COMPARATIVE EVALUATION OF COLOUR STABILITY OF NANO HYBRID COMPOSITE AFTER IMMERSION IN DIFFERENT TEMPERATURE OF TEA AND COFFEE - AN INVITRO STUDY

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Abstract

Introduction: Nano field composites have recently been developed to improve optical and physical properties of resins. Consumption of certain beverages may affect the esthetic and physical properties of the resin composite, thereby undermining the quality of restorations.The aim of the study is to assess the colour stability of a nano hybrid composite after immersion in different temperatures of tea and coffee.

Materials and methods: In our study we used Ez Fill nanohybrid composite,coffee and tea solutions used as a staining agent in this study. We took 10 test samples which were prepared in the form of disks measuring 10 mm in diameter and 2 mm in thickness. Each disc was prepared using a Teflon mold of this size.The mold was filled with nanohybrid composite,light cured for 20 secs. Then all the specimens were polished and labeled, then the pre and post value of colour stability of specimens was measured using the VITA spectrophotometer after immersion in different temperatures of tea and coffee.Mean and standard deviation for ΔE value was calculated using a one way Anova test.

Results: Pre-immersion and post-immersion values of each composite specimens were recorded and the change in the color (ΔE*ab) was calculated for each specimen.We compared the colour stability of each composite specimen after immersion in hot and cold coffee and tea solutions, and distilled water for 24 hrs. In group 1 the lowest ΔE mean value was recorded as 6.465, whereas in group 2, highest mean value 15.43 was recorded in cold coffee and tea solutions.The comparison of mean and standard deviation between two groups; p value (0.045) shows statistically significant.

Conclusion: From the results obtained, we can conclude that nano hybrid composite showed significant discoloration when exposed to cold and hot temperatures.However, specimens kept at cold temperatures showed good colourstability,when compared to specimens stored at hot temperatures as it shows significant color changes.

Key words: Colourstability;nano hybrid composite; temperature; coffee; tea.

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1. Introduction

Esthetics has been a significant factor in the advancement of dentistry and dental research. The development of tooth-colored restoratives that as nearly approximate the tooth as possible has been made possible by the drive toward a natural appearance. New restorative resins are being developed rapidly in response to the rising demand for cosmetic dentistry. The characteristics of the more recent universal composite systems incorporate those of the older hybrid and microfilled composites[1]. The mechanical and aesthetic capabilities of traditional resin-based composite have been enhanced by changing the fillers. Successful color matching of the restoration is one of the critical clinical requirements to increase the acceptance of any dental restoration.One of the most significant advancements in recent years has involved the application of nanotechnology to resin composites.Incorporating nanoscale fillers into composite resins is made possible by the use of nanotechnology. The advantages of resin nanocomposites are numerous, including improved mechanical and optical qualities as well as reduced wear in general[2] .The nanofilled resin composite has particles that are 5 to 20 nm in size, but they are agglomerated into particle sizes that reach 600 to 1400 nm, exceeding the sizes of the smaller particles in the nanohybrid resin composite. The nanohybrid resin composite has particles with sizes ranging from 40 to 3000 nm, whereas the nanofilled resin composite has particles with smaller sizes. With superior gloss, contemporary nanocomposites with particle sizes between 0.1 nm and 100 nm satisfy the aesthetic needs of the anterior aesthetic zone of the mouth[3].

Over the past two decades, considerable research is going on to improve the clinical performance of the material where the surface roughness and color stability parameter are being evaluated in accordance with the updated United States Public Health Service requirements. Both intrinsic and external causes may contribute to the discoloration of tooth-colored resin composite[4-5]. The Bis-GMA matrix's composition and the type of bonding between the fillers and matrix determine intrinsic variables.Toothdiscolouration of a colored resin composite caused by either intrinsic or extrinsic factors. Intrinsic factors depend on the composition of the matrix Bis-GMA, type of bonding between the fillers and matrix elements. Extrinsic factors such as adsorption or absorption of extrinsic stains pose a major problem for esthetic restorations, retention of colored substances from dietary constituents significantly contribute to the formation of extrinsic stains[6]. Surface smoothness of a restoration is associated with its inherent characteristics, such as the type of organic matrix, size, composition, and distribution of filler particles, also the material's exposure to low pH food, drinks, and mouth rinse solutions.[7]

The capacity of the restoration to maintain the original colour is known as colour stability. Being a psychological issue, colour perception differs from person to person and can be expressed differently by many people. In order to solve this issue, colour assessment tools were used, and data was collected using the "CIE L*a*b* system. The "CIE L*a*b* system" analyses three-dimensional colorimetric measurement: "L* values" correspond to colour intensity, "a* values" to red and green content, and "b* values" to yellow-blue content. With subsequent formulation, the colour variations (E) are calibrated using the L*, a*, and b* values for each subsequent formulation.Only a few studies have shown the relationship between color stability and temperature variation in beverages[8-9]. Many studies have been reported on the colour stability of composite resins, which is affected by filler particle size, beverage type, and pH. The goal of this study is to assess the colour stability of a nano hybrid composite after immersion in different temperatures of tea and coffee.

2. Materials and methods:

In our study we used Ez Fill nanohybrid composite, coffee and tea solutions used as a staining agent in this study. We took 10 test samples which were prepared in the form of disks measuring 10 mm in diameter and 2 mm in thickness.

Specimen preparation:

Each disc was prepared using a Teflon mold of this size.The mold was filled with nanohybrid composite,light cured for 20 secs. Then all the specimens were polished and labelled , then pre value of colour stability was measured using the VITA spectrophotometer. The prepared specimens were divided into 2 groups; group 1 : 5 composite specimens were separated and immersed in hot coffee and tea solution and group 2: other 5 specimens were immersed in cold coffee and tea solutions (Figure1). Hot Coffee and tea solution was prepared by dissolving 1.3% of commercially available coffee and tea powder in 150 ml of distilled water and it was boiled for 50 to 60 degree celsius for 10 mins and then filtered through filter paper. Cold coffee and tea solutions were prepared the same as hot solutions and it was stored in a cold room at -20 degree celsius (Figure 2). After 24 hrs, all the composite specimens were taken out, allowed to dry and colour stability was checked, post values noted and statistically analysed. The

total colour difference ΔE for each disk sample was calculated using the following equation:
$\Delta E^*ab = [(\Delta L^*)^2 + (\Delta a^*)^2 + (\Delta b^*)^2]^{½}$ ΔE^*ab = is the difference in color, ΔL^* = is the difference in brightness values (L2 –L1). "L1" indicates the pre staining value, "L2" indicates the post staining value and "L" indicates the brightness. Δa^* = is the difference in the red green scale (a2– a1). a1 is pre staining value, a2 is post staining values, Δb^* = determines the difference in yellow blue scale (b2 – b1).Mean and standard deviation of ΔE values for each composite was calculated using one way Anova test.

Figure 1: Polished composite specimens; Ez Fill nano hybrid composite

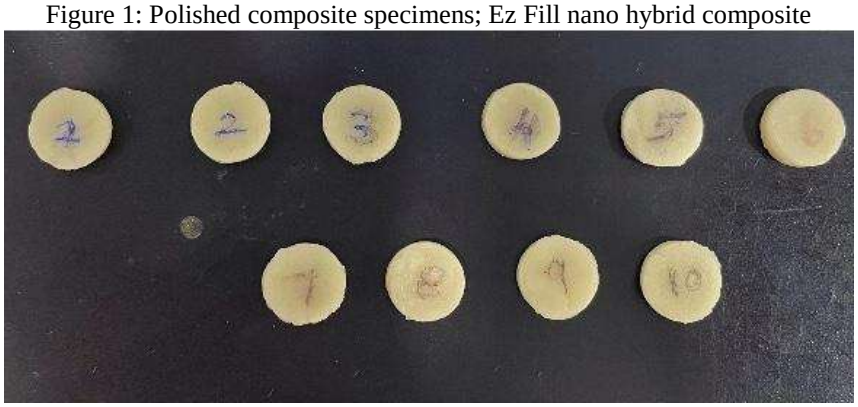
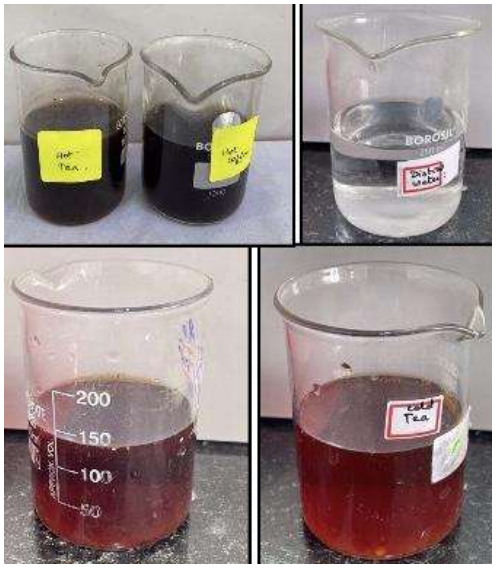


Figure 2: Prepared coffee and tea solutions and distilled water used for storing composite specimens



3. Results

Pre-immersion and post-immersion values of each composite specimens were recorded and the change in the color (ΔE^*ab) was calculated for each specimen.We compared the colour stability of each composite specimens after immersion in hot and cold coffee and tea solutions, and distilled water for 24 hrs (Figure 3). Mean and standard deviation for ΔE value was calculated using a one way Anova test. On comparing group 1 composite specimens exhibited the lowest ΔE mean value was recorded as 6.465, whereas in group 2 , highest mean value 15.43 was recorded in cold coffee and tea solutions.

Here higher the ΔE value lesser the color stability, in our study we found that composite specimens stored in hot coffee and tea solutions exhibited higher ΔEvalue, this indicates nano hybrid composite produce less colour stable which can cause tooth discoloration. So the composite specimens which are stored under The colour stability between the two groups of composite specimens were compared statistically and it was found to be significantly different from the control group ($P< 0.001$). The difference in the p value was found to be 0.045 this indicates that it is statistically significant. There was no significant difference between the 2 groups of composite specimens when it is exposed to two different temperatures (Table 1).

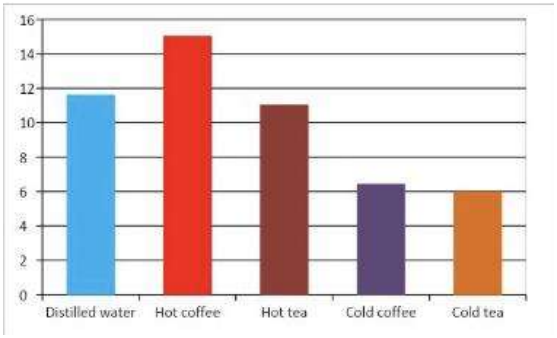


Figure 3: Bar graph represents the comparative analysis of colour stability of composite specimens after immersion in distilled water, hot and cold beverages.Here it indicates composite specimens stored in hot coffee solutions exhibited higher ΔE value.

Data Summary

Groups	N	Mean	Std. Dev.	Std. Error
Group 1	2	6.465	2.6092	1.845
Group 2	2	15.04	0.5374	0.38

ANOVA Summary

Source	Degrees of Freedom DF	Sum of Squares SS	Mean Square MS	F-Stat	P-Value
Between Groups	1	73.5306	73.5306	20.7224	0.045
Within Groups	2	7.0967	3.5484		
Total:	3	80.6273			

Table 1 : This represents one way anova analysis showing the comparison of mean and standard deviation between two groups; p value (0.045) shows statistically significant.

4. Discussion

Color stability constitutes one of the major preliminary factors influencing esthetic outcome and the clinical performance of composite restorations. Color alterations and surface deteriorations observed during clinical longevity could be related to both the material itself and the habitual factors of the individuals.[20] In the present study in order to eliminate composite-related factors affecting polymerization variability of materials with different filler size, percentage, and monomer type, a nanohybrid composite, Filtek Z550, was selected. One of the primary initial elements determining the aesthetic success and clinical performance of composite restorations is colour stability. During clinical longevity, colour changes and surface deterioration may be seen. These changes may have been caused by both the material itself and habitual habits of the people. A nanohybrid composite, Filtek Z550, was chosen for the current study in order to avoid composite-related issues that may affect the polymerization variability of materials with various filler sizes, percentages, and monomer types.[21] We used staining agents that are widely used in daily life such as coffee and tea which have a high potential for staining tooth-colored restorative materials. In our present study we used Ezfill nano hybrid composite, whereas a study done by Reddy et al. examined the effect of cola, coffee, and tea on the colour stability of nano, microhybrid, and hybrid resin composites. This study results showed that nanofilled composites have less colour change than microhybrid and hybrid composite resin.[22]

A study done by Ruyter et al showed that tea and coffee contain yellow colorants, which have different polarities.This study illustrated that higher polarity components present in tea are eluted first and lower polarity components in coffee eluted later. Therefore, the discoloration caused by tea was triggered by the adsorption of polar colourants onto the surface of materials, which may be cleaned regularly by brushing the teeth. Contrarily, discoloration of coffee was caused due to adsorption and absorption of colourants. Due to the polymer phase's compatibility with the yellow coffee colourants were absorbed and penetrated into the materials' organic phase.[23]The results of the current study demonstrated that nano hybrid composites immersed in hot tea and coffee solutions had unacceptable discolouration (**ΔE** = 6.465). Al-Haj Ali et al. conducted a similar study

in which they looked at the colour stability of nano- and microcomposites in relation to typical soft beverages. This study shown that all soft drinks have higher colour stability with microhybrid composite.[24] Kheraif et al. previously investigated the impact of coffee, tea, cola, and distilled water on the colour stability and degree of conversion of nano- and microhybrid composites. This study findings demonstrated that as compared to microhybrid composites, colour stability and discolouration were significantly lower in nanohybrid composites with a high conversion degree.[25]

Nanohybrid composites, on the other hand, are made up of agglomeration particles known as nanoclusters. Due to their high water absorption capacities, these particles may be less resistant to discolouration than silicon-zirconia micron-sized fillers in microhybrid composites. In comparison to microhybrids, smaller filler particles are removed during polishing and finishing procedures in nanohybrids, and small voids remain at the surface of the restorative material. This benefit of nanohybrid composites does not appear to make them stain-resistant.[26-27] The first hypothesis was accepted since numerous studies also indicated that the kind and mode of light-curing devices had an impact on the colour of the nanohybrid composites. Also colour variations were also noticeable between beverages and immersion times.[28-29] The influence of Light Curing Modes on the Color Stability of a Nanohybrid Composite Immersed in Different Beverages was investigated by Ozan G et al. According to this study, nanohybrid resin composite's colour stability is also influenced by the light-curing method. When kept in hot coffee and tea solutions, nano hybrid composite specimens within the subjects of our study exhibit noticeable discolorations. Therefore, the future scope of our study will include more sample sizes with different types of composite resins and its effectiveness of colour stability on coloured foods and drink.[30]

5. Conclusion

Considering the obtained results, consumption of hot and cold beverages have influence on tooth discolouration over composite restoration.From the results obtained, we can conclude that nano hybrid composite showed significant discoloration when exposed to cold and hot temperatures.However specimens kept at cold temperatures showed good colourstability,when compared to specimens stored at hot temperatures as it shows considerable color changes.

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Conflict of interest

The authors declare no conflict of interest.

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6. References

Topcu FT, Sahinkesen G, Yamanel K, Erdemir U, Oktay EA, Ersahan S. Influence of different drinks on the color stability of dental resin composites. Eur J Dent. 2009;3:50–56.

Chowdhury D, Mazumdar P, Desai P, Datta P. Comparative evaluation of surface roughness and color stability of nanohybrid composite resin after periodic exposure to tea, coffee, and Coca-cola - An in vitro profilometric and image analysis study. J Conserv Dent. 2020 Jul-Aug;23(4):395-401. doi: 10.4103/JCD.JCD_401_20. Epub 2021 Jan 16. PMID: 33623243; PMCID: PMC7883790.

McLaren EA, Cao PT. Smile analysis and esthetic design: "In the Zone." Inside Dent. 2009;5:e7–11. [Google Scholar]

Oysaed H, Ruyter IE, Kleven U. Release of formaldehyde from dental composites 1988. J Dent Res.

Gaintantzopoulou M, Kakaboura A, Vougiouklakis G. Colour stability of tooth-coloured restorative materials. Eur J ProsthodontRestor Dent 2005;13(2):51-6.

Gupta R, Parkash H, Shah N, et al. A spectrophotometric evaluation of colour changes of various tooth coloured veneering materials after exposure to commonly consumed beverages. J Indian Prosthodont Soc 2005;5(2):72-8.

Um CM, Ruyter IE. Staining of resin-based veneering materials with coffe and tea. Quintessence Int 1991;22:377- 386.

Yannikakis SA, Zissis AJ, Polyzois GL, Caroni C. Colour stability of provisional resin restorative materials. J Prosthet Dent 1998;80:533-539.

Yousef M, Abo el Naga a. Color stability of different restoratives after exposure to coloring agents. J Am Science. 2012;8:20-26

Aldhuwayhi, Sami, Sreekanth Kumar Mallineni, SrinivasuluSakhamuri, Amar Ashok Thakare, Sahana Mallineni, RishithaSajja, Mallika

Sethi, Venkatesh Nettam, and Azher Mohiuddin Mohammad. 2021. "Covid-19 Knowledge and Perceptions Among Dental Specialists: A Cross-Sectional Online Questionnaire Survey." *Risk Management and Healthcare Policy* 14 (July): 2851–61.

Dua, Kamal, Ridhima Wadhwa, Gautam Singhvi, VamshikrishnaRapalli, Shakti Dhar Shukla, Madhur D. Shastri, Gaurav Gupta, et al. 2019. "The Potential of siRNA Based Drug Delivery in Respiratory Disorders: Recent Advances and Progress." *Drug Development Research* 80 (6): 714–30.

Gan, Hongyun, Yaqing Zhang, Qingyun Zhou, Lierui Zheng, XiaofengXie, Vishnu Priya Veeraraghavan, and Surapaneni Krishna Mohan. 2019. "Zingerone Induced Caspase-Dependent Apoptosis in MCF-7 Cells and Prevents 7,12-Dimethylbenz(a)anthracene-Induced Mammary Carcinogenesis in Experimental Rats." *Journal of Biochemical and Molecular Toxicology* 33 (10): e22387.

Jayaraj, Gifrina, Pratibha Ramani, Herald J. Sherlin, Priya Premkumar, and N. Anuja. 2015. "Inter-Observer Agreement in Grading Oral Epithelial Dysplasia – A Systematic Review." *Journal of Oral and Maxillofacial Surgery, Medicine, and Pathology*. https://doi.org/10.1016/j.ajoms.2014.01.006.

Li, Zhenjiang, Vishnu Priya Veeraraghavan, Surapaneni Krishna Mohan, Srinivasa Rao Bolla, Hariprasath Lakshmanan, Subramanian Kumaran, Wilson Aruni, et al. 2020. "Apoptotic Induction and Anti-Metastatic Activity of Eugenol Encapsulated Chitosan Nanopolymer on Rat Glioma C6 Cells via Alleviating the MMP Signaling Pathway." *Journal of Photochemistry and Photobiology B: Biology*. https://doi.org/10.1016/j.jphotobiol.2019.111773.

Markov, Alexander, Lakshmi Thangavelu, Surendar Aravindhan, Angelina OlegovnaZekiy, Mostafa Jarahian, Max Stanley Chartrand, Yashwant Pathak, FarooghMarofi, Somayeh Shamlou, and Ali Hassanzadeh. 2021. "Mesenchymal Stem/stromal Cells as a Valuable Source for the Treatment of Immune-Mediated Disorders." *Stem Cell Research & Therapy* 12 (1): 192.

Mohan, Meenakshi, and Nithya Jagannathan. 2014. "Oral Field Cancerization: An Update on Current Concepts." *Oncology Reviews* 8 (1): 244.

Neelakantan, Prasanna, Deeksha Grotra, and Subash Sharma. 2013. "Retreatability of 2 Mineral Trioxide Aggregate-Based Root Canal Sealers: A Cone-Beam Computed Tomography Analysis." *Journal of Endodontia* 39 (7): 893–96.

Paramasivam, Arumugam, JayaseelanVijayashreePriyadharsini, Subramanian Raghunandhakumar, and Perumal Elumalai. 2020. "A Novel COVID-19 and Its Effects on Cardiovascular Disease." *Hypertension Research: Official Journal of the Japanese Society of Hypertension*.

Sheriff, K. Ahmed Hilal, K. Ahmed Hilal Sheriff, and Archana Santhanam. 2018. "Knowledge and Awareness towards Oral Biopsy among Students of Saveetha Dental College." *Research Journal of Pharmacy and Technology*. https://doi.org/10.5958/0974-360x.2018.00101.4.

Fontes ST, Fernandez MR. Color stability of nanofilled composite, effect of different immersion media. J Appl Oral Sci 2009;17(5):388-391

Gupta R, Parkash H, Shah N. A spectrophotometric evaluation of color changes of various tooth colored veneering materials after exposure to commonly consumed beverages. The Journal of Indian Prosthodontic Society 2005;5(2):72-78.

Reddy PS, Tejaswi KS, Shetty S, Annapoorna BM, Pujari SC, Thippeswamy HM. Effects of commonly consumed beverages on surface roughness and color stability of the nano, microhybrid and hybrid composite resins: an in vitro study. The journal of contemporary dental practice. 2013 Jul 1;14(4):718.

Ruyter IE. Composites- characterization of composite filling materials: reactor response. Adv Dent Res 1988;2:122-129.

Al-Haj Ali SN, Alsulaim HN, Albarrak MI, Farah RI. Spectrophotometric comparison of color stability of microhybrid and nanocomposites following exposure to common soft drinks among adolescents: an in vitro study. Eur Arch Paediatric Dent. 2021;22:675–83.

Al Kheraif AA, Qasim SS, Ramakrishnaiah R, Rehman IU. Effect of different bev- erages on the color stability and degree of conversion of nano and microhybrid composites. Dent Mater J. 2013;32:326–31

Khokhar ZA, Razzoog ME. Color stability of restorative resins. Quintessence International 1991;22(9):733-737.

Thakib A, Al-Shalan. In vitro staining of nanocomposites exposed to a Cola beverage; Pakistan Oral and Dental Journal 2009;29(1):79-84.

Topcu FT, Sahinkesen G, Yamanel K. Influence of different drinks on the color stability of dental resin composites. European Journal of Dentistry 2009;350-356

Asmussen E. Factors affecting the colour stability of restorative resins. Acta OdontolScand 1983;41:11–18.

Palanivelu, J., Thanigaivel, S., Vickram, S., Dey, N., Mihaylova, D., & Desseva, I. (2022). Probiotics in functional foods: survival assessment and approaches for improved viability. Applied Sciences, 12(1), 455.

Ozan G, Sancakli HS, Tiryaki M, Bayrak I. Effect of Light Curing Modes on the Color Stability of a Nanohybrid Composite Immersed in Different Beverages. Odovtos-International Journal of Dental Sciences. 2020;22(2):71-81.