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EVALUATION OF COLOUR STABILITY OF TYPE II, TYPE VII, AND NANO-SYNTHESIZED GLASS IONOMER CEMENT AFTER EXPOSURE TO HOT BEVERAGES: AN IN VITRO STUDY

Running title: *Evaluation of color stability of GIC cements on exposure to hot beverages*

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ABSTRACT

Introduction
For dentists, restoring cervical lesions has been a difficult task. It is well recognised that as people age, these lesions become more common. The restorative material of choice for cervical lesions is glass ionomer cement (GIC). Two significant factors within the many causes for repetition of the restoration are intrinsic or extrinsic material discolouration. It is crucial to identify which tooth-colored restorative materials are subject to colour change because they are frequently used. Tooth-colored materials must sustain intrinsic colour stability and a resistance to surface discolouration in order to provide excellent aesthetics. The aim of this study is to evaluate the colour stability of type II, type VII, and nano-synthesized glass ionomer cements post exposure to hot beverages.

Materials and Method
Commercially available Type II GIC, Type VII GIC were selected. Five disc-shaped samples of each type I, type VII, and Nano-synthesised GIC which were prepared using a mold. The discs were divided randomly in two subgroups for immersing in the test solutions. The test solutions prepared were black Tea and black Coffee. All analysis was done using KONICA MINOLTA Spectrophotometer CM-5. Comparison of the mean difference of ΔE among the test solutions was made using one-way ANOVA with the post-hoc Conover test.

Results
The color absorbance with coffee was higher in type II GIC followed by Nano-synthesised GIC and type VII GIC. It is observed that the color stability of Type II GIC was least and that of Type VII GIC was highest with coffee whereas the color absorbance with Tea was higher in Nano-synthesised GIC followed by Type II GIC and type VII GIC. It is observed that the color stability of Nano-synthesised GIC was least and that of Type VII GIC was highest with Tea.

Conclusion
Type VII GIC showed the best color stability in both solutions compared to type II and nano-synthesised GIC in both solutions. In coffee solution, nano-synthesised GIC showed more color stability than type II and in tea type II GIC showed better color stability than nano-synthesised GIC.

Keywords
Colour stability, glass ionomer cement, hot beverages, restoration discolouration

1.INTRODUCTION

For dentists, restoring cervical lesions has been a difficult task. It is well recognised that as people age, these lesions become more common. The restorative material of choice for cervical lesions is glass ionomer cement (GIC).(1) They don't require the removal of the enamel borders for beveling as is necessary with composites and have improved retention due to chemical attachment to the tooth structure, even in sclerotic dentin. Great biocompatibility, fluoride-releasing property, lesser acceptable aesthetics, reduced microleakage and decreased shrinkage are further qualities. (2)

Two significant factors within the many causes for repetition of the restoration are intrinsic or extrinsic material discolouration. Changes in the chemical structure of the restorative material brought on by physical and chemical factors are one cause of intrinsic discolouration.

Exogenous stains absorption and adsorption are the main causes of extrinsic discolouration. Extrinsic stains are believed to be primarily caused by diet, according to studies.(3)There have been recommendations for the use of surface protection materials that could assist in maintaining the water balance inside the material during setting in an effort to combat the issue of GICs dehydrating and hydrating. Such surface shielding compounds may also lessen the amount of stains that the repair absorbs. Low viscosity protective resin covering was successful when used with traditional GI repairs.(4,5)

It is crucial to identify which tooth-colored restorative materials are subject to colour change because they are frequently used. Tooth-colored materials must sustain intrinsic colour stability and a resistance to surface stain in order to provide excellent aesthetics. (6) Extrinsic discolouration of restorations can result from a variety of causes in the oral environment, including mouthwash use and intake of foods and beverages that are acidic or coloured.(7) In today's world, especially in industrialised nations, tea, coffee, and soft drinks are very popular beverages. The colour stability of esthetic dental materials is often paid less attention, compared to other physical and mechanical properties when choosing a tooth-colored dental material. (8) The aim of this study is to evaluate the colour stability of type II, type VII, and nano-synthesized glass ionomer cements post exposure to hot beverages.

2.MATERIALS AND METHODS

2.1 Preparation of the specimen: Commercially available conventional Type II GIC(Shofu Dental Corporation, Japan), Type VII GIC(Shofu Dental Corporation, Japan) were selected. Nano-synthesised GIC was prepared by mixing 0.2 gram (10 percent by weight) of ZnO nanoparticles and was reinforced with 2 grams of commercially available conventional type II GIC for the study. Five disc-shaped samples of each type II, type VII, and Nano-synthesised GIC which were prepared using a stainless mold of standard dimensions measuring around 10 mm for diameter and 2 mm for height. The respective cements were manipulated as per the guidelines provided by the manufactures and filled into the mold, which were then pressed tightly between two glass plates to remove the excessive cement and acquire smooth, flat surfaces. As soon as the materials were set, the discs were removed from the mold and all the samples were evaluated for craze line and irregularities and the samples were stored in water for 24 hours to achieve rehydration.Before starting the immersion regime, the baseline color assessment of the samples were evaluated using KONICA MINOLTA CM-5 Spectrophotometer with the CIELAB scale L*, a*, and b *.
The discs were divided randomly in two subgroups for submerging in the test solutions.

2.2 Preparation of the test solutions: The solutions prepared were black Tea (Brooke Bond 3 Roses, Hindustan Unilever Ltd, India), and black Coffee (Nestle Nescafe Sunrise, Jhaveri Flexo India Pvt Ltd, India). Each set was submerged in the respective solution in a glass beaker as shown in fig. 2 for coffee and fig. 3 for tea. Duration of the test was 7 days.The test solutions were changed every day to prevent fungal contamination.
2.3 Colour Analysis: All the specimens were analysed for change in colour on the 7th day using KONICA MINOLTA CM-5 Spectrophotometer with the CIELAB scale L*, a*, and b * and the black and white calibration was performed to compensate for the effects of stay light. Colour evaluations were made with the standard illumination D65 and 10 ° standard observer. Readings were obtained in three sets, and an average value was calculated.
Comparison of the mean for ΔE (baseline - 7 days) was made between the three sample materials. All the analyses were done using SPSS version 23. A p-value of <0.05 was considered statistically significant. Comparison of mean difference in ΔE among the four test

solutions was made using one way ANOVA with post-hoc Conover test.

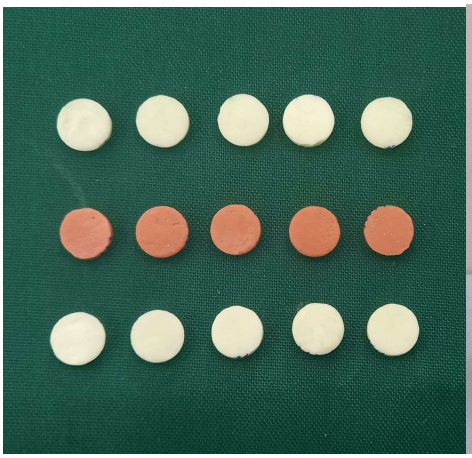

Fig1. Type II, Type VII and Nano-synthesised GIC discs

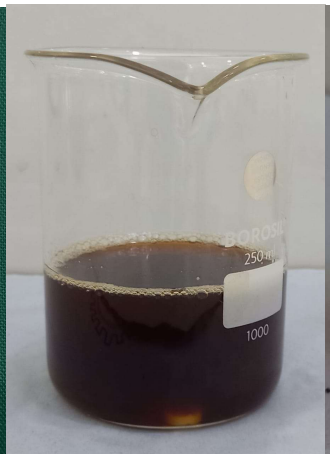

Fig 2. Coffee

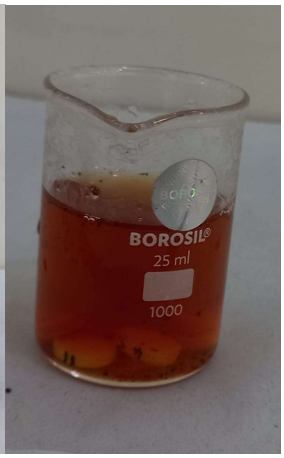

Fig 3. Tea

3.RESULTS

The comparison within the group indicated that all the samples in all three groups exhibited significant difference in the mean ΔE value from baseline through the 7 days in concern to the test solutions (tea and coffee). According to the post-hoc test, throughout all the test solutions, the ΔE value was significantly greater at 7 days and at baseline being lowest for all three groups of samples. This indicates that both the test solutions significantly heightened the mean ΔE over the course of 7 days.

The mean, standard deviation, mean difference, and p value (sig.) of the three materials Nano-synthesised GIC, typeII and type VII GIC in the test solution Coffee is given in table 1.1. In figure 4, the color absorbance with coffee was higher in type II GIC followed by Nano-synthesised GIC and type VII GIC. It is observed that the color stability of Type II GIC was least and that of Type VII GIC was highest with coffee.

GROUPS	MEAN	STD. DEVIATION	SIG.
Nano	5.1600	0.15556	0.015
Type 7	3.5700	0.59397	
Type 2	6.1750	0.26163	

Coffee group		Mean difference (I-J)	sig.
nano	Type 7	1.59000	0.052

	Type 2	-1.01500	0.151
Type 7	nano	-1.59000	0.052
	Type 2	-2.60500	0.013
Type 2	nano	1.01500	0.151
	Type 7	2.60500	0.013

Table 1.1. Mean, standard deviation, mean difference, and p value of Nano-synthesised, type II and type VII GIC in Coffee immersion.

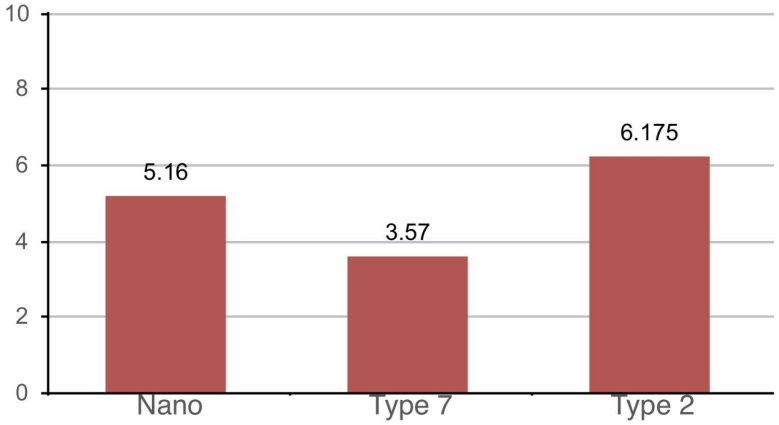

Fig. 4 Comparison of color stability of nano-synthesised, type II, and type VII GIC in Coffee immersion.

The mean, standard deviation, mean difference, and p value (sig.) of the three materials Nano-synthesised GIC, typeII and type VII GIC in the test solution Tea is given in table 1.2. In figure 5, the color absorbance with Tea was higher in Nano-synthesised GIC followed by Type II GIC and type VII GIC. It is observed that the color stability of Nano-synthesised GIC was least and that of Type VII GIC was highest with Tea. It was also observed that the color stability of all three GICs were more in coffee and comparatively less in tea.

GROUPS	MEAN	STD. DEVIATION	SIG.
Nano	11.6850	0.68589	0.088
Type 7	5.0750	3.04763	
Type 2	8.6200	1.03238	

Tea group		Mean difference (I-J)	sig.
nano	Type 7	6.61000	0.079
	Type 2	3.06500	0.366
Type 7	nano	-6.61000	0.079
	Type 2	-3.54500	0.292
Type 2	nano	-3.06500	0.366
	Type 7	3.54500	0.292

Table 1.2. Mean, standard deviation, mean difference, and p value of Nano-synthesised, type II and type VII GIC in Tea immersion.

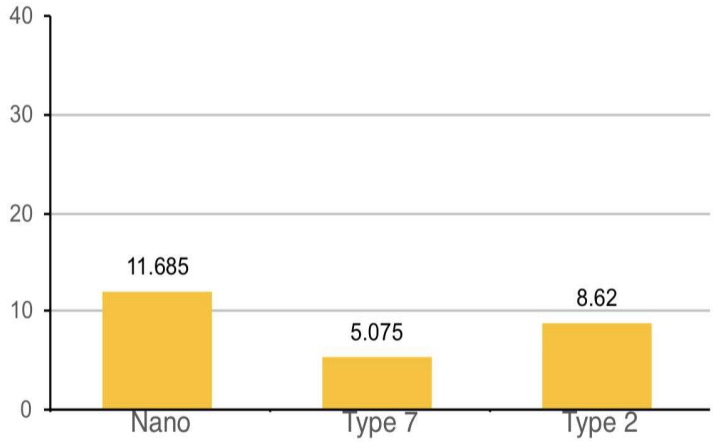

Fig. 5 Comparison of color stability of nano-synthesised, type II, and type VII GIC in Tea immersion.

4.DISCUSSION

The present in vitro study was conducted for the evaluation and determination of the staining potential of the commonly consumed beverages on type II, type VII, and nano-synthesised glass ionomer cements restorative materials. Instrumental or visual methods can be used for the evaluation of the color stability. Spectrophotometer was used to analyse the color changes in dental materials since the readings from instruments obliterate the interpretation of colour stability comparison. Colour inconsistency beneath the visual perception threshold can be identified by using spectrophotometers.(9) Colour determination in dentistry can be categorised into two categories: visual determination and instrumental determination. Instrumental colorimetry can possibly exterminate the subjective errors in the assessment of color.(10) Compared to other subjective guides for shade the use of *L*a*b* color axes is more accepted

universally as a better technique for the determination of measure of color change. (11)

In a study conducted by Shehla etal using herbal tea preparations, GC Fuji IX samples reported to have higher mean difference in ΔE value than samples of Ketac Universal when tested in green tea, tulsi tea, and areca tea preparations.(5) A study by Farkhondeh etal with composite resin, it was concluded that the resistance to staining of spectrum TPH was beneath to that of Denfil and Filtek Z250. (12). Sharat etal in their study using nanoparticle reinforced glass ionomer cements, glass ionomer cement reinforced with carbon nanotube was found to have higher colour stability than glass ionomer cements reinforced with silver nanoparticles.(13)

In a study by Hotwani etal, it was concluded that giomer showed less color changes as compared to resin modified GIC (RMGIC) indicating a better color stability.(14) Adusumilli etal in his study of children's drinks it was reported that giomer showed more resistance to color change than conventional GIC in all the test immersions. (15) On studying the stability of colour of glass ionomer restoration and surface coating resin by Rossini etal, resin modified gic and non-coated showed greater color changes in coffee relative to wine, but monohybrid resin and glass ionomer with a coating agent showed more significant color changes in wine than coffee.(16)

In a study by Burak etal, it was concluded that the coating of GICs showed relatively better color stability property and protection from discoloration of the restoration. (17) The susceptibility to staining of resin based materials may be related to their degree of water sorption and nature of high affinity to water of the matrix resin, in other words, if the resin composite is able to absorb the water then it can also absorb other fluids like tea and coffee. (18) The glass filler particles will absorb water on the material surface but cannot absorb water in bulk of material. Studies suggest that the hydrophobic materials like resin composites are believed to exhibit higher stain stability or colour staining resistance than materials of hydrophilic nature like compomers and glass ionomer cements.(19) The limitation of the study was the small sample size used to assess the colour stability as well as limited duration of the study. A large sample size for the cements and a study over a longer time duration with a much wider range of consumed beverages can provide for the future scope of the study. (20–29)

5.CONCLUSION

From the present study, the conclusion can be drawn that both tea and coffee solution tested showed to exhibit staining potential, which increased with increase in period of time from baseline through the course of 7 days. Coffee solution caused more staining than compared to staining by tea. Type VII GIC showed the best color stability in both solutions compared to type II and nano-synthesised GIC in both solutions. In coffee solution, nano-synthesised GIC showed more color stability than type II and in tea type II GIC showed better color stability than nano-synthesised GIC.

6.ACKNOWLEDGEMENT

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CONFLICT OF INTEREST

The author declares that there was no conflict of interest in the present study

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REFERENCES

1. Francisconi LF, Scaffa PMC, de Barros VR dos SP, Coutinho M, Francisconi PAS. Glass ionomer cements and their role in the restoration of non-carious cervical lesions [Internet]. Vol. 17, Journal of Applied Oral Science. 2009. p. 364–9. Available from: http://dx.doi.org/10.1590/s1678-77572009000500003
2. Kampanas NS, Antoniadou M. Glass Ionomer Cements for the Restoration of Non-Carious Cervical Lesions in the Geriatric Patient [Internet]. Vol. 9, Journal of Functional Biomaterials. 2018. p. 42. Available from: http://dx.doi.org/10.3390/jfb9030042
3. Clarence S, Chakravarthy Y. The effect of red wine on colour stability of three different types of esthetic restorative materials: An in vitro study [Internet]. Vol. 21, Journal of Conservative Dentistry. 2018. p. 319. Available from: http://dx.doi.org/10.4103/jcd.jcd_293_17
4. Scott DA. Influence of Food-Stimulating Solutions and Surface Finish on Susceptibility to Staining of Aesthetic Restorative Materials [Internet]. Vol. 2006, Yearbook of Dentistry. 2006. p. 9–10. Available from: http://dx.doi.org/10.1016/s0084-3717(08)70010-2
5. Haque SW, Muliya VS, Somayaji K, Pentapati KC. Effect of Different Herbal Tea Preparations on the Color Stability of Glass Ionomer Cements [Internet]. Vol. 13, Clinical, Cosmetic and Investigational Dentistry. 2021. p. 121–5. Available from: http://dx.doi.org/10.2147/ccide.s306919
6. Kumari RV, Nagaraj H, Siddaraju K, Poluri RK. Evaluation of the Effect of Surface Polishing, Oral Beverages and Food Colorants on Color Stability and Surface Roughness of Nanocomposite Resins. J Int Oral Health. 2015 Jul;7(7):63–70.
7. Kao EC. Influence of food-simulating solvents on resin composites and glass-ionomer restorative cement [Internet]. Vol. 5, Dental Materials. 1989. p. 201–8. Available from: http://dx.doi.org/10.1016/0109-5641(89)90014-6
8. Bagheri R, Burrow MF, Tyas M. Influence of food-simulating solutions and surface finish on susceptibility to staining of aesthetic restorative materials [Internet]. Vol. 33, Journal of Dentistry. 2005. p. 389–98. Available from: http://dx.doi.org/10.1016/j.jdent.2004.10.018
9. Ahmed K, Sajjan G. Color stability of ionomer and resin composite restoratives in various environmental solutions: An invitro reflection spectrophotometric study. J Conserv Dent. 2005;8(1):45.
10. 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. Pesqui Bras Odontopediatria Clin Integr [Internet]. 2020 Feb 10 [cited 2022 Sep 14];20. Available from: https://www.scielo.br/j/pboci/a/DFSNDnCN8bf5FR5tbGSsSHC/?lang=en&format=pdf
11. Aburaisi S, Basha A, Al Najjar K, Al Saqat H, Al Askar F, Al Nazer F. The colour stability of crystallized acetyl resin material in comparison to other restorative materials. An in-vitro study. BDJ Open. 2021 Feb 24;7(1):11.
12. Raeisosadat F, Tabrizi MA, Zonooz SH, Nakhostin A, Raoufinejad F, Javid B, et al. Staining Microhybrid Composite Resins With Tea and Coffee. Avicenna Journal of

Dental Research. 2013;9(1):e30443–e30443.
13. Pani SC, Aljammaz MT, Alrugi AM, Aljumaah AM, Alkahtani YM, AlKhuraif A. Color Stability of Glass Ionomer Cement after Reinforced with Two Different Nanoparticles. Int J Dent. 2020 May 31;2020:7808535.
14. Hotwani K, Thosar N, Baliga S. Comparative *in vitro* assessment of color stability of hybrid esthetic restorative materials against various children's beverages. J Conserv Dent. 2014 Jan 1;17(1):70.
15. Adusumilli H, Avula JSS, Kakarla P, Bandi S, Mallela GMK, Vallabhaneni K. Color stability of esthetic restorative materials used in pediatric dentistry: An in vitro study. J Indian Soc Pedod Prev Dent. 2016 Jul;34(3):233–7.
16. Savas S, Colgecen O, Yasa B, Kucukyilmaz E. Color stability, roughness, and water sorption/solubility of glass ionomer-Based restorative materials. Niger J Clin Pract. 2019 Jun;22(6):824–32.
17. Çarikçioğlu B. THE EFFECT OF COATING MATERIAL ON THE COLOR STABILITY OF GLASS-IONOMER-BASED RESTORATIVE MATERIALS: AN IN-VITRO STUDY. Cumhuriyet Dental Journal. 2022 Jan 3;24(4):386–94.
18. Yap AU, Sim CP, Loganathan V. Color stability of a resin-modified glass ionomer cement. Oper Dent. 2001 Nov;26(6):591–6.
19. Mutlu-Sagesen L, Ergün G, Özkan Y, Semiz M. Color Stability of a Dental Composite after Immersion in Various Media. Dent Mater J. 2005;24(3):382–90.
20. Wadhwa R, Paudel KR, Chin LH, Hon CM, Madheswaran T, Gupta G, et al. Anti-inflammatory and anticancer activities of Naringenin-loaded liquid crystalline nanoparticles in vitro. J Food Biochem. 2021 Jan;45(1):e13572.
21. 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. 2020 Apr 1;18(1):379–86.
22. Eapen BV, Baig MF, Avinash S. An Assessment of the Incidence of Prolonged Postoperative Bleeding After Dental Extraction Among Patients on Uninterrupted Low Dose Aspirin Therapy and to Evaluate the Need to Stop Such Medication Prior to Dental Extractions. J Maxillofac Oral Surg. 2017 Mar;16(1):48–52.
23. Devarajan Y, Nagappan B, Choubey G, Vellaiyan S, Mehar K. Renewable Pathway and Twin Fueling Approach on Ignition Analysis of a Dual-Fuelled Compression Ignition Engine. Energy Fuels. 2021 Jun 17;35(12):9930–6.
24. Barabadi H, Mojab F, Vahidi H, Marashi B, Talank N, Hosseini O, et al. Green synthesis, characterization, antibacterial and biofilm inhibitory activity of silver nanoparticles compared to commercial silver nanoparticles [Internet]. Vol. 129, Inorganic Chemistry Communications. 2021. p. 108647. Available from: http://dx.doi.org/10.1016/j.inoche.2021.108647
25. Manickam A, Devarasan E, Manogaran G, Priyan MK, Varatharajan R, Hsu CH, et al. Score level based latent fingerprint enhancement and matching using SIFT feature. Multimed Tools Appl. 2019 Feb 1;78(3):3065–85.
26. Subramaniam N, Muthukrishnan A. Oral mucositis and microbial colonization in oral cancer patients undergoing radiotherapy and chemotherapy: A prospective analysis in a tertiary care dental hospital [Internet]. Vol. 10, Journal of Investigative and Clinical Dentistry. 2019. Available from: http://dx.doi.org/10.1111/jicd.12454
27. Rohit Singh T, Ezhilarasan D. Ethanolic Extract of Lagerstroemia Speciosa (L.) Pers., Induces Apoptosis and Cell Cycle Arrest in HepG2 Cells. Nutr Cancer. 2020;72(1):146–56.
28. Wahab PUA, Abdul Wahab PU, Senthil Nathan P, Madhulaxmi M, Muthusekhar MR, Loong SC, et al. Risk Factors for Post-operative Infection Following Single Piece

Osteotomy [Internet]. Vol. 16, Journal of Maxillofacial and Oral Surgery. 2017. p. 328–32. Available from: http://dx.doi.org/10.1007/s12663-016-0983-6

29. Krishnamurthy A, Sherlin HJ, Ramalingam K, Natesan A, Premkumar P, Ramani P, et al. Glandular odontogenic cyst: report of two cases and review of literature. Head Neck Pathol. 2009 Jun;3(2):153–8.