

## **Original Research Article**

### **EFFECT OF THERMOCYCLING ON COLOUR STABILITY OF ALKASITE RESTORATIVE MATERIAL (CENTION N) - AN IN VITRO STUDY**

#### **ABSTRACT**

**Introduction:** Cention N is an alkasite, a resin-based self-curing powder liquid restorative material it is far less expensive unlike composite materials, has fluoride-releasing characteristics, and has a strength comparable to that of amalgam restoration. Colour stability is one of the major and important characteristics in dentistry, dental restoration and esthetics. The main aim of the study is to evaluate the colour stability of alkasite restorative material (Cention N) before and after thermocycling.

#### **Materials and Methods:**

Eight disc shaped samples of alkasite restorative material Cention N with 2 mm of thickness were prepared using a customised mould. After the preparation of discs, they are numbered accordingly and color stability was measured by using Vita easy shade advance spectrophotometer, the pre colour value was taken. L, a and b values were obtained prior to thermocycling. The samples were placed in the thermocycler and thermocycling was done where 1000 cycles was done equating 6 months. The thermocycler that was used here is TC 4 SD Mechatronik. The colour stability value after thermocycling was again determined using the vita easy shade spectrophotometer. Control group samples were not subjected to thermocycling. The colour stability values prior and after thermocycling were obtained and the values were tabulated.

**Result:** Thermocycled cention N samples had low delta E values when compared to non thermocycled samples. Statistical analyses were done using spss software and independent t test was done. The P value is found to be 0.616 that is greater than that of 0.05 showing that it is statistically insignificant.

**Conclusion:** From this research we can conclude that thermocycling has an effect on the colour stability of the cention N material. Thermocycled cention N samples had better color stability when compared to non thermocycled cention N samples.

**Keywords:** Restorative material, Cention N, Colour stability, Thermocycling, Spectrophotometer, Innovative measurement

**Running title :** Effect of thermocycling on colour stability of cention N

## **INTRODUCTION:**

Composite materials are widely used these days and more than 90% of the restoration is done by composite resin materials(1). They are the synthetic material that combined with dispersion of glass, mineral or resin filler particles(2). The traditional composite are large particles of ground amorphous silica and quartz. Composite can be classified as chemically activated resin and photochemically activated resin. In dentistry, aesthetics plays a major role(3). Many materials have come into dentistry for restoration material which have a good esthetic such that of the natural tooth and compressive stability of that of amalgam restoration. Cention N is one such new product which is an alkasite, a resin-based self-curing powder liquid restorative material and it has the fluoride releasing ability which helps in the release of the hydroxyapatite in the tooth and helps in in the repair and remineralisation of the enamel, thus helping to prevent tooth sensitivity(4). Cention-N is a recently introduced bulk-fill restorative material which is both self-cure and light-cure, thus making the curing depth theoretically unlimited. It exhibits a sustained release of fluoride and hydroxyl ion in various conditions (below critical pH) as claimed by the manufacturers.

Thermocycling is also known as thermal cycling, a process in which the required substance is processed through a number of cycles between 2 extreme temperatures simultaneously(5). Thermocycling is a test done to evaluate the product reliability and strength. Thermocycling requires a medium to maintain a constant temperature in a water bath. There are specific standards, immersion times and temperature to establish the test. It is mainly based on the diffusion of heat and also moisture to test the specimen according to the criteria provided (4).

Thermocycling is most effective in the aging process(6). The cycle is influenced by the flow of alternate high and low temperatures (7).

Colour stability is a desirable property of resin based restorative materials. Composite resins, however, contain a variety of organic compounds which may be responsible singly or collectively for internal discoloration. Such compounds include amines and benzoyl peroxide, which are necessary for the polymerization reaction, and hydroquinone monomethyl ether, which is an inhibitor. Several studies have suggested that self cure composites discolour to a greater extent than light-cure materials(8). This research fulfills the colour stability of Cention N as it is a new product in the field and no previous research has been done on the effects of thermocycling on this product Cention N. Our team has extensive knowledge and research experience that has translated into high quality publications (9–18),(19–22),(23–27),(28). The main aim of the study is to evaluate the colour stability of alkasite restorative material (Cention N) before and after thermocycling.

## **MATERIALS AND METHODS:**

### **Sample preparation:**

The study was done at White Lab, Saveetha Dental College and Hospital, Chennai, India. For this study, cention N restorative material was taken. Eight disc shaped samples of alkasite restorative material Cention N with 2 mm of thickness were prepared using a customised mould. 4 samples in test and 4 samples in control group.

### **Pre thermocycling color stability testing:**

After the preparation of discs, they are numbered accordingly and color stability was measured by using Vita easy shade advance spectrophotometer, the pre colour value was taken. L, a and b values were obtained prior to thermocycling.

### **Thermocycling:**

The samples were placed in the thermocycler and thermocycling was done where 1000 cycles was done equating 6 months. The temperature was 10°C when cold and 60°C when hot. The dwelling time was found to be 30 seconds and the draining time was 10 seconds. The

thermocycler that was used here is CS 4.2-SD Mechatronik. Control group samples were not subjected to thermocycling.

**Post thermocycling color stability testing:**

The colour stability value after thermocycling was again determined using the vita easy shade spectrophotometer. The colour stability values prior and after thermocycling were obtained and the values were tabulated, with the tabulated values descriptive analysis such as “t test” was performed and the result of the analysis test carried out was depicted in the form of a bar graph.

**RESULTS AND DISCUSSION:**

**Table 1: Table showing L, A, B values before placing sample in thermocycling**

<b>Samples</b>	<b>L value</b>	<b>a value</b>	<b>b value</b>
<b>1</b>	<b>76.2</b>	<b>1.4</b>	<b>14.6</b>
<b>2</b>	<b>77.1</b>	<b>1.1</b>	<b>13.9</b>
<b>3</b>	<b>78.6</b>	<b>1.3</b>	<b>14.6</b>
<b>4</b>	<b>75.1</b>	<b>0.9</b>	<b>12.5</b>
<b>5</b>	<b>69.1</b>	<b>1.0</b>	<b>12.9</b>
<b>6</b>	<b>73.4</b>	<b>1.0</b>	<b>12.2</b>
<b>7</b>	<b>76.9</b>	<b>1.4</b>	<b>14.0</b>
<b>8</b>	<b>76.1</b>	<b>1.5</b>	<b>15.2</b>

**Table 2: Table showing post LAB values after removing samples from thermocycling**

<b>Samples</b>	<b>L value</b>	<b>a value</b>	<b>b value</b>
<b>1</b>	<b>61.1</b>	<b>2.0</b>	<b>13.3</b>
<b>2</b>	<b>69.0</b>	<b>2.0</b>	<b>13.7</b>
<b>3</b>	<b>58.0</b>	<b>2.1</b>	<b>12.5</b>
<b>4</b>	<b>62.0</b>	<b>1.8</b>	<b>12.3</b>
<b>5</b>	<b>57.4</b>	<b>1.4</b>	<b>11.6</b>
<b>6</b>	<b>55.8</b>	<b>1.6</b>	<b>10.1</b>
<b>7</b>	<b>66.7</b>	<b>1.6</b>	<b>12.3</b>
<b>8</b>	<b>67.8</b>	<b>1.9</b>	<b>.1</b>

**Table 3: Table showing delta E value of each sample**

<b>Samples</b>	<b>Delta E value</b>
<b>1</b>	<b>15.59</b>
<b>2</b>	<b>8.15</b>
<b>3</b>	<b>20.72</b>
<b>4</b>	<b>13.13</b>
<b>5</b>	<b>11.78</b>
<b>6</b>	<b>17.74</b>
<b>7</b>	<b>10.34</b>

<b>8</b>	<b>8.80</b>
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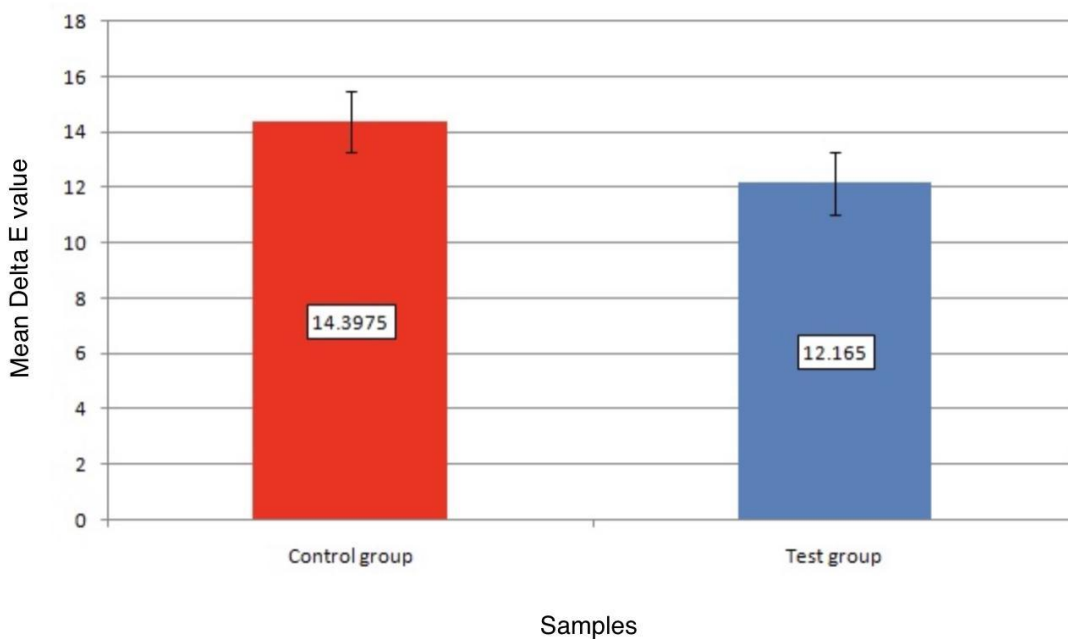
**Table 4:** table representing the mean, standard deviations of the control and test groups obtained from pre-thermocycling and post-thermocycling values.

<b>Group</b>	<b>N</b>	<b>Mean</b>	<b>Std. deviation</b>	<b>P value</b>
<b>Control</b>	<b>4</b>	<b>14.3975</b>	<b>5.22921</b>	<b>0.616</b>
<b>Test</b>	<b>4</b>	<b>12.1650</b>	<b>3.91078</b>	

In Table 1 it shows the pre values of L,A and B of samples before placing it for thermocycling. The L,A and B value for sample 1 is 76.2, 1.4 ,14.6 and for sample 2 it is 77.1, 1.1, 13.6. The L,A and B values for sample 3 are 78.6, 1.3, 14.6 and for sample 4 it is 75.1, 0.9, 12.5 , for sample 5 the values are 69.1, 1.0, 12.9 and for sample 6 the values are 73.4, 1, 12.2. The L,A and B value for sample 7 is 76.9, 1.4, 14.0 and for sample 8 the values are 76.1, 1.5, 15.2. In Table 2 it shows the post values of L,A and B of samples after placing it for thermocycling. The L,A and B value for sample 1 is 61.1, 2, 13.3 and for sample 2 it is 69, 2, 13.7 . The L,A and B values for sample 3 are 58.0,2.1, 12.5 and for sample 4 it is 62.0, 1.8, 12.3 , for sample 5 the values are 57.4, 1.4, 11.6 and for sample 6 the values are 55.8, 1.6 , 10.1. The L,A and B value for sample 7 is 66.7,1.6 ,12.3 and for sample 8 the values are 67.8, 1.9, 0.1.

In Table 3 it shows the delta E value of each sample. Sample 1 is the delta E value is 15.59 and for sample 2 it is 8.15 and for sample 3 it is 20.72, sample four it is 13.13 and for 5th sample it is 11.78 and for sixth it is 17.74. Seventh sample the delta E value is 10.34 and for the eight value it is 8.80. Figure 1 shows the mean value of delta E of the control group and test group of CENTION N restorative material. From Table 4 the group statistic values were obtained via independent sample t test where the mean, standard deviations, and statistical significance were

determined. The mean values of pre-thermocycling(control group) and pos-thermocycling(test group) for the control group was found to be 14.39 while the test group was found to be 12.16 and the standard deviation was 5.22921 and 3.91078 and the  $p$  value is 0.616 which is greater than 0.05 showing the results are insignificant.



**FIGURE 1:** This graph shows the delta E values of the CENTION N restorative material. The X-axis represents the control group and test group of cention N samples and the Y axis shows the delta E value. Test group samples were more color stable. The P value is found to be .616 that is greater than that of 0.05 showing that it is insignificant.

Cention N is an alkasite, a resin-based self-curing powder liquid restorative material it's far less expensive unlike composite materials, has fluoride-releasing characteristics, and has a strength comparable to that of amalgam restoration. Thermocycling is one of the processes that is involved in calculating many parameters such as aging, colour etc. This study mainly focused on the colour of the composite before and after thermocycling. A study was conducted by A Arikan et al on pink and white acetal resin with one conventional polyresin to study the colour stability of the resin material when subjected to thermocycling. From the results obtained the mean value of the materials were obtained. Conventional poly resin showed 0.69 and the white acetal resin

showed the mean to be 0.74 and the pink acetal resin showed 0.77 on long exposure to 100 hours of simultaneous thermocycling (29). A study proposed by Arregui et al explained the colour stability of 2 self adhesive composite. The delta E values were recorded after submerging the composites for 10 days. It was concluded that water had no effect on the colour change (30).

Another in vitro study was done by Bhattacharya on the effects of thermocycling on the colour stability of esthetic materials. In this study the author has compared the colour stability of cention N , Fuji IX GP Extra, and Fuji IX GP after thermocycling. The color parameters of the discs were measured using a spectrophotometer . The materials were divided into three groups and The changes in the colour of the material as expressed in  $\Delta E$  were found to be  $1.01 \pm 0.79$  and  $2.15 \pm 0.71$  at the end 250 cycles and 500 cycles respectively in Group I. In Group II,  $\Delta E$  values after 250 cycles and 500 cycles were found to be  $1.36 \pm 0.29$  and  $3.60 \pm 0.84$  respectively. Group III, on the other hand, showed  $\Delta E$  values of  $1.32 \pm 0.50$  and  $2.55 \pm 0.62$  at the end of 250 cycles and 500 cycles of thermocycling. From the result he concluded that Cention N exhibited better color stability compared to Glass ionomer cements(31).

The study on the colour stability comparison of the flowable composite was done by YK Lee et al, where the 5 samples of each composite were taken and it was subjected to artificial aging such as thermocycling to observe the colour change. It was noted that flowable composites showed maximum colour change(32). A study proposed by Maria et al explained the colour stability of 2 self adhesive composite and 4 methacrylate-based composites before and after storage in water. The delta E values were recorded after submerging the composites for 30 days(33). The present study however puts forth limitations such as restricted sample size and only one type of restorative material was used. Further advanced research about the thermocycling effects on different types of restorative materials can be conducted.

## **CONCLUSION:**

From this research we can conclude that thermocycling has an effect on the colour stability of the cention N material. Thermocycled cention N samples had better color stability when compared to non thermocycled cention N samples.

## REFERENCES:

1. Zimmerli B, Strub M, Jeger F, Stadler O, Lussi A. Composite materials: composition, properties and clinical applications. A literature review. *Schweiz Monatsschr Zahnmed* [Internet]. 2010;120(11):972–86. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/21243545>
2. Özel Bektas Ö, Eren D, Herguner Siso S, Akin GE. Effect of thermocycling on the bond strength of composite resin to bur and laser treated composite resin. *Lasers Med Sci* [Internet]. 2012 Jul;27(4):723–8. Available from: <http://dx.doi.org/10.1007/s10103-011-0958-2>
3. Miletic V. *Dental Composite Materials for Direct Restorations* [Internet]. Springer; 2017. 319 p. Available from: <https://play.google.com/store/books/details?id=cktADwAAQBAJ>
4. Ernst C-P, Canbek K, Euler T, Willershausen B. In vivo validation of the historical in vitro thermocycling temperature range for dental materials testing. *Clin Oral Investig* [Internet]. 2004 Sep;8(3):130–8. Available from: <http://dx.doi.org/10.1007/s00784-004-0267-2>
5. El-Araby AM, Talic YF. The effect of thermocycling on the adhesion of self-etching adhesives on dental enamel and dentin. *J Contemp Dent Pract* [Internet]. 2007 Feb 1;8(2):17–24. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/17277823>
6. Peumans M, Hikita K, De Munck J, Van Landuyt K, Poitevin A, Lambrechts P, et al. Bond durability of composite luting agents to ceramic when exposed to long-term thermocycling. *Oper Dent* [Internet]. 2007 Jul;32(4):372–9. Available from: <http://dx.doi.org/10.2341/06-106>
7. Kiomarsi N, Saburian P, Chiniforush N, Karazifard M-J, Hashemikamangar S-S. Effect of

- thermocycling and surface treatment on repair bond strength of composite. *J Clin Exp Dent* [Internet]. 2017 Aug;9(8):e945–51. Available from: <http://dx.doi.org/10.4317/jced.53721>
8. Lee Y-K. Comparison of CIELAB DeltaE(\*) and CIEDE2000 color-differences after polymerization and thermocycling of resin composites. *Dent Mater* [Internet]. 2005 Jul;21(7):678–82. Available from: <http://dx.doi.org/10.1016/j.dental.2004.09.005>
  9. Muthukrishnan L. Imminent antimicrobial bioink deploying cellulose, alginate, EPS and synthetic polymers for 3D bioprinting of tissue constructs. *Carbohydr Polym* [Internet]. 2021 May 15;260:117774. Available from: <http://dx.doi.org/10.1016/j.carbpol.2021.117774>
  10. PradeepKumar AR, Shemesh H, Nivedhitha MS, Hashir MMJ, Arockiam S, Uma Maheswari TN, et al. Diagnosis of Vertical Root Fractures by Cone-beam Computed Tomography in Root-filled Teeth with Confirmation by Direct Visualization: A Systematic Review and Meta-Analysis. *J Endod* [Internet]. 2021 Aug;47(8):1198–214. Available from: <http://dx.doi.org/10.1016/j.joen.2021.04.022>
  11. Chakraborty T, Jamal RF, Battineni G, Teja KV, Marto CM, Spagnuolo G. A Review of Prolonged Post-COVID-19 Symptoms and Their Implications on Dental Management. *Int J Environ Res Public Health* [Internet]. 2021 May 12;18(10). Available from: <http://dx.doi.org/10.3390/ijerph18105131>
  12. Muthukrishnan L. Nanotechnology for cleaner leather production: a review. *Environ Chem Lett* [Internet]. 2021 Jun 1;19(3):2527–49. Available from: <https://doi.org/10.1007/s10311-020-01172-w>
  13. Teja KV, Ramesh S. Is a filled lateral canal - A sign of superiority? *J Dent Sci* [Internet]. 2020 Dec;15(4):562–3. Available from: <http://dx.doi.org/10.1016/j.jds.2020.02.009>
  14. Narendran K, Jayalakshmi, Ms N, Sarvanan A, Ganesan S A, Sukumar E. Synthesis, characterization, free radical scavenging and cytotoxic activities of phenylvilangin, a substituted dimer of embelin. *ijps* [Internet]. 2020;82(5). Available from: <https://www.ijpsonline.com/articles/synthesis-characterization-free-radical-scavenging-and-cytotoxic-activities-of-phenylvilangin-a-substituted-dimer-of-embelin-4041.html>

15. Reddy P, Krithikadatta J, Srinivasan V, Raghu S, Velumurugan N. Dental Caries Profile and Associated Risk Factors Among Adolescent School Children in an Urban South-Indian City. *Oral Health Prev Dent* [Internet]. 2020 Apr 1;18(1):379–86. Available from: <http://dx.doi.org/10.3290/j.ohpd.a43368>
16. Sawant K, Pawar AM, Banga KS, Machado R, Karobari MI, Marya A, et al. Dentinal Microcracks after Root Canal Instrumentation Using Instruments Manufactured with Different NiTi Alloys and the SAF System: A Systematic Review. *NATO Adv Sci Inst Ser E Appl Sci* [Internet]. 2021 May 28 [cited 2021 Aug 5];11(11):4984. Available from: <https://www.mdpi.com/2076-3417/11/11/4984>
17. Bhavikatti SK, Karobari MI, Zainuddin SLA, Marya A, Nadaf SJ, Sawant VJ, et al. Investigating the Antioxidant and Cytocompatibility of *Mimusops elengi* Linn Extract over Human Gingival Fibroblast Cells. *Int J Environ Res Public Health* [Internet]. 2021 Jul 4;18(13). Available from: <http://dx.doi.org/10.3390/ijerph18137162>
18. Karobari MI, Basheer SN, Sayed FR, Shaikh S, Agwan MAS, Marya A, et al. An In Vitro Stereomicroscopic Evaluation of Bioactivity between Neo MTA Plus, Pro Root MTA, BIODENTINE & Glass Ionomer Cement Using Dye Penetration Method. *Materials* [Internet]. 2021 Jun 8;14(12). Available from: <http://dx.doi.org/10.3390/ma14123159>
19. Rohit Singh T, Ezhilarasan D. Ethanolic Extract of *Lagerstroemia Speciosa* (L.) Pers., Induces Apoptosis and Cell Cycle Arrest in HepG2 Cells. *Nutr Cancer* [Internet]. 2020;72(1):146–56. Available from: <http://dx.doi.org/10.1080/01635581.2019.1616780>
20. Ezhilarasan D. MicroRNA interplay between hepatic stellate cell quiescence and activation. *Eur J Pharmacol* [Internet]. 2020 Oct 15;885:173507. Available from: <http://dx.doi.org/10.1016/j.ejphar.2020.173507>
21. Romera A, Peredpaya S, Shparyk Y, Bondarenko I, Mendonça Bariani G, Abdalla KC, et al. Bevacizumab biosimilar BEVZ92 versus reference bevacizumab in combination with FOLFOX or FOLFIRI as first-line treatment for metastatic colorectal cancer: a multicentre, open-label, randomised controlled trial. *Lancet Gastroenterol Hepatol* [Internet]. 2018 Dec;3(12):845–55. Available from: [http://dx.doi.org/10.1016/S2468-1253\(18\)30269-3](http://dx.doi.org/10.1016/S2468-1253(18)30269-3)

22. Raj R K, D E, S R.  $\beta$ -Sitosterol-assisted silver nanoparticles activates Nrf2 and triggers mitochondrial apoptosis via oxidative stress in human hepatocellular cancer cell line. *J Biomed Mater Res A* [Internet]. 2020 Sep;108(9):1899–908. Available from: <http://dx.doi.org/10.1002/jbm.a.36953>
23. Vijayashree Priyadharsini J. In silico validation of the non-antibiotic drugs acetaminophen and ibuprofen as antibacterial agents against red complex pathogens. *J Periodontol* [Internet]. 2019 Dec;90(12):1441–8. Available from: <http://dx.doi.org/10.1002/JPER.18-0673>
24. Priyadharsini JV, Vijayashree Priyadharsini J, Smiline Girija AS, Paramasivam A. In silico analysis of virulence genes in an emerging dental pathogen *A. baumannii* and related species [Internet]. Vol. 94, *Archives of Oral Biology*. 2018. p. 93–8. Available from: <http://dx.doi.org/10.1016/j.archoralbio.2018.07.001>
25. Uma Maheswari TN, Nivedhitha MS, Ramani P. Expression profile of salivary micro RNA-21 and 31 in oral potentially malignant disorders. *Braz Oral Res* [Internet]. 2020 Feb 10;34:e002. Available from: <http://dx.doi.org/10.1590/1807-3107bor-2020.vol34.0002>
26. Gudipani RK, Alam MK, Patil SR, Karobari MI. Measurement of the Maximum Occlusal Bite Force and its Relation to the Caries Spectrum of First Permanent Molars in Early Permanent Dentition. *J Clin Pediatr Dent* [Internet]. 2020 Dec 1;44(6):423–8. Available from: <http://dx.doi.org/10.17796/1053-4625-44.6.6>
27. Chaturvedula BB, Muthukrishnan A, Bhuvanaraghan A, Sandler J, Thiruvengkatachari B. Dens invaginatus: a review and orthodontic implications. *Br Dent J* [Internet]. 2021 Mar;230(6):345–50. Available from: <http://dx.doi.org/10.1038/s41415-021-2721-9>
28. Kanniah P, Radhamani J, Chelliah P, Muthusamy N, Joshua Jebasingh Sathiya Balasingh E, Reeta Thangapandi J, et al. Green synthesis of multifaceted silver nanoparticles using the flower extract of *Aerva lanata* and evaluation of its biological and environmental applications. *ChemistrySelect* [Internet]. 2020 Feb 21;5(7):2322–31. Available from: <https://onlinelibrary.wiley.com/doi/10.1002/slct.201903228>

29. Ozkan Y, Arikan A, Akalin B, Arda T. A study to assess the colour stability of acetal resins subjected to thermocycling. *Eur J Prosthodont Restor Dent* [Internet]. 2005 Mar;13(1):10–4. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/15819144>
30. Arregui M, Giner L, Ferrari M, Mercadé M. Colour Stability of Self-Adhesive Flowable Composites before and after Storage in Water [Internet]. Vol. 631, *Key Engineering Materials*. 2014. p. 143–50. Available from: <http://dx.doi.org/10.4028/www.scientific.net/kem.631.143>
31. Bhattacharya S, Purayil TP, Ginjupalli K, Kini S, Pai S. Effect of Thermocycling on the Colour Stability of Aesthetic Restorative Materials: An in-vitro Spectrophotometric Analysis [Internet]. Vol. 20, *Pesquisa Brasileira em Odontopediatria e Clínica Integrada*. 2020. Available from: <http://dx.doi.org/10.1590/pboci.2020.020>
32. Yu B, Lee Y-K. Differences in color, translucency and fluorescence between flowable and universal resin composites [Internet]. Vol. 36, *Journal of Dentistry*. 2008. p. 840–6. Available from: <http://dx.doi.org/10.1016/j.jdent.2008.06.003>
33. Maria A. Masking the Discolored Enamel Surface with Opaquers before Direct Composite Veneering [Internet]. Vol. 3, *Journal of Dentistry, Oral Disorders & Therapy*. 2015. p. 01–8. Available from: <http://dx.doi.org/10.15226/jdodt.2015.00143>