Dental Journal
Majalah Kedokteran Gigi
Vol. 42. No. 3 July–September 2009

Research Report

Storage duration effect on deformation recovery of repacked alginates

Siti Sunarintyas and **Dyah Irnawati**
Department of Dental Biomaterials
Faculty of Dentistry, Gadjah Mada University
Yogyakarta - Indonesia

ABSTRACT

Background: *Manufacturers supply alginate impression materials as a powder that is packaged in bulk and in individual container. Some Indonesian dental suppliers often repackage the bulk alginate into individual plastic packages which are not tied tightly and stored in the display room without air conditioner. It is known that critical factors to the shelf life of alginate includer avoidance of moisture contamination which may lead to premature setting of the alginate and avoidance of high temperature which may cause depolymerization of the alginate.* ***Purpose:*** *The aim of this study was to determine storage duration effect of repacked alginates on deformation recovery.* ***Methods:*** *Two brands of alginates (Tulip®TU, and Aroma Fine DF III®AF) were repacked into 120 plastic containers. The samples were stored in room condition (temperature 29° C ± 1° C, relative humidity 60% ± 10%) for 1, 2, 3, 4 and 5 weeks. The alginates setting time and recovery from deformation were measured according to the ANSI/ADA specification number 18 (ISO 1563).* ***Result:*** *The results revealed that there was decreased setting time during 5 weeks but there was slight decreased in deformation recovery after 3 weeks storage. The ANOVA showed there was no significant difference of alginates deformation recovery among the storage times ($p > 0.05$).* ***Conclusion:*** *Storage duration of repacked alginates in plastic containers during 5 weeks in room condition do not influence the alginate deformation recovery.*

Key words: *storage time, alginates, deformation recovery*

Correspondence: Siti Sunarintyas, c/o: Bagian Biomaterial Kedokteran Gigi, Fakultas Kedokteran Gigi Universitas Gadjah Mada. Jl. Denta, Sekip Utara, Yogyakarta 55281, Indonesia. E-mail: sunarintyassiti@yahoo.com, Phone/fax no. 062-274-515307.

INTRODUCTION

Alginate is the most widely used dental impression material. The wide use of alginates relates to the ease of mixing and manipulating the material, the flexibility, the accuracy, and the relatively inexpensive comparing to other impression materials.[1] The disadvantages of alginates are that they do not transfer as much surface details to gypsum dies as agar or rubber impressions do, and the storage stability is a critical characteristic for them.[2] The physical, mechanical, and chemical properties of alginates may be affected by the period of time they are stored before use and the conditions under which they are stored.[3]

Alginates are supplied by manufacturers as powder that are packaged in bulk or in individual container. The bulk materials are packaged in a sealed screw-topped plastic container or in a hermetically sealed metal can, such as one used to package coffee. The pre weighed packages are constructed of plastic and metal foil and contain enough material for a single full-arch impression.[4,5]

The bulk alginate is cheaper than the individual manufacturer package. The dental suppliers often repackage the bulk one into individual plastic packages in order to be able to sell more alginates. The consumers tend to buy the repacked one because the cost is lower than the bulk one or the manufacturer pre weighed one.

The repacked alginates are supplied in plastic bags which are tied in their one end. These repacked are not legibly marked with the information of manufacturer's name, initial setting time, storage conditions, expiry date, minimum net mass of the contents, and batch number as the ANSI/ADA specification number 18 recommendation.[6] These repacked were often stored by the dental supplier in their display case for one up to five weeks until all the

alginates are sold. These plastic repacked alginate do not seem to have the property of being tightly closed container to protect the alginate from moisture contamination.

Critical factors to the shelf life of alginate include avoidance of moisture contamination, which may lead to premature setting of the material in the container, and avoidance of high temperature, which may cause depolymerization of the alginate.[7] Alginate powder is unstable in a storage with presence of moisture or in warm temperatures over 23° C. Storaging alginate powder in room temperature of 65° C for 1 month could make the alginate deteriorate and could not be used as impression material as the setting time was faster than usual.[4] Storage of alginate in a tropical country with temperature around 27–30° C and relative humidity of 50–70% without air conditioner for a long time is risky.[8] Storage-dependent deterioration may have detrimental effects on the clinical usefulness of alginate. Since the set alginate is held between the impression tray and the tissue, it is important to know the extent of any recovery from deformation during the removal of the impression from the mouth. The purpose of this study was to determine storage duration effect of repacked alginates on recovery from deformation.

MATERIALS AND METHODS

The materials used in this study were two brands of bulk dental impression material (Tulip® TU, and Aroma Fine DF III® AF), plastic bag, and tap water. The equipments used were analytical balance, measurement glass, rubber bowl and spatula, stopwatch, room thermometer, hygrometer, setting time and recovery from deformation apparatus (as indicated in the ANSI/ADA specification number 18),[6] water bath, and flat glass plate.

Bulk dental impression materials were repacked in plastic bags. The alginates which were packaged in a sealed screw-topped plastic container were opened and weighed of 6.5 gram to be stored in 120 plastic bags. The air in the plastic bag was removed by pressing both of the plastic end sides outward, and then the plastic end was tied. The packages were placed in an opened plastic box and stored in the display case. The samples were stored in room condition (temperature 29° C ± 1° C, relative humidity 60% ± 10%) for 1, 2, 3, 4, and 5 weeks. The alginates recovery from deformation were measured according to the ANSI/ADA specification number 18 (ISO 1563). The control group was alginate without storage.[6]

The deformation measurement needed the initial setting time data of the repacked alginates. The setting time measurement was done by a poly (methyl methacrylate) cylindrical test rod of 10 cm long and 6.35 mm in diameter. The sample ring mould was overfilled with repacked alginate powder and water mixed, then stroke off even with the top of the mould. Immediately thereafter, the end of the test rod was placed into momentary contact with the unset material. The test rod was withdrawn and cleared it off any material left from the contract. The contact and withdrawal steps were repeated at 10 second intervals until the rod was separated cleanly from the material.

The recovery from deformation measurement needed the deformation apparatus: split mould with fixation ring, flat glass plates, water bath and c-clamps. There were two steps in measuring the deformation: the preparation of the test specimen and the measurement procedure. In preparation of the test specimen, the fixation ring was placed on a glass plate and filled it slightly more than one-half full with alginate material mixed in accordance with the manufacturer's instructions. The split mould was pressed into the fixation ring until the bottom of the mould touched the glass plate and alginate extruded above the top of the mould. The second plate was clamped over the mould to force away the excess alginate and to form the upper surface of the specimen. Thirty seconds after the end of mixing, the split mould assembly and its accompanying plates were placed and fixed by a c-clamp in the water bath maintained at 35±1° C. At the initial setting time that had been measured, the assembly was removed from the water bath. After removing the flask, the specimen was separated from the split mould assembly. The flat plate was centered on the top of the specimen. The specimen was placed on the table of the deformation apparatus.

The deformation measurement was done following the criteria in Table 1 (t was the initial setting time obtained). The obtained alginates recovery from deformation data were calculated as a percentage using the following formula:[6]

$$100\ (1- a-b/20)$$

Where 20 was the length of the mould in millimeters. The data were analyzed by two ways analysis of variance (ANOVA).

Table 1. The alginate recovery from deformation measurement

Time	Test procedure
t + 45 s	The spindle of the dial indicator was gently lowered so that it came into contact with the plate on the specimen.
t + 55 s	The dial indicator was read, the value was recorded as reading a, and the spindle was fixed in the up position.
t + 60 s	The specimen was deformed to height of 16 mm±0.1 mm within 1 s and maintained this deformation for 5 s ± 0.5 s, then the deforming force was released.
t + 90 s	The spindle of the dial indicator was gently lowered so that it came into contact with the plate on the specimen.
t + 100 s	The dial indicator was read and the value was recorded as reading b.

RESULT

The average of setting time and recovery from deformation of repacked alginates in various storage duration were shown at Table 2. The results revealed the decreasing in setting time during 5 weeks but slight decreasing in recovery from deformation after 3 weeks storage. The Two-Ways ANOVA (Table 3) showed there was not any significant difference of alginates recovery from deformation among the storage duration ($p > 0.05$). There was a significant difference between brands and also among brand and storage duration ($p < 0.05$).

DISCUSSION

Storage stability or shelf life was a critical property of perishable dental materials. Two major factors that affected the shelf life of alginate impression materials were storage temperature and moisture contamination from ambient air.[9,10]

Table 2 revealed that during 5 weeks storages there was a trend toward a shorter setting time in both of the alginate brands and decreasing in recovery from deformation during 3 weeks storage. Those phenomena may be because of partial spontaneous polymerization of the alginate material in the plastic bags, perhaps prompted by moisture contamination from relative humidity during storage. Repacked bulk alginates by the plastic bags which were tied in their one end did not seem to protect the alginate powder from the environmental humidity. The presence of water in the alginate powder caused a chemical reaction that cross linked the polymer chain, so formed a three-dimensional polymer network structure. As some of the repacked alginate powder had changed into the polymer networks, the setting time measurement of the material became shorter. Research on material containers[11] revealed that aluminum foil package became the best container followed by plastic and paper. Plastic container was recommended as the alternative of aluminum container regarding on its thickness.

The slight decrease in recovery from deformation of the repacked alginates after 3 weeks storage up to 5 weeks storage may be explained by premature polymerization because fewer sites may be available for calcium cross-linking. As the polymer network formed, viscosity increased, resulting in less elasticity and decreasing in recovery from deformation.[12] However, the ANOVA showed that there was not any significant influence of storage duration up to 5 weeks of repacked alginates on recovery from deformation. The recovery from deformation of the alginate was still within the ADA limit of 95%.[6] This finding may indicate that for most clinical cases, this repacked alginate in plastic container with one end tied (not sealed tightly enough) which was stored by dental supplier for 5 weeks remained efficacious to be used, assuming of course, that the ADA limit was not excessively lenient.

Shelf life study on the physical and mechanical properties of an alginate impression material on exposure to various environmental conditions for more than 78 months revealed that there was an increase in strength and working time and a decrease in recovery from deformation at 30 to 50 months: strength and recovery from deformation then remained constant past 6 years, whereas working time and creep compliance decreased. Only the most stressful environmental conditions (heat and humidity) caused spontaneous failure of the material to set.[13] Another shelf study on the storage effect of non aqueous elastomeric impression materials revealed that there were changes in viscosity, working and setting time, elastic recovery, and creep compliance over 72 months storage period.[14]

Table 2. Average of setting time and recovery from deformation of repackaging alginates in various storage duration

Storage duration	TU		AF	
	Setting time (Second)	Recovery from deformation (%)	Setting time (Second)	Recovery from deformation (%)
Control	66.00 ± 2.23	97.93 ± 0.09	78.80 ± 1.09	98.56 ± 0.26
1 week	62.80 ± 0.84	97.95 ± 0.47	76.40 ± 0.55	98.27 ± 0.16
2 weeks	59.80 ± 2.28	97.57 ± 0.72	76.20 ± 4.15	98.60 ± 0.39
3 weeks	48.60 ± 0.55	97.96 ± 0.23	75.20 ± 3.56	98.62 ± 1.09
4 weeks	46.60 ± 0.54	97.73 ± 0.13	73.60 ± 2.07	98.55 ± 0.49
5 weeks	45.60 ± 0.52	97.56 ± 0.19	67.20 ± 0.83	98.29 ± 0.24

TU: Tulip®; AF: Aroma Fine DF III®

Table 3. Result of Two-Ways ANOVA of recovery from deformation of repackaging alginates in various storage duration

Source	Sum of squares	df	Mean square	F	Sig
Brand	4.320	1	4.320	20.039	0.001
Storage duration	1.402	5	0.280	1.301	0.279
Brand*Storage duration	2.979	5	0.596	2.764	0.028
Error	10.347	48	0.216		
Total	576866.810	60			

This recent finding strengthen the above studies as it was proven that 5 weeks storage of repacked alginate in a tropical country did not alter the alginate physical property significantly.

Combination of elevated temperature and moisture has an adverse effect upon the shelf life of the material.[15] Tulip® and Aroma Fine DF III® guaranteed that the alginates were in good quality for 3 years, period provided that the packs were unopened and stored in a cool and dry place.[16,17] Storage of such a perishable material in tropical country with high humidity without air conditioner needed special attention especially in its container and storage periods. Further research on the shelf life of repacked alginates was needed especially on the molecular weight determination to prove the contribution of water from the environment humidity on alginates.

The conclusion of the study revealed that the storage duration of repacked alginates in plastic container during 5 weeks in room condition did not significantly influence alginate recovery from deformation. The alginates recovery from deformation remained within the ADA specification limit.

REFERENCES

1. Craig RG, Powers JM, Wataha JC. Dental materials properties and manipulation. 7th ed. St Louis: Mosby Co; 2000. p. 138–41.
2. Gladwin M, Bagby M. Clinical aspect of dental materials. Philadelphia: Lippincot Williams & Wilkins; 2000. p. 100–1.
3. Craig RG, Powers JM. Restorative dental materials. 11th ed. St Louis: Mosby Co; 2002. p. 330–40.
4. Combe EC. Notes on dental materials. 6th ed. Edinburgh: Churchill Livingstone; 1992. p. 115–25.
5. McCabe JF. Anderson's applied dental materials. 6th ed. New York: Blackwell scientific Publication; 1987. p. 113–5.
6. Council on Dental Materials, Instruments and Equipment, American National Standard/American Dental Association (ANSI/ADA Specification no. 18, Alginate Impression Materials); 1992. p. 1–8.
7. Noort RV. Introduction to dental materials. 1st ed. London: Mosby Co; 1994. p. 162–5.
8. Badan Meteorologi dan Geofisika. Prakiraan cuaca kota propinsi Indonesia. Available at: Http://www.meteo.bmg.go.id/cuacaindo.jsp. Accessed January 27, 2007.
9. Vanable DE, LoPresti LR. Using dental materials. New Jersey: Pearson Prentice Hall; 2004. p. 87–91.
10. Klettke T, Kuppermann B, Ranftl D, Hampe R. Temperature effect on setting of dental impression materials. IADR/AADR/CADR 85th General session and exhibition 2007 March; p. 110.
11. Robi'in. Perbedaan bahan kemasan dan periode simpan dan pengaruhnya terhadap kadar air benih jagung dalam ruang simpan terbuka. Buletin Teknik Pertanian 2007; 1: 7–9.
12. Ellis B, Lamb DJ. The setting characteristics of alginate impression materials. Brit Dent J 1981; 151: 343–6.
13. Hondrum SO, Fernandez Jr. R. Effect of long-term storage on properties of an alginate impression material. J Prosthet Dent 1997; 77: 601–6.
14. Hondrum SO. Changes in properties of non aqueous elastomeric impression materials after storage of components. J Prosthet Dent 2001; 85: 73–81.
15. Ferracane JL. Materials in dentistry principles and applications. 2nd ed. Philadelphia: Lippincot Williams & Wilkins; 2001. p. 173–201.
16. Tulip alginate. Product information on Tulip color switch dust free alginate impression material with color change. Available at: Http://www.cavex.nl/3/3_imp_alg_tul_pic.html. Accessed December 10, 2006.
17. Aroma. Aroma Fine DF III Normal Set. Available at: Http://www.gceurope.com/pid/iii/ifu/g.cAroma_Fine_DFIII_Normal/pdf. Accessed January 18, 2007.