RESEARCH PAPER

Comparison of Color Stability of Conventional and Hydroxyapatite Modified Glass Ionomer Cements After Immersion in Fruit Juices: An In Vitro Study

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ABSTRACT

Background: Glass polyalkenoate, sometimes referred to as glass-ionomer cements (GICs), have been widely employed in restorative dentistry as luting materials, cavity liners, and fillings[1,2]. Glasses that can be ionized make up GICs. Wilson and Kent at the Laboratory of the Government Chemist in London, UK, first used conventional glass ionomer cement (GIC) in 1971. [7] It was made of ion-leachable aluminosilicate glass and an aqueous copolymer of acrylic acid solution. Hydroxyapatite inclusion in the GIC composition is one method. It is commonly known that hydroxyapatite (HA), an inorganic compound with a composition similar to natural bone mineral, belongs to the apatite group (a group of mineral phosphate). The aim of the study is to compare the color stability of conventional type 2 GIC and hydroxyapatite GIC after immersion in Fruit juices.

Materials and methods: 2 groups of samples were taken - conventional GIC, hydroxyapatite modified GIC nanoparticles. 8 disc shaped samples were prepared in total, 4 from each group having 10mm and 2 mm in thickness as dimensions. Orange and grape juices of required amounts were taken in glass beakers and color stability was checked with the help of a spectrophotometer and one way ANOVA using SPSS software version 23.0 was used for statistical analysis.

Results: It was observed that hydroxyapatite modified GIC had the maximum color stability with a ΔE value of 17.20 and conventional GIC had the minimum color stability with a ΔE value of 2.75. On analysis of p-value via one way ANOVA, it was observed that p-value is 0.35, which is greater than 0.05, meaning that it is not significant.

Conclusion: On comparing the 2 groups, conventional GIC was the least color stable than Type 2 modified GIC when immersed in the fruit juices.

Keywords: Conventional GIC, Fruit juices, Color stability, Hydroxyapatite modified GIC, Glass ionomer cement

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INTRODUCTION:

Glass polyalkenoate, sometimes referred to as glass-ionomer cements (GICs), have been widely employed in restorative dentistry as luting materials, cavity liners, and fillings(1) (2). Glasses that can be ionized make up GICs. Based on a poly (acrylic) acid aqueous solution and a calcium fluoro-aluminum-silicate system, or occasionally an acrylic itaconic acid copolymer. Thus, the creation of multivalent counterions-containing, acidic polymer chains that are ionically cross-linked is implicated in the setting reaction, leading to the self-hardening process(3)(4). The latter chance is credited due to the inherent chemical properties of GICs, which include their low exothermic setting reaction and adhesion to metals and bone (5,6). Additionally, the inclusion of bioactive particles, such as hydroxyapatite (7) or sol-gel bioglass (8), can improve the bioactivity of traditional GICs.

The use of glass ionomer cement in adhesive dentistry dates back many years. It is mostly utilized as a restorative material, while it is occasionally employed as an interim base or liner (1,9). The particular adherence of GIC to teeth to avoid corrosion or leakage, the gradual release of fluoride ions over time to maintain dental health, and its color resemblance to human teeth are just a few of the benefits that make it a popular choice for restorative materials (10). But no dental material possesses the optimal qualities for a dental application. The brittleness, poor fracture and wear resistance, unsuitable surface characteristics, and sensitivity to moisture when used in the oral cavity(11,12) are some drawbacks of GIC.

Wilson and Kent at the Laboratory of the Government Chemist in London, UK, first used conventional glass ionomer cement (GIC) in 1971(13). It was made of ion-leachable aluminosilicate glass and an aqueous copolymer of acrylic acid solution. This cement has several different qualities, such as fluoride release, adherence to enamel and dentin, thermal expansion resembling dentin, and biocompatibility. Glass ionomer is commonly used as cement in dentistry, although it has numerous drawbacks, the most significant of which is that it lacks sufficient strength and durability. As a result, there have been numerous efforts made to modify GIC in order to improve its mechanical and physical properties. Hydroxyapatite inclusion in the GIC composition is one method. It is commonly known that hydroxyapatite (HA), an inorganic compound with a composition similar to natural bone mineral, belongs to the apatite group (a group of mineral phosphate). The chemical formula for HA is Ca10(PO4)6(OH)2, which distinguishes it from other apatite compounds by having a hydroxyl end-member of the apatite group (14,15). With a calcium-to-phosphate ratio of 1.67 (Ca/P = 1.67) and a hexagonal crystal shape, HA is a significant mineral present in bone and teeth(16) . According to Ramsden and colleagues, HA contains osteoconductive and bioactive qualities that make it an excellent orthopedic and dental application.

Color stability, sometimes referred to as chromaticity stability, refers to a light source's capacity to preserve its color characteristics over time. For both dentists and GIC producers, the oral environment presents unique difficulties. Saliva, oral microbiota, frequently ingested colorful food, and fizzy beverages all come into contact with the cement after a GIC restoration. The conventional kind of GIC's physicochemical characteristics, in particular, are crucial during the early phases of setup and are highly impacted by the environment.The unfavorable environment may have an adverse effect on the material's mechanical and aesthetic qualities, which will eventually affect its long-term therapeutic performance (17). Aesthetic issues may result from the GIC's surface degradation. According to certain investigations, standard GI restoratives exhibited the greatest color alterations, particularly under acidic conditions(18,19). So the aim of the study is to compare the color stability of conventional type 2 GIC and hydroxyapatite GIC after immersion in Fruit juices.

Materials and method

1. **Preparation of specimen**

For this investigation, three different kinds of GIC were used. One was hydroxyapatite GIC, while the other was standard GC. 8 disc-shaped samples in total, 4 of each type. According to the manufacturer's directions, these GIC specimens were made by pouring the powder and liquid in the right amounts, loading them into PTFE (polytetrafluorethylene) molds, and letting them cure. After they had dried and hardened, they were removed from the molds, and any extra flash was removed and smoothed out using a polishing bur and micromotor. The experiment was only carried out on specimens that were determined to have smooth surface finishes.

2. **Preparation of staining or immersing solutions** Fruit juices in the required amounts were weighed and put into a beaker.
3. **Immersing method**

The samples were submerged in glass beakers filled with four samples of orange juice and four samples of grape juice, respectively. After that, they were rinsed with distilled water and tested with a Vita simple shade advance spectrophotometer for color stability.

4. **Calculation of color stability**

In order to determine color stability, a spectrophotometer of reflection time based on the Commission Internationale de l' Eclairage lab (CIELAB) system was employed in 1976 to measure color variations (E). The L*a*b color space is another name for CIELAB. Perceptual lightness, abbreviated L*, refers to values of lightness to darkness that range from 0 to 100. A* and B* stand for the four distinct colors that the human eye can distinguish, where A* stands for green to red and B* for blue to yellow, with values ranging from -127 to +128. Prior to immersion, the color values of the specimens were used as a baseline. The Konica Minolta CM 5 Spectrophotometer was used to determine the L, a, b, and E values for color stability. Then, using SPSS software version 23.0, pre and after immersion values were compared and examined.

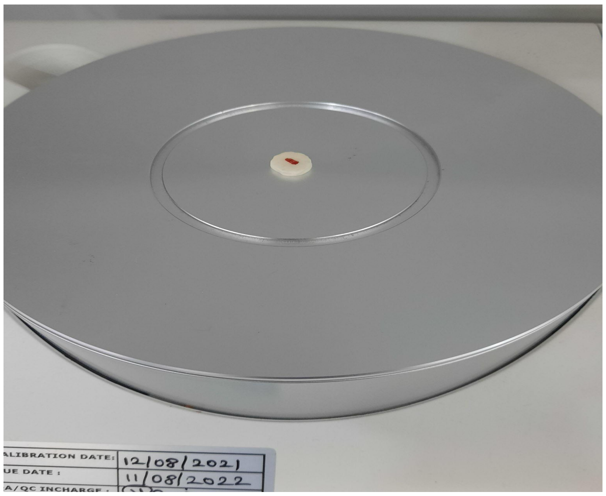

FIGURE 1: Represents the Konica minolta CM-5 spectrophotometer

RESULT:

The mean and standard deviations were calculated by descriptive statistics and the groups were compared using ANOVA test. The P value was not significant when <0.05. Table 1 shows the comparison of mean values, standard deviation of the 2 different groups and the significance. The p value is 0.3589, meaning that it is not significant.

GROUP	MEAN	STD.DEV	P VALUE
1	8.07	6.2084	0.3589
2	12.315	5.8736	0.3589

TABLE 1: Table represents the mean, std deviation and p value of the study of the 2 groups after being immersed in juices.

DISCUSSION:

Long-term color stability of restorative materials is crucial for the effectiveness of dental treatments since it increases patient pleasure and trust, particularly in sectors like aesthetic and pediatric dentistry. One of the primary reasons that restorative resins fail is color instability, which results from their lengthy and continuous contact in the mouth cavity to different types of drinks with pigments, germs, fizzy beverages, meals with spices, etc.(20)

Similarly another study also showed that carbonated beverages showed the highest color change among different immersion media (21,22). This could have been due to the change in the surface roughness and low pH which led to the increased adsorption of color from the beverage(23). In a study that looked at how color stability and degree of conversion affected nano and micro hybrid composites, the findings revealed that although nano composites had a higher degree of conversion, they also displayed less color stability and had higher E values when exposed to coffee solutions (24,25). A recent study from 2021 found that all forms of soft drinks caused composite and GIC materials to discolor in an unsatisfactory way, and that a micro hybrid submerged in iced tea caused the most degradation. Its delta E value for polyacid-modified composite resin immersed in coffee and tea was higher than it was for cola, according to an in vitro study looking at the susceptibility of restorative staining by liquids such tea, coffee, and cola(26). Similar to this, a 2020 study discovered that a high viscosity glass ionomer cement exposed to cola had the most color change(27). However, exterior coloring and hardness modification were not able to affect nanohybrid composite resins (28).

In this current study we could see that the Hydroxyapatite modified GIC has more color stability than the conventional GIC, Glass ionomers are frequently employed as an aesthetic restorative material, especially in primary teeth, despite the fact that they lack the aesthetic advantages of composites. According to research, glass ionomers' color stability decreases when additives are used. The degree and clinical importance of this color instability, however, differ depending on the filler particle type used. It has been shown that the L a b axis approach using the CIELAB system is the most recommended way out of the many ones that may be employed to detect color changes(29). The system enables the use of accurate, quantitative, and repeatable color change recording. Hence by using this method we could conclude that Hydroxy apatite modified GIC is more color stable than conventional GIC(30). The study's sample size was limited, and the immersing solutions utilized for comparison were not as numerous. It will take more research with a large sample size to determine how fizzy beverages affect restorative materials. Future in vivo studies can be performed to evaluate the treatment's efficacy. Thus, based on the aforementioned publications, it can be concluded that GIC enhanced with nanoparticles and restorative materials are negatively impacted by fruit juices as well as other drinks like coffee and tea.

CONCLUSION:

The current study evaluated the influence of fruit juices on 2 types of GIC with respect to color stability and on comparing the 2 groups it was concluded that Hydroxyapatite modified GIC was more color stable with respect to color stability, after immersion on Fruit juices.

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Conflict of interest

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