENGERAS)

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JHDS.unjani.ac.id/jite
Doi: 10.54052/jhds.

Article History
Received:22/05/2022
Accepted: 29/05/2022

ABSTRACT

The alginate moulding material is a negative mold of the teeth and oral cavity tissue. The alginate molding material is hydrophilic and is used as a pre-elimination mold to a custom tray for a more accurate second mold. The dimensional stability of the alginate mold is essential for the success of making a precise mold model. Changes in alginate dimensions are related to the contraction during the hardening process of the alginate molding material or the setting time. The addition of Trisodium Phosphate (TSP) is known to prolong the hardening time of alginates by slowing down the reaction of alginate salts and calcium sulfate. The purpose of this study was to compare the dimensional

stability test of the alginate molding material with the addition of 2% trisodium phosphate and those without 2% trisodium phosphate after hardening. This research is pure laboratory experimental research. Alginate was divided into two groups: the group according to the manufacturer's provisions and the group added with 2% trisodium phosphate. The results of this study were analyzed using the unpaired T-test, and the results showed a p-value <0.05, namely (0.00 <0.05), so there was a significant difference in the dimensional stability of alginate without TSP 2% with the addition of TSP 2%. This study showed that the addition of 2% TSP improved dimensional stability in the group with the addition of 2% TSP.

Keywords: alginate; dimensional stability; irreversible hydrocolloid; TSP

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. 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 nilai p-value <0.05 yaitu (0.00 < 0.05) maka 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; hidrokoloid ireversibe;, stabilitas dimens;, TSP*

INTRODUCTION

Alginate impression material is one of the materials widely used in dentistry. Alginate impression material creates a negative impression of the teeth and oral tissues. The resulting appearance is cast with gypsum so that a working model or study model is obtained, a replica of the teeth and oral tissues. [1] Alginate material is a water-soluble salt of sodium, potassium or ammonium alginate. The alginate impression material consists of 15% potassium alginate, 16% calcium sulfate, 4% zinc oxide, 3% potassium titanium fluoride, 60% diatomaceous earth and 2% sodium phosphate. Manipulation of alginate impression material in the form of powder mixed with water to form a gel.[2]

The dimensional stability of alginate impressions is essential in making accurate mold models. This can cause changes in the shape or dimensions of the mold so that it is easy for expansion to occur, which can cause inaccurate alginate impressions. Another factor that affects the dimensional stability of the alginate impression material is the distortion or creep that will happen if the alginate impression material does not change its elasticity when the alginate impression material hardens and the undercut is removed. [5,6,7,8]

One of the properties that the impression material must own is elasticity and changes in deformity so that it can print undercuts without changing dimensions. The printed material's dimensions will affect the plaster model's result. The dimensional stability of the impression material must be maintained so that the positive impression has the same shape and size as the original shape and size of the teeth and soft tissues. Recovery from deformity is the percentage of the impression material's ability to return to its original dimensions and return when the compressive load is removed. Therefore, the dimensional stability of the alginate

impression is important for the success of the next mold model. In addition, alginate is easy to shrink when left too long in the open air. So, it is important to maintain the humidity of the alginate mold so that its dimensional stability is well maintained. [9.10] Besides being influenced by temperature, the type and nature of the printing material used, the printing technique, and the proportion of the mixture of printing materials. The dimensional stability of the alginate impression material is influenced by the presence of exudate or foreign objects on the gel surface. A retarder was added to control the setting time. A water-soluble phosphate salt is added to the composition as an inhibitor to prolong the working time. The amount of retarder is adjusted to provide the correct setting time. [10,11,15]

Trisodium phosphate serves as an ingredient to slow the setting time. The percentage of trisodium phosphate in commercial materials is 2%. The more the trisodium phosphate retarding agent is added, the slower the setting time of the impression material. In a previous study, Farras added 2% trisodium phosphate to normal set alginate powder. They obtained a setting time (of 2.24 minutes) before adding trisodium phosphate, while after adding 2% trisodium phosphate, the setting time was (4.47 minutes). So there is a significant increase in time when 2% trisodium phosphate is added to alginate. The casting time delay can affect the resulting mould's dimensional stability. The results of the alginate impression should be cast directly, or it can be delayed for a maximum of 12 minutes. Therefore, the authors are interested in conducting research on experimental tests regarding the dimensional stability of alginate impression materials after the addition of 2% trisodium phosphate with 2% trisodium phosphate not added as a retarder after hardening. Dimensional stability of the alginate impression material is needed to prevent the shrinkage process from occurring on the alginate impression material.

METHOD

This research method is an experimental laboratory to determine the characteristics of alginate impression material that have been added with 2% TSP, and 2% TSP is not added. The tools used are a rubber bowl, spatula, measuring cup, stopwatch, glass lab, *stainless steel mold with* a diameter of 33 mm and a height of 16 mm, a digital calliper, and a digital analytical scale. The materials used in this study were normal set alginate, room temperature distilled water, and TSP in powder form. The object of this research is normal to set alginate impression material

with 2% TSP added.

Number of samples

In this study, there were two groups. Namely, the control group sample was alginate impression material without adding 2% TSP, and the treatment group was alginate impression material with 2% TSP added. They determined the number of samples using the Federer formula and obtained results of a minimum of 16 samples per group.

Procedures

1. Weighing 8.4 grams of alginate and 0.168 grams of TSP 2%.
2. Alginate manipulation
   a. Alginate impression material that has been weighed is placed in a container. In the alginate group with the addition of2% TSP, 0.168 grams of TSP was added into the container.
   b. Measure out 20 ml of water and mix it into a container.
   c. Stirring using a spatula in a circular motion, the other hand rotates the rubber bowl until a smooth alginate mixture is obtained homogeneous.
   d. After the mixture of alginate impression material is homogeneous, the alginate mixture in a rubber bowl is collected using a spatula.
3. Then put in a *metal plate* with a diameter of 30 mm and a height of 16 mm. Samples were stored in an open room at a room temperature of 20 $^{0C.}$
4. After *setting* the results removed from the *metal plate*, *setting the* alginate-based on the consistency of the alginate that has hardened when pressed.
5. Then the measurement of dimensional stability is carried out based on the vertical and horizontal distances.
6. The mould was not treated as a control for 5 minutes, 10 minutes, 15 minutes, and 20 minutes.
7. The length of the specimen diameter was measured again with a calliper, and the average dimension was sought.

Data analysis

The addition of trisodium phosphate as a retarder on alginate impression material aims to slow down the setting time. A dimensional stability test was carried out to determine the shape changes in the alginate impression material. After the data was obtained, it was analyzed using *Statistical Product and Service Solution* (SPSS). The first test was carried out, namely the normality test using the Shapiro Wilk test and the homogeneous test using the Levene test. If the conditions for normality and homogeneity are met, the data analysis used

is the unpaired T-test.

RESULT

Table 1 shows data from research and analysis on adding trisodium phosphate 2% on alginate for dimensional stability after hardening. There were 2 sample groups in the treatment group (i.e. alginate with the addition of 2% trisodium phosphate) and (alginate without the addition of 2% trisodium phosphate) as a control group. The following data were obtained from the two groups:

Table 1. Data of the measurement results of the dimensions and height of the sample

Sample	0 minute (mm)		5 minute (mm)		10 minute (mm)		15 minute (mm)		20 minute (mm)	
	D	T	D	T	D	T	D	T	D	T
1	33	16	33	16	32,7	16	32,5	15,8	32,2	15,7
2	33	16	32,9	16	32,7	16	32,4	15,8	32,2	15,7
3	33	16	32,5	15,8	32,4	15,7	32,3	15,6	32,3	15,6
4	33	16	32,7	15,9	32,6	15,8	32,6	15,7	32,3	15,4
5	33	16	32,8	15,9	32,7	15,8	32,6	15,8	32,5	15,7
6	33	16	32,8	15,8	32,7	15,7	32,6	15,7	32,4	15,5
7	33	16	32,9	15,8	32,7	15,7	32,4	15,7	32,4	15,6
8	33	16	32,6	15,8	32,5	15,7	32,4	15,7	32,3	15,6
9	33	16	32,9	15,9	32,7	15,8	32,6	15,7	32,5	15,6
10	33	16	32,5	15,8	32,4	15,7	32,3	15,6	32,2	15,5
11	33	16	32,7	15,8	32,6	15,7	32,6	15,6	32,3	15,6
12	33	16	32,8	15,9	32,7	15,8	32,6	15,7	32,5	15,7
13	33	16	32,6	15,7	32,5	15,6	32,4	15,5	32,3	15,5
14	33	16	32,9	16	32,7	16	32,5	15,8	32,4	15,8
15	33	16	32,8	15,9	32,7	15,8	32,6	15,7	32,5	15,7
16	33	16	32,9	15,9	32,8	15,8	32,7	15,7	32,5	15,7
x	33.00	16.00	32.76	15.86	32.63	15.78	32.50	15.69	32.36	15.61
sd	0.00	0.00	0.15	0.08	0.13	0.12	0.12	0.08	0.11	0.10

Control										
1	33	16	32,8	15,8	32,7	15,8	32,6	15,7	32,6	15,7
2	33	16	32,9	16	32,8	15,9	32,7	15,8	32,7	15,8
3	33	16	33	16	32,9	15,9	32,9	15,9	32,8	15,8
4	33	16	32,9	15,9	32,8	15,8	32,7	15,7	32,6	15,6
5	33	16	32,8	15,8	32,7	15,7	32,6	15,7	32,6	15,7
6	33	16	32,8	15,8	32,7	15,8	32,7	15,8	32,6	15,7
7	33	16	32,9	16	32,8	15,9	32,8	15,8	32,7	15,8
8	33	16	33	16	32,9	15,9	32,8	15,9	32,8	15,9
9	33	16	32,9	15,9	32,8	15,9	32,7	15,8	32,6	15,8
10	33	16	32,8	15,8	32,7	15,8	32,6	15,7	32,6	15,7
11	33	16	32,9	16	32,8	15,9	32,7	15,8	32,6	15,7
12	33	16	32,9	15,9	32,8	15,8	32,7	15,7	32,6	15,6
13	33	16	32,8	15,9	32,7	15,9	32,6	15,8	32,6	15,8
14	33	16	32,9	16	32,8	15,9	32,7	15,9	32,7	15,9
15	33	16	33	16	32,9	15,9	32,7	15,8	32,7	15,8
16	33	16	32,8	15,8	32,7	15,8	32,6	15,7	32,6	15,6
x	33.00	16.00	32.88	15.91	32.78	15.85	32.69	15.78	32.65	15.74
sd	0.00	0.00	0.07	0.08	0.07	0.06	0.08	0.07	0.07	0.09

Description: For D shows the dimension, T shows the height, x shows the average value and sd show the standard deviation.Tables 1 and 2 show that the results of dimensional stability in each group experienced a change. Still, those who experienced more changes in dimensional stability occurred in the group with the addition of 2% TSP.

Table 2. Dimensional stability volume calculation results

Sample	0 minute (mm^3)	5 minute (mm^3)	10 minute (mm^3)	15 minute (mm^3)	20 minute (mm^3)
1	828,96	828,96	821,424	806,195	793,697
2	828,96	826,448	821,424	803,714	793,697
3	828,96	806,195	798,627	791,091	791,091
4	828,96	816,290	808,675	803,557	780,949
5	828,96	818,786	811,156	808,675	801,092
6	828,96	813,636	806,022	803,557	788,454
7	828,96	816,117	806,022	798,627	793,540
8	828,96	808,675	801,092	798,627	791,091
9	828,96	821,282	811,156	803,557	795,99
10	828,96	806,195	798,627	791,091	783,587
11	828,96	811,156	803,557	798,439	791,091
12	828,96	818,786	811,156	803,557	801,092
13	828,96	803,557	795,99	788,454	786,020
14	828,96	826,448	821,424	806,195	793,540
15	828,96	818,786	811,156	803,557	801,092
16	828,96	821,282	813,636	806,022	801,092
x	828,96	816,41	808,82	800,93	792,94
sd	0,00	7,71	8,15	6,05	6,25

Table2. . Dimensional stability volume calculation results

Control	0 minute (mm^3)	5 minute (mm^3)	10 minute (mm^3)	15 minute (mm^3)	20 minute (mm^3)
1	828,96	813,636	811,156	803,557	803,557
2	828,96	826,448	818,786	811,156	811,156
3	828,96	828,96	821,282	821,282	813,636
4	828,96	821,282	813,636	806,022	798,439
5	828,96	813,636	806,022	803,557	803,557
6	828,96	813,636	811,156	811,156	803,557
7	828,96	826,448	818,786	813,636	811,156
8	828,96	828,96	821,282	818,786	818,786
9	828,96	826,448	818,786	811,156	803,557
10	828,96	813,636	811,156	803,557	803,557
11	828,96	826,448	818,786	811,156	803,557
12	828,96	821,282	813,636	806,022	798,439
13	828,96	818,786	816,290	803,557	803,557
14	828,96	826,448	818,786	816,290	816,290
15	828,96	828,96	821,282	811,156	811,156
16	828,96	813,636	811,156	803,557	798,439
x	828.96	821.79	815.74	809.72	806.39
sd	0.00	6.34	4.66	5.78	1.60

Description: x shows the average value and sd shows the standard deviation.

Data analysis

The normality test of numerical data is tested using the *Kolmogorov Smirnov test* if the amount of data is > 50, and the *alternative is the Shapiro Wilks* test. If the amount of data is <50, that is the measurement of dimensions and height measurements at minute 0 to minute 20 for the treatment and control groups.

Table 3. Normality and Homogeneity Test

	Normality test		Homogeneity Test	
	P-Value	Interpretation	P-Value	Interpretation
No TSP 2%	0.274	Normal		
With 2% TSP	0.059	Normal	0.063	Homogeneous

Table 3 shows that the dimensional stability data is normally distributed (p>0.05) in each sample group. The homogeneity test was obtained (p>0.05), indicating homogeneous data. Thus, the analysis used a parametric test using an unpaired t-test.

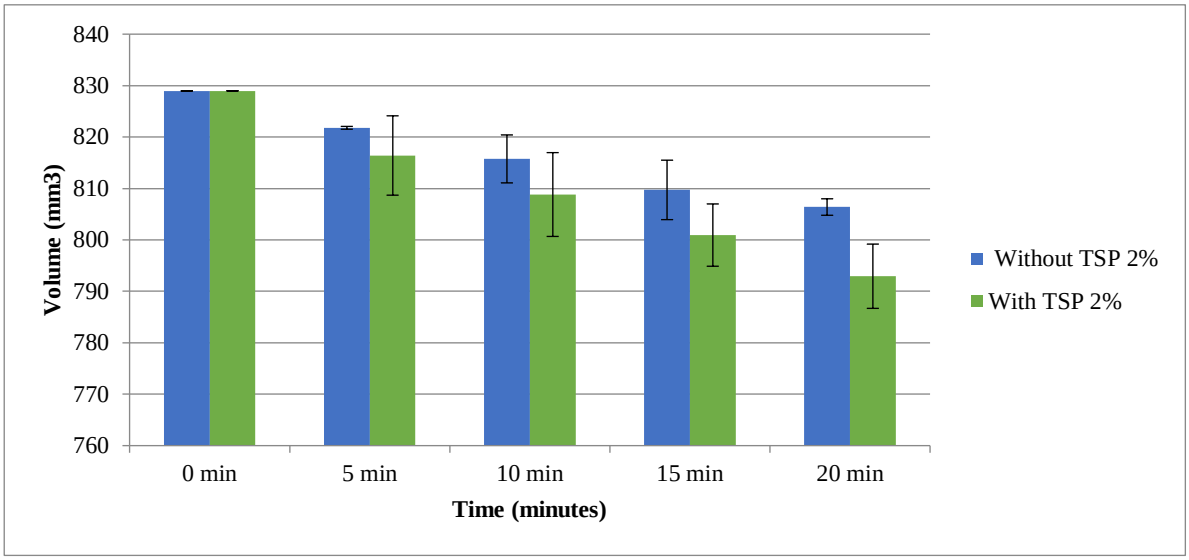

Figure 1 Graph of dimensional stability results with and without TSP.

Figure 1 shows that the observation of dimensional stability with and without the addition of 2% TSP in the alginate impression material experienced a change. Still, there was a minor change in the group without the addition of 2% TSP (control group) compared to the group with the addition of 2% TSP (treatment group). To find out whether there is an effect with and without the addition of 2% TSP on the dimensional stability of the impression material after hardening, it was tested with *unpaired t.*

Furthermore, the results of the statistical comparison of the two groups, where the results of the t-test test show that the probability value (p-value) between the two groups is 0.00 because the p-value <0.05, namely (0.00<0.05), then there is a difference in dimensional stability between without the addition of 2% TSP and with the addition of 2% TSP which can be seen in table 4.

Table. 4 Unpaired T-Test

Group	N	x	± SD	T	p
With 2% TSP	16	808.82	± 8.153		
				2.950	0.000
No TSP 2%	16	815.75	± 4.663		

In table 4, the p-value between the two groups was $p<0.05$, this indicates that there is a significant difference in dimensional stability between the alginate group given TSP 2% and the alginate group without TSP 2%, the mean value of the dimensions of the alginate group that was given TSP given a TSP of 2%, which is 808.82 ± 8.153. It is lower than the group without adding 2% TSP with dimensions of 815.75 ± 4,663. So it can be concluded that the group was given TSP 2% dimensional stability was lower than the group without adding TSP 2%.

DISCUSSION

This study aims to compare the dimensional stability of alginate impression material with 2% TSP added with 2% TSP not added. TSP is a material to slow the setting reaction. When the TSP manipulation changes its shape into a gel form, the TSP plays a role in holding the dough so it doesn't turn into a solid, so the gelation process becomes slower. In alginate impression materials, dimensional changes can occur during the gelatin process in the presence of stress applied or on the impression material during mold takes.

According to Glickman, the factors that influence the solubility of alginate well are temperature, concentration, polymer size and water solvent as physical factors. The number of retarder influences alginate setting time added, normal type alginate *setting time* reaches a gel form within 3 to 4 minutes. The printout can be good if the accuracy is guaranteed and does not change dimensions. Changes in the dimensions of alginate are influenced by various factors, namely the pressure received by the gel on the printing spoon during the gelation process, the imbibition process, syneresis, the type and nature of the impression material used, printing technique, and the proportion of the mixture of impression materials.

Changes in chemical reactions in the alginate impression material can cause changes in the shape or dimensions of the impression so that it is easy to expand, which can cause inaccuracies in the alginate impression. Therefore, the dimensional stability of the alginate impression is essential for the success of the subsequent mold modelling. The accuracy and dimensional stability of alginate are essential for the overall success of the impression. Changes in the impression dimensions can occur due to shrinkage and changes in chemical reactions so that they can affect the physical characteristics of the alginate impression material.

Table 1 shows that there are

significant differences in each group with the addition of 2% TSP and without the addition of 2% TSP. According to Walker, the time delay for filling the alginate prints is 30 minutes because there will be a change in dimensions if it is done afterwards. The results of this study showed that the dimensional stability was lower in the group with the addition of 2% TSP.

Figure 1 shows that the results of dimensional stability at minute 0 of each sample did not experience a change in dimensions. At minute 5, minute 10, minute 15 and minute 20 printed material with the addition of TSP, 2% experienced the shift in dimensional stability was more than the change in dimensional stability in the control group. With the use of alginate for dental students in the preclinical stage and the addition of TSP as a retarding agent or retarder, several factors can control the *setting time* by manipulating the ratio of water and powder but are at risk of being swallowed during printing.

CONCLUSION

Based on the results and discussion, it can be concluded that the value between the two groups is $p<0.05$. It indicates a difference in dimensional stability between alginate with 2% TSP added and alginate without 2% TSP added. The alginate impression material with the addition of 2% TSP experienced more dimensional changes, so the alginate group's dimensional stability with 2% TSP was lower.

SUGGESTIONS

Based on the research that has been done, some suggestions can be given for further research so that further research is expected to be better, namely as follows:

1. Further research can use alginate impression materials with different *setting* times.
2. Future research can examine the measurement time of dimensional stability for longer.

ACKNOWLEDGEMENT

We want to express our gratitude to the professionals who have assisted in the research and preparation of papers, namely the supervisors and examiners of the Faculty of Dentistry, Universitas Jenderal Achmad Yani.

REFERENCES

1. Anusavice KJ. Philips buku ajar ilmu bahan kedokteran gigi. Edisi 10. Jakarta: EGC, 2003. Hal.105, 107-108.
2. Erungan AC. Modifikasi pati ubi kayu (Manihot Utilisima) dengan cara hidrolisis menggunakan HCl dan a –

Amilase. Tesis, Pasca Sarjana KPK, IPB – UNSTRAT Manado, 1992: 21–49.

3. Zilda DS. Eksplorari sejumlah isolat Bacillus Sp. lokal penghasil silodestrin glikosil transferase pada substrat pati singkong. Tesis, Pascasarjana, Institut Pertanian Bogor, Indonesia, 1998: 7–6.
4. McCabe JF and Walls A. Applied Dental Material Nine Edition. USA: Blackwell publishing; 2008. p. 137-154.
5. Arinawati DY., Triawan A. Uji Temperatur Air Pencampur Terhadap Setting Time Bahan Cetak Kulit Buah Manggis (Garcinia Mangostana). Progam Pendidikan Kedokteran Gigi UMY. 2012; 1(1): 55-61.
6. Greig V, Craig's Restorative Dental Materials 11thed, Mosby, Toronto, 2003: 330 – 346.
7. Graig V, Craig's. Restorative Dental Materials. 12th ed, St. Louis, Missousi, 2006: 333.
8. Craig RG, Powers JM. Restorative dental materials 11th ed. St Louis: CV Mosby Co.; 2002. p. 332.
9. Bhat VS, Shetty MS, Shenoy KK. Infection control in the prosthodontic laboratory. Journal Indian Prosthodont Society. 2007. p. 62-5.
10. Annusavice KJ. Phillips' science of dental materials 11th ed. St. Louis: Elsevier; 2003. p. 239-248
11. Bhat, Nandish S, Science of dental materials 2nd ed. New Delhi: CBS Publisher & Distributor Pvt. Ltd., 2006. p. 304-321
12. O'Brien WJ. Dental materials and their selection 3rd ed. Chicago: Quintessence; 2002. p. 96-99.
13. Walyanis MF, Pengaruh Penambahan Trisodium Fosfat Sebagai Retarder Terhadap Setting Time Bahan Cetak Hidrokoloid Ireversibel. Cimahi: Fakultas Kedokteran Universitas Jenderal Achmad Yani. 2017.
14. Shillingburg HT, Sather DA,Wilson E, Cain Jr.Mitchell DL, Blanco IJ,Kessler JC, Fundamentals of Fixed Prosthodontics, 4th ed. Chicago: Quintessence Publishing 2012.
15. Zarb G, Hobkirk JA Eckert S, Jacob RF. Prostodontic Treatment for Endotolous Patient. 13th ed. St. Louis: Mosby 2013
16. Vidyashree Nandini, Vijay Venkatesh, Chandrasekhran Nair. Alginate Impression; A Parspeective, Supplement to J Consev Dent.2008 p.37-41
17. Anusavice KJ. Philip's science of dental materials. 11th Edition. St Louis, Missouri: Saunders, 2003.p.242.
18. Anwar A, UL Qader SA, Raiz A, Iqbal S, Azhar A. Calcium alginate: a support material for immobilization of

proteases from newly isolated strain of Bacillus subtilis KIGBE-HAS. W orldAppl. Sci. J. 2009; 7(10): 1281.

19. Craigs, John M. Powers, Ronald L. Sakaguchi. Restorative Dental Material. Twelfth Edition. USA: Mosby. 2006.
20. Philips, RW. Science of Dental Material. 11th ed. St. Louis, Missousi, WB. Saunder's Company, 2003: 239.
21. Anusavice KJ. Philips' science of dental materials.12th ed.Missouri: Elsevier, 2013: 172.
22. Scheller, Sheridan C. Basic guide to dental materials. India: Wiley Blackwell, 2010: 189-190.
23. Van Noort, R. Introduction to dental materials, 3th edn, Mosby Elsevier, Philadelphia. 2007. p. 142-144
24. Anwar A, UL Qader SA, Raiz A, Iqbal S, Azhar A. Calcium alginate: a support material for immobilization of proteases from newly isolated strain of Bacillus subtilis KIGBE-HAS. W orldAppl. Sci. J. 2009; 7(10): 1281.
25. Runnells RD, Saxon BA, Whisenant BK. The presence and identification of organisms transmitted to dental laboratories. J Prosthet Dent.1990; vol 64: 235.
26. M Darvell, BW. Materials Science for Dentistry. 6 th ed. Hong Kong, 2000:158-161.
27. Panza, 2005. Evaluation of Dementional Stability of Impression Materials Immersed in Desinfectant Solution Using a Tray, Revista Odonto Ciencia. p. 319-323.
28. Paramita VN, Rachmadi P, Arya IW. Stabilitas dimensi hasil cetakan alginat setelah dilakukan penyemprotan infusa daun sirih merah (piper crocatum ruiz & pav) 50% sebagai desinfektan. Jurnal Dentino Kedokteran Gigi 2014: 74-8
29. Badan Pusat Statistika. Statistik Perdagangan Luar Negeri Indonesia. vol. I. BPS RI., Jakarta 2018.
30. Sheridan, C Scheller. Basic guide to dental materials. 1ST Edition. West Sussex: Wiley-blackwell, 2010. P.184.
31. Mrzezo in Dental Nursing and Assisting. Dental materials equipment. https://pocketdentistry.com/19-dental-materials equipment/. Jan 8, 2015 [acceesed October 21th 2020]
32. Jeff Fleisher. Caliper Comparison: Fraction Dial vs. Digital. https://www.highlandwoodworking.com /woodworkingtips1703mar/toolreview/ woodworking-cliper-comparison-tool-review.html. Mar 2017 [accesed October 21th 2020.