# Evaluation of the Effects of Different Mouthrinses on the Color Stability of One Type of Glass Ionomer, Compomer and Giomer


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***Received 12 September 2015 and Accepted 18 November 2015***


## Abstract

**Objectives:** The aim of this study was to evaluate the effect of four commercially available mouthrinses on the color stability of one type of glass ionomer, giomer and compomer. **Method:** 60 disc-shaped specimens, 180 in total (7*2mm), fabricated from each of the following materials: A resin modified glass ionomer Fuji II LC (GC International Corp), a giomer Beautifil II (SHOFU INC) and a compomer Ionosit (DMG). All specimens were stored in artificial saliva at 37˚C for 24 hours in an incubator. The initial colour value (L*,a*,b*) were recorded with spectrophotometer according to CIELAB scale. After baseline evaluation, the specimens were divided into five subgroups, according to the testing and control storage solutions (n=12). Randomly selected specimens from each material were immersed in 20 ml of the treatment solutions (Oral-B Pro Expert, Listerine, Colgate Plax, Irasha) at 37˚c for 24 hours. Each specimen was then subjected to second color measurement. The collected data was statistically analyzed using two-way analysis of variance (ANOVA) and Tukey's HSD at a significance level of 0.05. **Results:** All samples displayed color changes after immersion in the mouthrinses. The observed color difference showed that mouthrinses have a significant effect on the color shift of tested materials. A significant interaction was found between the materials and the mouthrinses. Overall, discoloration with all mouthrinses was significant when compared to the control specimens stored in artificial saliva. Oral-B induced the highest level of discoloration ($\Delta E^*$= 11.62 in Compomer) and the least discoloration was found with Irsha ($\Delta E^*$= 1.47 in RMGI). **Conclusions:** All tested restorative materials showed a color shift after immersion in mouthrinses, amongst which compomer displayed the highest change. Discolorations were clinically perceptible in most of the cases. Thus it can be concluded that daily use of mouthrinses increases the stainability of tested materials**.**



**Key words:** artificial saliva, bracket, galvanic corrosion, orthodontic archwire.

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Razavi R, AhmadiZenouz G, Gholinia H. Jafari M. Evaluation of the Effects of Different Mouthrinses on the Color Stability of One Type of Glass Ionomer, Compomer and Giomer. J Dent Mater Tech 2016; 5(1):36-42.


## Introduction

Tooth-colored restorative materials have been widely used to meet patient's esthetic needs in restorative dentistry (1). Color matching plays an important role in achieving good results. However, discoloration of tooth colored restorations may occur from time to time, and may lead to patient dissatisfaction and replacement of these restorations (1, 2). Currently, the demand for products with adhesive and caries protective properties together have led to the development of restorative materials that combine conventional glass ionomer and light cured resin (3). Hence fluoride-releasing esthetic restorative materials have been extensively used due to their caries preventive effect (4). There are different kinds of fluoride-releasing tooth-colored material, introduced to dental practice including: glass ionomer, resin modified glass ionomer, compomer and giomer.

Glass ionomer cements (GICs) were introduced in 1970s for the first time showing two individual properties; fluoride release and adherence to both enamel and dentin. Nevertheless, one of the major weak points of conventional GICs was color instability. Thus, different hybrid restorative materials, such as resin modified glass ionomer cement (RMGIC) followed by poly-acid modified glass ionomer, so-called compomers and Giomer, developed to improve both physical and esthetic properties of the materials(4,5). Compomer is a hybrid material combining properties of resin composites (comp) and glass ionomers (omer). Dimethacrylate monomers with two carboxylic groups present in their structure and filler particles, similar to glass present in GIC, are two main components of these materials (6). Lately Giomer has been introduced to field of dentistry as a new group of hybrid fluoride releasing aesthetic material. Since Giomers are hybrid material of glass ionomers and resin composites, they have fluoride release properties and acceptable aesthetic, polishability and strength (7). However, there is limited information regarding the color stability of these hybrid restoratives.

Discoloration of tooth-colored restorative materials may be caused by internal and external factors. External color changes can be due to absorption or adsorption of stains (8). Impact of external discoloration depends on factors such as type of staining particles, surface roughness, type of restorative material and duration of exposure to coloring environment(9), hygiene habits and smoking (10).

Color stability of cosmetic restorative materials to date has been widely tested. A laboratory study has shown that foods and drinks can affect the dental composites (11). In addition, due to the increasing use of mouthwash solutions, they are considered to be another factor for color change. Although the main use of oral rinses is an effective plaque and gingivitis control method, people also tend to use mouth-rinses for social and cosmetic reasons (12). It has been reported that the use of oral rinses for three weeks caused discoloration of natural teeth, which was clinically unacceptable (2). Mouth rinse solutions have various components such as detergents, emulsifiers, organic acids and dyes; which could affect the color of restorative materials.

Despite the increased use of mouthrinses, research comparing color changes associated with use of them is limited. Thus, the aim of the present study was to evaluate the effect of four different oral rinses on the color stability of three different kind of fluoride-releasing materials.

The null hypothesis tested in present study was that daily use of mouth rinses does not significantly affect color stability of tested restorative material.

## Materials and Methods

Four types of mouth-rinses (Oral-b, Colgate, Listerine, Irsha) and three restorative material were used in this study (RMGI, compomer and Giomer). Artificial saliva was used as control group. pH of the mouth-rinses was determined with pH meter. The details of material used in this study are available in Table 1.

One-hundred eighty disc shaped specimens, sixty from each restorative material, were made in prefabricated celluloid mould with dimensions of 7*2 mm to match with the tip of VITA Easyshade Advance® (VITA Zahnfabrik). Restorative materials were placed into moulds and covered with a 1mm width glass slab. Each specimen was light-cured with VALO broadband LED light cure device (light intensity> 800 mW/cm2) for 20 seconds on both sides. Light intensity was checked with a radiometer (Kerr, Demetron, Orange, CA, USA). After polymerization, the upper surface of each specimen was ground with 600, 800 and 1000-grit silicon carbide papers successively, under running water.

All specimens were stored in artificial saliva at 37˚c for 24 hours in an incubator, allowing post polymerization. Prior the insertion of samples in the treatment solutions, the initial colour values (L*,a*,b*) were measured and recorded for each specimen using spectrophotometer (VITA Easyshade Advance®) in basic shade measurement mode against a white background by placing the probe tip perpendicular and flush with the specimen surface. The spectrophotometer was calibrated before colour measurement of each sample by placing the probe tip against the calibration block.

The amount of color shift was recorded in CIELAB system, which is a three-dimensional color space: color luminosity that varies from white to black (L*), and the chromaticity of the color as a* and b*, red-green (a*), and blue-yellow (b*).

After baseline evaluation, the specimens were divided into five subgroups, according to the testing solutions (n=12). Randomly selected specimens from each material were immersed in 20 ml of the treatment solutions at 37˚c for 24 h, which is equivalent to 2 minutes daily use for 2 years of mouth rinses. Specimens were kept in dark container and maintained inside incubator throughout the study.

After 24h, specimens were removed and washed under running water. Each specimen was then dried and subjected to second color measurement.

The total color difference ΔE* was calculated using fallowing formula:

ΔE* = (ΔL*2 + Δa*2 + Δb*2)1/2

The collected data was statistically analyzed using two-way analysis of variance (ANOVA) to evaluate the effects of the material type and mouth-rinse on color changes, and Tukey's HSD (Honestly Significant Differences) between the means when ANOVA test was significant. The level of significance was primarily set as 0.05 in all tests.

**Table1.** Tested restorative materials.

| Material | Principal components | Manufacturer instructions | Manufacture |
|---|---|---|---|
| **Beautiful II (Nano-hybrid resin based Giomer material)** | Matrix: 16.7wt% of resin (Bis-GMA and TEGDMA).<br>Filler structure: Surface Pre-Reacted Fluoroboroaluminosilicate Glass Filler, Nano Filler, MultiFluoroboro-aluminosilicate Glass Filler (68.6vol% and 83.3wt%) | 1. Dispense the necessary amount of material from the syringe into the mold. The dispensed material should be protected from light.<br>2. Pack the material into the mold.<br>3. Light cure the material for 20 sec. | SHOFU INC., Kyoto, Japan |
| **Fuji II LC (resin modified glass ionomer)** | Powder: Fluoroaluminosilicate glass<br>Liquid: acrylic acid, maleic acid, HEMA, water, comphorquinon<br>Filler content: 76% by weight, 55% by vol. | 1. Adequate powder to liquid ratio is 1:2.<br>2. Put 1 scoop of powder on pad and divide it to two<br>3. Spread liquid out to thin layer<br>4. Pull half of the powder and mix<br>5. Pull in remaining powder and mix to a glossy consistency.<br>6. Light cure for 20 sec. | GC International Corp., Tokyo, Japan |
| **Ionosit (compomer)** | Ionomer glass in a matrix of polymerizeable oligo- and polycarbonic acids<br>Ionomer glass used contains fluoride and zinc ions<br>Filler content: 72% by weight, 55% by vol. | 1. Dispense the necessary amount of material from the syringe into the mold. Prevent the material from premature activation by ambient light and close the syringe immediately after use.<br>2. Light cure the material for 20 sec. | DMG , Germany |

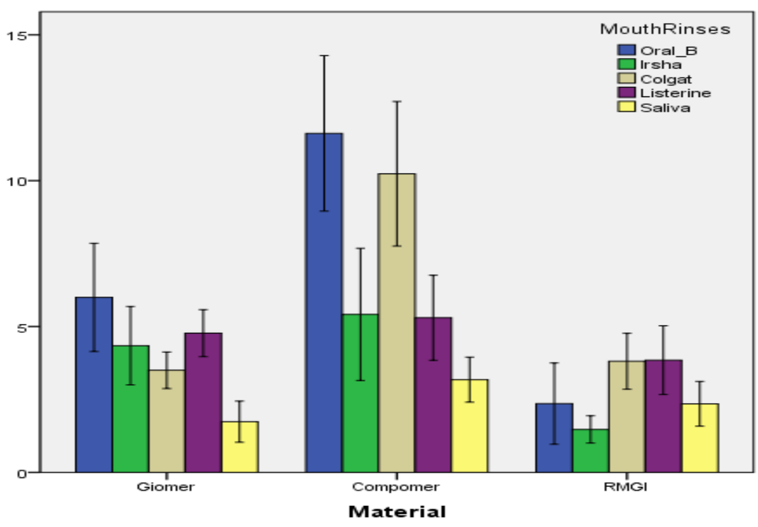


**Figure 1.** ΔE values of tested restorative materials in different solutions.

**Table 2.** Mean value and standard deviation (SD) of color change (ΔE*) of test materials listed for each solution separately

| | Compomer | Giomer | RMGI |
|---|---|---|---|
| **Oral-B** | 11.62±4.19(a) | 5.99±2.91(b) | 2.35±2.1(c) |
| **Colgate** | 10.23±3.90(a) | 3.50±0.98(b) | 3.81±1.51(b) |
| **Irsha** | 5.41±3.56(a) | 4.34±2.11(a) | 1.47±0.73(b) |
| **Listerine** | 5.30±2.29(a) | 4.77±1.26(a) | 3.84±1.85(a) |
| **Saliva** | 3.17±1.21(a) | 1.7±1.1(bc) | 2.35±1.20(ca) |

Same letters in the same rows were not significantly different (ρ<0.05)

**Table 3.** Mean value and SD of color change (ΔE*) of test materials after 24H immersion in different solutions

| | Oral-B | Colgate | Irsha | Listerine | Saliva |
|---|---|---|---|---|---|
| **Giomer** | 5.99±2.91(c) | 3.50±0.98(ab) | 4.34±2.11(bc) | 4.77±1.26(bc) | 1.73±1.10(a) |
| **Compomer** | 11.62±4.19(a) | 10.23±3.90(a) | 5.41±3.56(b) | 5.30±2.29(b) | 3.17±1.21(b) |
| **RMGI** | 2.35±2.18(ab) | 3.81±1.51(a) | 1.47±0.73(b) | 3.84±1.85(a) | 2.35±1.20(ab) |

Same letters in the same rows were not significantly different (ρ<0.05)

## Results

Figure 1 and tables 2 and 3 present the means and standard deviations (SD) of the color change values (ΔE*) of each material after immersion in the test and control solutions.

The results of the present study showed that the ΔE of compomer is higher (ΔE*=7.15) than that of Giomer (ΔE* = 4.07) and RMGI (ΔE* = 2.76).

All samples displayed color changes after immersion in the mouthrinses. The results showed that the effects of the mouthrinses on the color change of the materials were different from that of control solution. In other words, statistically significant interaction was found between the materials and the mouthrinses (P<0.001).

As mentioned, Compomer (Ionosit) was the material with the highest discoloration and there was a significant difference between ΔE* values of compomer and two other materials, Giomer (P<0.001) and RMGI (P<0.001). Also the color shift of RMGI and Giomer were significantly different from each other (P<0.001).

Amongst specimens immersed in artificial saliva, all material showed color change less than 3.3, which is considered visually un-perceptible. Overall, comparing to the control specimens stored in artificial saliva, discoloration derived from the four mouthrinses was significant (P<0.001).

Among the four test solutions, Oral-B induced the highest level of discoloration (ΔE*= 11.62 in Compomer). Least discoloration was found in Irsha (ΔE*= 1.47 in RMGI). Post immersion ΔE* values in Listerine, were not significantly different between restorative materials (P=0.17).

Comparison of discolorations with the oral rinses after immersion for 24 hours revealed significant differences (P<0.001). Amongst the Giomer specimens, those immersed in Oral-b showed highest level of ΔE* which was significantly different from Colgate (P=0.013) and artificial saliva (P=0.000….). Comparing mouthrinses affecting compomers, Oral-b showed highest value of ΔE*, significantly different from Irsha (P<0.001), Listerine (P=<0.001) and artificial saliva(P<0.001). Listerine and Colgate both together showed highest color shift for RMGI.

## Discussion

The present study evaluated the effect of four commercially available mouthrinses on the color stability of three different fluoride-containing tooth-colored restorative materials. According the results of current study daily use of mouthrinses increased the staining of these materials, thus the null hypothesis of the study should be rejected.

The results showed that all test materials had colour changes with □E values ranging between 1.47 and 11.62. In dentistry a discoloration that is more than perceivable (□E< 1.0) will be rated as acceptable up to a value of □E = 3.3 which is considered the upper limit of acceptability. Discoloration with □E values above this level will be rated as unacceptable (13).

In the current study compomer showed the greatest color change in comparison with a RMGI and a Giomer. Among the treatment groups, compomer in Oral-B mouthwash showed the highest level of discoloration ($\Delta E$ = 11.62± 4.19).

It is suggested that many internal and external factors may change the color of an aesthetic restorative material (14). Additionally, color changes have been reported to be dependent on the brand (15).

Compomers and Giomers are similar in being a hybrid material in which both are made up of a composite component and a GI component (16). The main difference between these two materials is that in Giomer, the acid-base reaction of the glass component occurs before incorporation within the resin matrix and pre-reacted glass particles are present in Giomer. But, in compomers, factors for the acid-base reaction are present in the material and once the setting reaction of the resin component took place, they initiate the acid-base reaction by absorbing water (17). It is reported that compomers are designed to absorb water up to 3.5% by mass on soaking (18), Thus, the process of water absorption could be a possible reason for the high value of $\Delta E$ of compomer.

The filler concentration of Beautifil II (Giomer) is 68% by volume while the filler concentration of Ionosit (compomer) is only 55% by volume. The fact that resin matrix content of Ionosit is high could be a possible reason that this material showed highest rate of discoloration. In previous studies, greater filler volume, showed the lowest color change rates (9, 12).

Water sorption also might be another possible reason of discoloration through degradation. Other fluids, like colorants of the mouthwashes, could be absorbed alongside with water by the resin matrix. Resin matrix can absorb water directly, but the glass particles only can adsorb water onto the surface and will not absorb water into the bulk of restoration. Hence, there are two main factors controlling amount of water sorption which are the resin content and the quality of bond between filler and resin matrix (19).

Ionosit not only has a low volume fraction of filler but also has an incomplete silanization of the filler that could be linked with its low color stability (6).

The results of the present study showed that RMGI exhibited higher color stability as compared to Giomer. This finding is not supported by previous studies, as glass ionomers have hydrophilic natures and supposed to absorb water more than resin-based materials (4, 20). In a similar study Gurdal et al reported greater discoloration of a composite than a conventional glass ionomer and they mentioned that a possible reason for this observation might be the composition of the resin matrix (12).

According to Villate et al., solutions with low pH could affect the surface integrity of composite resins and cause discoloration (21). We found that at the pH of approximately 6 (Colgate Plax) $\Delta E$ of Compomer and Giomer was not significantly different. Likewise, in a previous study, it has been reported that at this pH a compomer and a Giomer showed a surface roughness which is not significantly different (22). Thus, we might assume that color change and surface roughness could be related to each other. Asmussen et al. suggest that pH of test solutions has no effect on color change of restorative materials (23). In present study despite relatively low pH of Listerine (4.03) there was no evidence of significantly higher discoloration caused by this mouthwash comparing to other mouthwashes.

In tested materials, the highest $\Delta E$ value was seen in Oral-B mouthrinse, which was significantly higher than that of the artificial saliva. This finding was consistent with results of Celik et al., which also reported that Oral-B caused the highest discoloration (1). A possible reason for the former statement might be the idea that less polar colorants and polyphenols in the colorants may have penetrated into the materials, probably because these kinds of colorants are more compatible with the polymer matrix of these materials.

In present study we were not able to find a significant relation between PH of mouthrinses and their effect on color change of restorative materials. Although, it seems that Irsha mouthwash with pH value of 6.7 (saliva=6.2 – 7.4) has the lowest effect on discoloration.

In clinical situations, there might be different factors affecting color stability of restorative material such as presence of saliva, salivary pellicle and effect of different foods and beverages, which are difficult to be replicated. Since exposure to different substances in the oral environment is cyclic, another critical factor would be the method of exposure to staining solutions. Further experiments are therefore needed to resemble in vivo conditions. vitro.

## Conclusion

The results of the present study indicate a significant difference between effect of mouthrinses and artificial saliva on color change of tested restorative materials. In most of cases the discolorations were clinically perceptible. All fluoride releasing restorative materials showed color shift after immersion in test solutions. Oral-B caused the highest discoloration and Irsha caused the lowest. The highest color change occurred to compomer and RMGI affected the least. In a nutshell, we can conclude that daily use of mouthrinses increases the staining ability of these materials.

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