Original Article

COMPARATIVE ANALYSIS OF COLOUR STABILITY OF ZIRCONOMER ON IMMERSION IN HOT BEVERAGES - AN IN VITRO STUDY

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Abstract

Introduction: Several esthetic restorative materials such as composite resins, glass ionomers, compomers, and zirconia-reinforced glass ionomer cement (GICs) are being used. Dental restorations are constantly prone to multiple oral environmental challenges such as variations in temperature and pH. Zirconia-reinforced GIC was introduced with the purpose to enhance the mechanical properties of conventional GIC as well as overcoming drawbacks of previously used tooth-colored esthetic restorative materials. The study aims to determine the color stability of zirconomer after and before immersion in hot beverages.
Materials and methods: Zirconomer was taken for the study. A total of 8 disc-shaped samples were made. Required quantities of tea, coffee were measured and taken in a beaker. The hydrated specimens were immersed in glass beakers containing the tea solution, coffee solution, and distilled water separately, 3 samples in both tea and coffee solution, 2 samples in distilled water. The specimen immersed in distilled water was taken as the control for 24 hrs. Then they were rinsed with distilled water and were checked for color stability (delta E) values using a VITA Easyshade advance spectrophotometer analyzed statistically using t-test and SPSS software version 23.0.
Results: In the tea solution, the ΔE value of Zirconomer was 6.74 which was higher than the coffee group which was 4.39 and the control group which was 2.55. P-value is 0.667 (>0.05) which is statistically not significant**.**
Conclusion: It can be concluded that tea produced a higher degree of color change than coffee in the prepared zirconomer restorative material samples.

KEYWORDS: Color stability, Zirconomer, Tea, Coffee, Spectrophotometer
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INTRODUCTION:

Esthetic appearance is one of the prime factors for social acceptance as well as professional success (Avula *et al.*, 2016). Several esthetic restorative materials such as composite resins, glass ionomers, compomers, and zirconia-reinforced glass ionomer cement (GICs) are being used. These materials are used for several purposes such as restoring decayed posterior as well as anterior teeth, to improve disfigured teeth (Topcu *et al.*, 2009). Dental restorations are constantly prone to multiple oral environmental challenges such as variations in temperature and pH. This results in extrinsic and intrinsic changes at the surface or within the body of the material that alter the physical, mechanical, chemical as well as esthetic properties of the material (Albeshti and Shahid, 2018). The various extrinsic and intrinsic factors cause discoloration of restorations leading to a high failure rate.

Extrinsic factors causing discolorations can be due to insufficient polymerization, frequent consumption of food and beverages as well as drug formulations containing coloring agents/additives (Erdemir, Yildiz and Eren, 2012). Discoloration due to intrinsic factors includes adsorption of coloring agent on the surface and absorption within the subsurface layer making it more prone for replacement, consuming money and time of patients as well as dental practitioners (Özdaş *et al.*, 2016). The longevity and acceptability of such restorations are directly proportional to the color stability of the restorative materials (Shamszadeh *et al.*, 2016). The color stability of restorative material depends on multiple factors including the type of matrix of restorative material, particle size, filler content, filler type, polymerization depth, mode of polymerization as well as contact with coloring agents.

It is also directly related to the hydrophilic property of the material (Chalissery *et al.*, 2016). Zirconia-reinforced GIC was introduced with the purpose to enhance the mechanical properties of conventional GIC as well as overcoming drawbacks of previously used tooth-colored esthetic restorative materials (Kalimireddy *et al.*, 2015). The composition of zirconomer is as follows: zirconium oxide, glass powder, tartaric acid, polyacrylic acid, and deionized water as its liquid (Silva *et al.*, 2009). The main component of zirconia-reinforced GIC is nano-sized zirconia filler particles ranging from 96.5% to 98.5%. These filler particles are proclaimed to impart a high level of translucency and achieve a closer resemblance to natural tooth color. Increased susceptibility to color change may be associated with the addition of variable-sized inert zirconia particles and translucency of the same. Our team has extensive knowledge and research experience that has translate into high quality publications(Dinesh *et al.*, 2013; Krishnan and Lakshmi, 2013; Muthukrishnan and Warnakulasuriya, 2018; Sekar *et al.*, 2019; Gomathi *et al.*, 2020) (Sathivel *et al.*, 2008; Panda *et al.*, 2014; Govindaraju, Neelakantan and Gutmann, 2017; Johnson *et al.*, 2020; Saraswathi *et al.*, 2020).The study aimed to determine the color stability of zirconomer before and after immersion in hot beverages.

MATERIALS AND METHODS:

This in-vitro study was done at White lab, material research centre at Saveetha dental college, Chennai. Before scheduling the research, the official permission was obtained from the institutional ethical committee.

Preparation of specimens

Zirconomer restorative material was taken for this study. A total of 8 disc-shaped samples were prepared (Figure 1). The Zirconomer specimens were prepared by dispensing the powder and the liquid in the proper proportion of 1:1 according to the manufacturer's instructions. It was then loaded into PTFE molds and allowed to set. They were retrieved from the molds after hardening. The excess flash if present were trimmed and smoothened with the help of polishing bur and micromotor. Only the specimens which were found to have a smooth surface finish were taken for further experiment.

Figure 1: Sample preparation

Preparation of Staining or immersing solutions

Required quantities of tea, coffee were measured and taken in a beaker (Figure 2).

Immersing method

The hydrated specimens were immersed in glass beakers containing the tea solution, coffee solution, and distilled water separately. 3 samples were added in both tea and coffee solution and 2 samples were added to distilled water solution. The specimen immersed in distilled water was taken as the control group for 24 hrs. Then they were rinsed with distilled water and were checked for color stability using a VITA Easyshade Advance spectrophotometer.

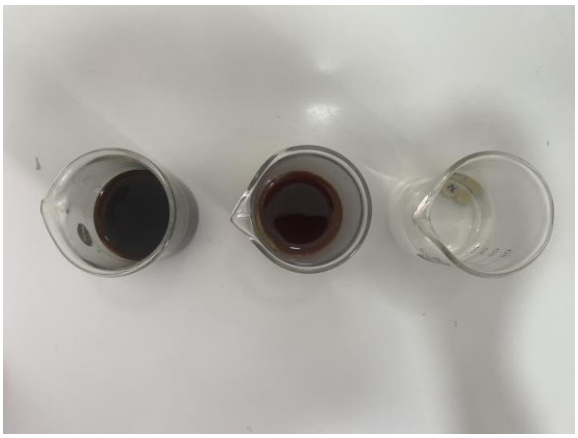


Figure 2: Immersion of samples in solutions

Calculation of color stability

For the determination of color stability, a spectrophotometer of reflection time was used for measuring the color changes (ΔE) based on the Commission Internationale de l'Eclairage lab (CIELAB) system. The color values of specimens before and after immersing were considered as pre and post-values of the materials micro-hybrid and the values were noted. The ΔE values were calculated to determine the degree of alteration in color at different stages. For this, the ΔE values were calculated using the formula from the L*ab values,

where *L** represents brightness or lightness (value)

a * and b * serve as numeric correlates both for hue and chroma.

The obtained values were analyzed using SPSS software version 23.0. The formula used was ΔE(L* a* b*) = [(ΔL*)2 + (Δa)2 + (Δb)2].

In which, ΔL* is the difference between the L* values

Δa* is the difference between the* values

Δb* is the difference between the b* values.

RESULT:

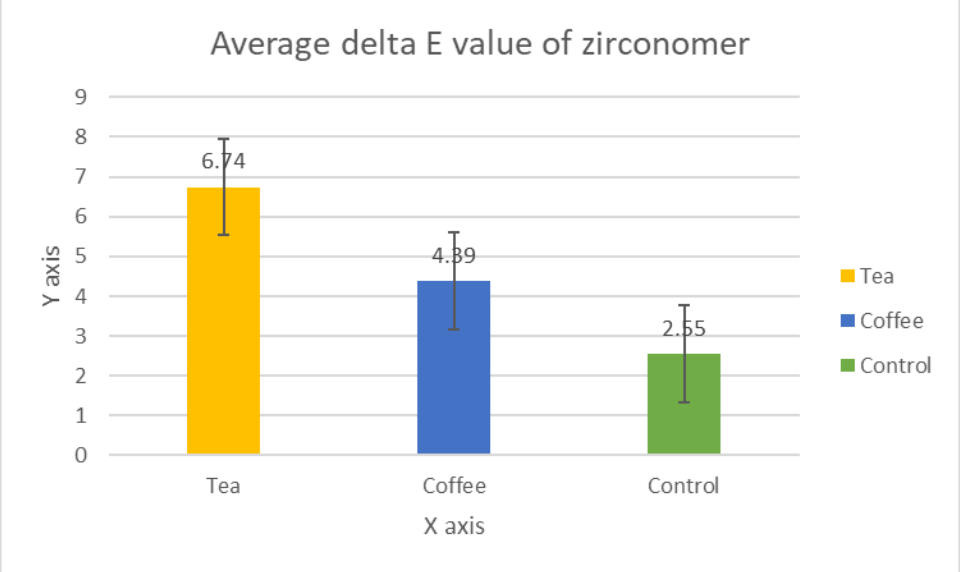
The use of the CIELAB for the evaluation of tooth-colored restorative materials is considered a universally accepted technique. The use of the L*a*b color axes for the measurement of color change is universally accepted as a better method than using more subjective shade guides. From the above figures, it can be seen that Zirconomer samples immersed in tea were more stained than Zirconomer samples immersed in coffee and least stained in control. The descending order in which Zirconomer was stained in immersing solutions is as follows: tea>coffee>control. In the tea solution, the ΔE value of Zirconomer was 6.74, the ΔE value in coffee was 4.39 and in the control group, the ΔE value was 2.55 (Table 1). The ΔE value of the zirconomer in the tea solution was higher than coffee and the control group.

A bar graph was plotted against the sample and mean ΔE values. It was found that tea has more mean ΔE values than coffee and control which indicates tea is less color stable than coffee and control (Graph 1). A paired sample t-test was done to find out the p-value. p= 0.667 >0.05 which is statistically not significant (Table 2).

Table 1: The table shows the average ΔE values of Zirconomer when immersed in tea, coffee, and control solutions.

Samples	**Tea**	**Coffee**	**Control**
Average ΔE values of Zirconomer	**6.74**	**4.39**	**2.55**

Graph 1: The graph depicts the association between samples and mean delta E value, where blue denotes 'Mean ΔE value of coffee', green denotes ''Mean ΔE value of control group' and yellow denotes ''Mean ΔE value of tea'. The x-axis represents the samples and the y-axis represents the Mean ΔE value. On comparing the above three, Mean ΔE values of tea were higher than coffee and control, which indicates zirconomer in tea solution is less color stable than coffee and control. A paired sample t-test was done to find the p values and was found to be statistically not significant (p= 0.66).



DISCUSSION:

Color stability of different dental restorative materials have been researched by following various immersion protocols in various studies. In a previous study the author had stated that among GIC, Zirconomer, and composite resin, the composite exhibits significant discoloration values when exposed to commonly used pediatric drugs. The high value of discoloration resulted in an increased proportion of silane structure in the material. The composite resins with a high amount of resin matrix, low concentration, and larger-sized filler particles have more tendency toward discoloration (Kale *et al.*, 2019).

A study reported that due to less color stability offered by reinforced glass ionomer cement it cannot be adequate to use as anterior esthetic restoration (Pani *et al.*, 2020). In a study when a compomer and resin-modified glass ionomer immersed in whiskey for 60 days demonstrated unacceptable color changes ΔE more than 11 (Abu-Bakr *et al.*, 2000). In another study, the degree of color stability of the restorative materials varied, according to the beverage in which they were immersed. For all the materials, immersion in chocolate milk and cola resulted in higher rates of color change (Kucukyilmaz *et al.*, 2019).

Another study found that conventional GIC showed more resistance to color changes (Kalimireddy *et al.*, 2015). In a study, the results were found out to be that the addition of reinforcing materials significantly reduces the color stability of glass ionomer cement (Yap, Teo and Teoh, 2001). Another study reported that the presence of inert zirconia filler particles and the difference between the refractive index of filler particles and reacted glass particles may also contribute to color change (Diaz-Arnold and Wilcox, 1990).

The present study suggested that zirconia reinforced glass ionomer cement (zirconomer) when immersed in hot beverages showed color changes. Zirconia-reinforced GIC was introduced to enhance the mechanical properties of conventional GIC as well as to overcome drawbacks of previously used tooth-colored esthetic restorative materials. Though the color stability of Zirconomer in a variety of immersing solutions has won interest amongst the researchers, the staining impact on the use of hot drinks has not been pronounced much. Hence, the current study has shown the impact of color stability of Zirconomer when immersed in hot drinks like tea and coffee. The limitations of the current study have a comparative lesser sample size so the results cannot be determined accurately. The samples can also be

tested in various solutions like drugs and syrups. Further research can be done in different solutions and more samples for determining the color stability of the zirconomer**.**

CONCLUSION:

The present study evaluated the influence of tea and coffee on the color stability of Zirconomer and compared their effects when immersed in hot drinks. It can be concluded that tea produced a higher degree of color change than coffee in the prepared zirconomer samples.

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