



Original research

Comparison of colour stability in bis-acryl resins

Alan Alejandro De Jesús Villarreal-González¹,
Rubén Romero-Herrera², Uriel Soto-Barreras³,
David Gutiérrez-Sánchez⁴

- ¹ Docente en licenciatura, Facultad de Odontología, Universidad Autónoma de Chihuahua. <https://orcid.org/0009-0003-3566-5117>
- ² Docente en Maestría en Estomatología área Prostodoncia, Facultad de Odontología, Universidad Autónoma de Chihuahua. <https://orcid.org/0009-0003-7442-8042>
- ³ Docente en Maestría en Estomatología área Prostodoncia, Facultad de Odontología, Universidad Autónoma de Chihuahua. <https://orcid.org/0000-0001-9858-4638>
- ⁴ Práctica privada, Chihuahua, México. <https://orcid.org/0009-0009-5774-7766>

Correspondence author:

Alan Alejandro De Jesús Villarreal-González
E-mail: avillarrealg@uach.mx

Received: 13 February 2025

Accepted: 20 August 2025

Cite as:

Villarreal-González AADJ, Romero-Herrera R, Soto-Barreras U, Gutiérrez-Sánchez D. Comparación de la estabilidad de color en resinas bisacrílicas [Comparison of Colour Stability in Bis-Acryl Resins]. *Rev Odontol Mex.* 2025; 29(3): 12-19. DOI: 10.22201/fo.1870199xp.2025.29.3.90887

ABSTRACT

Introduction: Provisional restorations must meet biological, mechanical, and aesthetic requirements. Bis-acryl resins offer advantages over polymethyl methacrylate (PMMA), such as lower shrinkage and greater fracture resistance, but also they have disadvantages such as high cost and colour instability. **Objective:** To compare the colour stability of four brands of bis-acryl resins (Bisacryl Nic Tone®, Cool Temp®, Luxatemp Star® and Structur Premium®) exposed to pigmentation



beverages. **Material and Methods:** Eighty bis-acryl resin samples (n=20 per group) with a diameter of 10 mm and a thickness of 2 mm were prepared. The samples were immersed at 24-hour intervals in coffee, cola, and green tea, and stored in the dark at room temperature. Colour measurement was performed with the values obtained from CIEDE2000 (ΔE_{00}) using a spectrophotometer, and the data were analysed. **Results:** Cool Temp[®] and Bisacryl Nic Tone[®] samples showed the greatest colour variability, while Structur Premium[®] samples had the least variability and the lowest ΔE_{00} values, indicating greater colour stability. On the other hand, the Luxatemp Star[®] samples exhibited intermediate and homogeneous values among them. Bisacryl Nic Tone[®] showed a significantly higher ΔE_{00} compared to Luxatemp Star[®] and Structur Premium[®]. **Conclusions:** Structur Premium[®] and Luxatemp Star[®] achieved greater colour stability compared to Bisacryl Nic Tone[®] and Cool Temp[®], making them more suitable for applications requiring colour stability. The findings highlight the importance of considering colour stability when selecting dental materials to improve clinical practice.

Keywords: Bis-acryl resins, colour stability, aesthetic evaluation, dental materials.

INTRODUCTION

Provisional restorations must meet three essential requirements: biological, to protect the tooth structure, soft tissues, and pulp; mechanical, to withstand masticatory forces without fracture or displacement; and aesthetic, ensuring adequate contour, colour, and translucency, especially during long-term treatment¹.

Polymethyl methacrylate (PMMA) has long been used in provisional restorations, but it has disadvantages such as significant shrinkage, exothermic reaction and unpleasant odour². In contrast, bis-acryl resins are easier to manipulate, have less shrinkage, less pulp irritation, and improve aspects such as occlusion and marginal adaptation³. These resins are free of methyl methacrylate and composed of dimethacrylates such as bisphenol A-glycidyl methacrylate (BIS-GMA) and urethane dimethacrylate (UDMA), as well as glass and silica fillers^{4,5}. Their formulation with nanoparticle fillers gives them high resistance to fracture⁶. Furthermore, the presence of functional methacrylate esters increases the number of crosslinks between monomers, providing improved surface polishing⁷.

However, high cost, low resistance to deformation and colour instability are disadvantages of these materials⁷. In this context, provisional bis-acryl resin restorations undergo colour alterations due to various factors, such as exposure to colouring agents and water absorption⁸. Colour and gloss stability are crucial, as they affect the patient's aesthetic perception^{8,9}. Factors such as inorganic filler, resin composition, diet, hygiene and surface roughness influence staining^{10,11}. To simulate this staining, the use of different substances such as coffee, tea, red wine, cola-based soft drinks, grape juice has been reported^{11,12}, and for aging, UV radiation, storage in distilled water, and artificial saliva have been used¹³⁻¹⁵. The resin's ability to absorb water is directly related to the oxidation of the polymer matrix¹⁶, or unreacted double bonds in residual monomers cause the material to absorb pigments, resulting in varying degrees of staining^{17,18}. Despite being a highly useful material in dentistry, bis-acryl resins have disadvantages. Therefore, the objective of this study is to compare the colour stability of four brands of bis-acryl resins immersed in different beverages.

MATERIALS AND METHODS

Four brands of bis-acryl resins were selected: Bisacryl Nic Tone® (MDC® Dental, Zapopan, Mexico), Structur Premium® (VOCO GmbH, Cuxhaven, Germany), Luxatemp Star® (DMG Chemisch-Pharmazeutische Fabrik GmbH, Hamburg, Germany) and Cool Temp® (Coltène/Whaledent AG, Altstätten, Switzerland). Each resin was dispensed, handled and polymerised following the manufacturer's instructions. Using a 20-cavity mould with dimensions of 10 mm in diameter by 2 mm thick each, 20 samples of each brand were prepared, obtaining a total of 80 samples.

The samples were removed from the mould 15 minutes after placement and were not polished to avoid introducing an additional source of variability. Before the immersion process, colour measurements were taken in triplicate at the centre of each disc. A spectrophotometer (SpectroShade™ Micro Dental, MHT S.p.A., Arbizzano di Negrar, Italy) was used, which was calibrated before each measurement. To avoid data variability, all measurements were performed in triplicate under controlled conditions of light, temperature (25 °C) and by the same operator.

The initial colour values (L_1 , a_1 , b_1) were obtained according to the CIELAB colour space, which served as a reference. Subsequently, all samples from each group were sequentially and cumulatively exposed to three pigment solutions, in the same order for 24 hours in each solution, following the established order: 4 grams of instant coffee (Nescafé®, Nestlé S.A., Vevey, Switzerland) dissolved in 200 ml of water, cola soft drink (Coca-Cola®, The Coca-Cola Company, Atlanta, USA) and one bag of 1.5 grams of green tea (*Camellia sinensis*) (McCormick®, McCormick & Company, Baltimore, USA) in 200 ml of water. The containers carrying the samples were stored in a dark place at room temperature to avoid the influence of light and temperature on the staining process. Between each solution change, the samples were rinsed with distilled water for 1 minute to remove any residue of the previous solution. Solution changes were made with a 24-hour interval between each one. After completing the immersion procedure, the samples were dried with absorbent paper without leaving any residue.

A final colour measurement was made in the centre of each disc under the same parameters as the initial measurements, recording the colour values (L_2 , a_2 , b_2). The total colour difference between the initial and final measurements was calculated using the CIEDE2000 formula (ΔE_{00})¹⁹. No intermediate measurements were made, so the final ΔE_{00} value reflects the total accumulated staining after 72 h of exposure, without differentiating the effect of each beverage. The intra-instrument reproducibility of the spectrophotometer was evaluated by intraclass correlation coefficient (ICC) analysis. For this purpose, 20 samples (5 per group) were randomly selected from the measurements performed in triplicate, and the ΔE_{00} value corresponding to each repetition was used to calculate the ICC under standardised conditions.

A descriptive analysis of the data was performed, calculating the mean and standard deviation of the ΔE_{00} values for each resin brand. The Shapiro-Wilks and Bartlett's tests were applied to determine the distribution of variables and homogeneity of variances respectively. In order to evaluate significant differences between brands, a one-way analysis of variance (ANOVA) was applied to compare the means of ΔE_{00} between groups. The Tukey's test was used *post hoc* to determine differences between groups. Additionally, to evaluate the magnitude of colour changes in relation to established clinical criteria, a dichotomous categorisation of ΔE_{00} values was done based on the thresholds of perceptibility ($\Delta E_{00} > 1.01$) and acceptability ($\Delta E_{00} > 2.66$)²⁰. The frequency and percentage of samples that exceeded these thresholds were determined in each experimental group. Exceeding the perceptibility threshold indicates that the colour

change is detectable by the human eye, while exceeding the acceptability threshold implies that the change is clinically unacceptable. A p -value of <0.05 was considered statistically significant. SAS Studio software (SAS Institute Inc., Cary, USA) was used for data processing and analysis.

RESULTS

The colour stability of the four bis-acryl resins was evaluated after immersion in pigment solutions (Figure 1). The intra-instrument reproducibility obtained an ICC greater than 0.90 in the measurement of the ΔE_{00} colour, which indicates adequate intra-instrument consistency in the measurements made with the spectrophotometer. Table 1 shows the colour differences between the bis-acryl resins tested. The results showed statistically significant differences in colour stability among the resins tested. Cool Temp[®] resin showed the greatest colour alteration ($\Delta E_{00} = 4.67 \pm 1.72$), followed by Bisacryl Nic Tone[®] resin ($\Delta E_{00} = 3.95 \pm 2.90$). Structur Premium[®] resin presented the lowest ΔE_{00} values and lower variability ($\Delta E_{00} = 1.75 \pm 0.82$), suggesting superior colour stability and uniformity between samples. Finally, Luxatemp Star[®] resin presented intermediate values ($\Delta E_{00} = 2.99 \pm 0.80$).

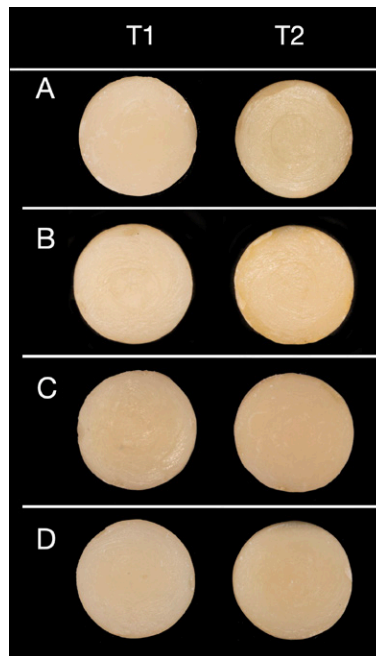


Figure 1. Bis-acryl resin discs before (T1) and after (T2) immersion in pigment-based beverages. A. Bisacryl Nic Tone[®]. B. Cool Temp[®]. C. Luxatemp Star[®]. D. Structur Premium[®].

Post hoc analysis indicated that Cool Temp[®] resin had significantly higher ΔE_{00} values than Luxatemp Star[®] and Structur Premium[®] resins. Likewise, Bisacryl Nic Tone[®] resin showed no significant differences with Cool Temp[®] or Luxatemp Star[®], while Structur Premium[®] showed the best colour stability, with significant differences compared to the other resins.

Table 1. Comparison of the colour difference (ΔE_{00}) in bis-acryl resins after exposure to pigment solutions

	Mean	\pm SD	p-value*
Bisacryl Nic Tone® (n=20)	3.95 ^{ab}	2.90	
Cool Temp® (n=20)	4.67 ^a	1.72	<0.001
Luxatemp Star® (n=20)	2.99 ^b	0.80	
Structur Premium® (n=20)	1.75 ^c	0.82	

SD: Standard deviation. One-way analysis of variance (ANOVA). *Post hoc* test (Tukey's test). Different letters in the mean indicate statistically significant differences ($p < 0.05$).

The results relating to the thresholds of perceptibility and acceptability (Table 2) highlight Structur Premium® as the resin with the greatest colour stability. Only 80% of their samples exceeded the perceptibility threshold, while only 15% exceeded the acceptability threshold, representing the lowest percentages among the bis-acryl resins tested. In contrast, Cool Temp® and Luxatemp Star® presented 100% of their samples above the perceptibility threshold, with percentages of 85% and 60% respectively, exceeding the acceptability threshold. The findings suggest that Structur Premium® resin showed greater colour stability after exposure to colouring agents, suggesting it is more suitable for applications where long-term colour stability is essential. It should be noted that these criteria are independent, which explains why the percentages are not mutually exclusive.

Table 2. Colour differences (ΔE_{00}) that exceed the thresholds of perceptibility and acceptability after exposure to pigmenting solutions.

Brand	Frequency	Percentage
<i>Threshold of perceptibility ($\Delta E_{00} > 1.01$)</i>		
Bisacryl Nic Tone®	19	95.0
Cool Temp®	20	100
Luxatemp Star®	20	100
Structur Premium®	16	80.0
<i>Acceptability threshold ($\Delta E_{00} > 2.66$)</i>		
Bisacryl Nic Tone®	13	65.0
Cool Temp®	17	85.0
Luxatemp Star®	12	60.0
Structur Premium®	3	15.0

DISCUSSION

In this study, significant differences in colour stability were observed between four brands of bis-acryl resins evaluated after sequential immersion in pigment solutions. Structur Premium® resin presented the lowest ΔE_{00} values (1.75 ± 0.82), indicating lower susceptibility to staining. Luxatemp Star® showed intermediate values (2.99 ± 0.80), while Bisacryl Nic Tone® and Cool Temp® exhibited greater colour alteration (3.95 ± 2.90 and 4.67 ± 1.72 respectively), mostly exceeding the clinical threshold of acceptability ($\Delta E_{00} > 2.66$). The findings highlight that there are significant differences in colour stability depending on the brand, underscoring the need to carefully evaluate the selection of these materials for long-term clinical applications.

It has been reported that composite materials with more homogeneous matrices and high filler loading tend to have lower susceptibility to dye absorption^{15,21,22}. Ardu *et al.*²³ reported considerable variations in colour stability among composite resins, attributing them to factors such as structural differences and chemical composition. Although these aspects were not directly evaluated in our study due to limitations in the information provided by manufacturers, structural differences could contribute, in part, to the observed variations in colour stability²⁴.

The protocol used in the present study was a cumulative sequential exposure to pigment solutions, to simulate a realistic clinical context in which patients consume various pigment drinks over time. Previous research has identified coffee and cola-type carbonated beverages as agents with high staining potential on dental materials, which is consistent with the differences observed in the present investigation^{25,26}. It is important to mention that in this study no intermediate measurements were made, so the ΔE_{00} value obtained reflects exclusively the final accumulated staining. Furthermore, the immersion protocol has been previously used in studies to reproduce accelerated clinical conditions simulating approximately one month of routine consumption of staining beverages by patients, allowing for rapid assessment of the staining potential of dental materials under controlled experimental conditions²⁵.

Surface finish and texture are also other factors that can influence the colour stability of bis-acryl resins²⁷. Studies have shown that smooth surfaces tend to absorb less pigment compared to rough or uneven surfaces^{8,22}. Some authors have suggested that polishing and the use of glazing agents can reduce surface roughness. Nevertheless, evidence on their actual impact on colour stability is variable and depends on the composition of the material²⁸. Furthermore, it has been proposed that the inherent polarity of bis-acryl resin polymers and their affinity for polar liquids may limit the effectiveness of surface treatments, suggesting that discoloration resistance may depend more on the chemical composition and internal structure of the material than on the surface finish itself²⁹.

This study has several limitations, the *in vitro* nature of the test, although it allows rigorous control of the variables, cannot fully replicate the conditions of the oral cavity, where factors such as saliva, oral microbiota, and variations in temperature and pH affect the performance of the materials³⁰. Clinical studies are necessary to confirm colour stability under real-life conditions. Furthermore, the lack of detailed information on the composition of each resin and the absence of analysis of specific components limits the ability to establish direct associations between the composition properties and the behaviour of each material. Future research could allow a deeper understanding of the interactions between the structural characteristics of resins and their colour stability.

From a clinical perspective, the results have important implications for the selection of provisional materials. The greater colour stability observed in Structur Premium® and Luxa-temp Star® resins makes them potentially suitable options for provisional restorations where aesthetics are a key factor and frequent exposure to colouring agents is anticipated. Although in this study the total exposure was relatively short (72 cumulative hours), previous studies with similar protocols have demonstrated the cumulative effects of regular consumption of pigment-enhancing beverages over longer periods under clinical conditions. In short-term applications, where colour stability may not be as crucial, resins with greater susceptibility to staining, such as Bisacryl Nic Tone® and Cool Temp®, could be considered viable options. However, the variability in colour stability observed among different resins underscores the importance of an informed selection, based not only on initial aesthetics, but also on the durability of the material's appearance under real-life conditions.

CONCLUSIONS

The bis-acryl resins evaluated showed significant variability among them in colour stability. Structur Premium® and Luxatemp Star® resins were the most stable materials, presenting the lowest average ΔE_{00} values. Furthermore, Structur Premium® showed the best clinical stability, as only 15% of its samples exceeded the clinical threshold of acceptability ($\Delta E_{00} > 2.66$). On the other hand, Bisacryl Nic Tone® and Cool Temp® resins showed greater chromatic fluctuations and higher percentages above the clinical thresholds of acceptability (65% and 85% respectively), indicating lower aesthetic predictability. Further clinical studies and detailed analyses of the composition of these materials will allow for a better understanding and selection of bis-acryl resins in dental practice.

BIBLIOGRAPHIC REFERENCES

1. Rosenstiel SF, Land MF, Fujimoto J. *Prótesis fija contemporánea*. 5ª ed. Barcelona: Elsevier; 2016.
2. Chen H, Huang J, Dong X, Qian J, He J, Qu X, et al. A systematic review of visual and instrumental measurements for tooth shade matching. *Quintessence Int*. 2012; 43(8): 649-659. PMID: 23034418
3. Strassler HE, Anolik C, Frey C. High-strength, aesthetic provisional restorations using a bis-acryl composite. *Dent Today*. 2007; 26(11):128-130. PMID: 18044129
4. Moulding MB, Teplitsky PE. Intrapulpal temperature during direct fabrication of provisional restorations. *Int J Prosthodont*. 1990; 3(3): 299-304. PMID: 2083018
5. Doray PG, Li D, Powers JM. Color stability of provisional restorative materials after accelerated aging. *J Prosthodont*. 2001; 10(4): 212-216. DOI: 10.1111/j.1532-849x.2001.00212.x
6. Arima T, Murata H, Hamad T. The effects of cross-linking agents on the water sorption and solubility characteristics of denture base resin. *J Oral Rehabil*. 1996; 23(7): 476-480. DOI: 10.1111/j.1365-2842.1996.tb00882.x
7. Burke FJT, Murray MC, Shortall ACC. Trends in indirect dentistry: 6. Provisional restorations, more than just a temporary. *Dent Update*. 2005; 32(8): 443-452. DOI: 10.12968/denu.2005.32.8.443
8. Rutkunas V, Sabaliauskas V, Mizutani H. Effects of different food colorants and polishing techniques on color stability of provisional prosthetic materials. *Dent Mater J*. 2010; 29(2): 167-176. DOI: 10.4012/dmj.2009-075
9. Lee J, Lee S. Evaluation of add-on methods for bis-acryl composite resin interim restorations. *J Prosthet Dent*. 2015; 114(4): 594-601. DOI: 10.1016/j.prosdent.2015.02.020
10. Joiner A, Luo W. Tooth colour and whiteness: A review. *J Dent*. 2017; 67: S3-S10. DOI: 10.1016/j.jdent.2017.09.006
11. Silva J, Rafael CF, Vaz PCS, Fernandes JCAS, Volpato CAM. Color stability of repairs on bis-acryl resin submitted to thermal aging and immersion in beverages. *J Esthet Restor Dent*. 2019; 31(5): 514-519. DOI: 10.1111/jerd.12523
12. Solow RA. Composite veneered acrylic resin provisional restorations for complete veneer crowns. *J Prosthet Dent*. 1999; 82(5): 515-517. DOI: 10.1016/s0022-3913(99)70048-x
13. Johnston WM. Color measurement in dentistry. *J Dent*. 2009; 37(Suppl 1): e2-e6. DOI: 10.1016/j.jdent.2009.03.011
14. Christiani JJ, Devecchi JR, Avalos Llano KR, Altamirano RH, Rocha MT. Estabilidad de color de resinas para prótesis provisional. *Rev Asoc Odontol Argent*. 2015; 53(1): 29-34. Disponible en: <https://repositorio.unne.edu.ar/handle/123456789/1631>

15. Macedo MGFP, Volpato CAM, Henriques BAPC, Vaz PCS, Silva FS, Silva CFCL. Color stability of a bis-acryl composite resin subjected to polishing, thermocycling, intercalated baths, and immersion in different beverages. *J Esthet Restor Dent*. 2018; 30(5): 449-456. DOI: 10.1111/jerd.12404
16. Sham AS, Chu FC, Chai J, Chow TW. Color stability of provisional prosthodontic materials. *J Prosthet Dent*. 2004; 91(5): 447-452. DOI: 10.1016/S0022391304001283
17. Augusto MG, de Andrade GS, Caneppele TMF, Borges AB, Torres CRG. Nanofilled bis-acryl composite resin materials: Is it necessary to polish? *J Prosthet Dent*. 2020; 124(4): 494.e1-494.e5 DOI: 10.1016/j.prosdent.2020.03.015
18. Kerby RE, Knobloch LA, Sharples S, Peregrina A. Mechanical properties of urethane and bis-acryl interim resin materials. *J Prosthet Dent*. 2013; 110(1): 21-28. DOI: 10.1016/S0022-3913(13)60334-0
19. Gómez-Polo C, Portillo Muñoz M, Lorenzo Luengo MC, Vicente P, Galindo P, Martín Casado AM. Comparison of the CIELab and CIEDE2000 color difference formulas. *J Posthet Dent*. 2016; 115(1): 65-70. DOI: 10.1016/j.prosdent.2015.07.001
20. Tejada-Casado M, Herrera LJ, Carrillo-Pérez F, Ruiz-López J, Ghinea RI, Pérez MM. Exploring the CIEDE2000 thresholds for lightness, chroma, and hue differences in dentistry. *J Dent*. 2024; 150: 105327. DOI: 10.1016/j.jdent.2024.105327
21. Joiner A. Tooth colour: a review of the literature. *J Dent*. 2004; 32(Suppl): 3-12. DOI: 10.1016/j.jdent.2003.10.013
22. Gantz L, Fauxpoint G, Arntz Y, Pelletier H, Etienne O. In vitro comparison of the surface roughness of polymethyl methacrylate and bis-acrylic resins for interim restorations before and after polishing. *J Prosthet Dent*. 2021; 125(5): 833.e1-833.e10. DOI: 10.1016/j.prosdent.2021.02.009
23. Ardu S, Duc O, Di Bella E, Krejci I. Color stability of recent composite resins. *Odontology*. 2017; 105(1): 29-35. DOI: 10.1007/s10266-016-0234-9
24. Sideridou I, Tserki V, Papanastasiou G. Effect of chemical structure on degree of conversion in light-cured dimethacrylate-based dental resins. *Biomaterials*. 2002; 23(8): 1819-1829. DOI: 10.1016/S0142-9612(01)00308-8
25. Manabe A, Kato Y, Finger WJ, Kanehira M, Komatsu M. Discoloration of coating resins exposed to staining solutions in vitro. *Dent Mater J*. 2009; 28(3): 338-343. DOI: 10.4012/dmj.28.338
26. Fathima JN, Hashir MMJ, Padmanabhan K. Spectrophotometric evaluation of color stability of composite resin after exposure to cold drinks: An in vitro study. *J Conserv Dent Endod*. 2024; 27(2): 195-199. DOI: 10.4103/JCDE.JCDE_230_23
27. Brito MGA, Pedrosa MS, Bona AJ, Rodrigues JA, do Amaral FLB, Peruzzo DC, *et al*. Finishing and polishing systems influence the roughness and color stability of acrylic and bis-acryl composite resins. *J Clin Exp Dent*. 2024;16(6): e700-e706. DOI: 10.4317/jced.61598
28. Commar BC, Danelon M, Panitente PA, Silva EVFD, Bitencourt SB, Barão VAR, *et al*. Effect of glaze and chlorhexidine on physical and mechanical properties of bis-acryl resin: An in situ study. *Polim Med*. 2022; 52(2): 93-99. DOI: 10.17219/pim/156868
29. Soares IA, Leite PKBS, Farias OR, Lemos GA, Batista AUD, Montenegro RV. Polishing methods' influence on color stability and roughness of 2 provisional prosthodontic materials. *J Prosthodont*. 2019; 28(5): 564-571. DOI: 10.1111/jopr.13062
30. Gujjari AK, Bhatnagar VM, Basavaraju RM. Color stability and flexural strength of poly (methyl methacrylate) and bis-acrylic composite based provisional crown and bridge auto-polymerizing resins exposed to beverages and food dye: an in vitro study. *Indian J Dent Res*. 2013; 24(2): 172-177. DOI: 10.4103/0970-9290.116672