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# Comparative Evaluation Of Surface Roughness Of Two Commercially Available Glass Ionomer Cement Before And After Immersion In Fizzy Drinks - An *In Vitro* Study

Research Article

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## Abstract

**Introduction:** Glass ionomer cement is a restorative material used in dentistry. It is used for its good biocompatibility and fluoride releasing properties. The aim of the study is to assess the surface roughness of two different brands of glass ionomer cement before and after immersion in fizzy drinks.
**Materials and Methods:** Two different brands of GIC collected (D-tech and Pyrax). Samples were prepared with the help of moulds. Around 6 samples were prepared in their own group. The prepared samples were trimmed to 2.5 mm using a polishing kit. Ra, Rq, Rz were calculated for pre and post immersion using a stylus profilometer- Mitutoyo SJ310, 2µm tip/60 degree angle. The immersion medium used is coca cola, 7 up and distilled water).
**Results:** On analysing the findings, Ra, Rq and Rz value of both types of GIC used got reduced after immersion in Coca cola, 7 up and distilled water. Ra and Rq values of all the six samples for each group before immersion remain constant and Ra and Rq values of all the six samples of each group after immersion also remain constant. But the Rz values of both the brands of GIC showed variations. Independent sample t test was done. P value is 0.097, considered to be statistically significant.
**Conclusion:** Our present study concludes that surface roughness of GIC decreases after immersion in fizzy drinks.

**Keywords:** Glass Ionomer Cement; Surface Roughness; Innovative Measurement; Fizzy Drinks.

## Introduction

The beverages sector in India has undergone a drastic change in the past decade. Carbonated soft drinks are highly popular among the Indian population. They are commonly available at home, in fast food restaurants and in stores all over the country. The global market of fizzy drinks is anticipated to reach around 410 billion dollars by the year 2023, with an annual growth rate of about 2.8% [1]. Coca cola is one of the most commonly used beverages in India. It contains a large amount of water, sugar, carbonic acid, artificial colouring, phosphoric acid, caramel colour and caffeine [2]. It has comparatively less pH than other soft drinks. Low PH has a significant role in eroding the tooth surface, restorative material and helps in increasing the surface saturation [3]. In this research, 7 up was also used as a beverage. Filtered carbonated water, high fructose corn syrup, natural citric acid, natural flavours, and natural potassium citrate are the main ingredients in 7 up.

Conventional glass ionomer belongs to the class of material known as acid-base cement. International organisation of standardisation, ISO named glass ionomer cement as glass polyalkenoate cement. Glass ionomer cement is a type of dental restorative material used in the field of dentistry. It can be used as luting and filling material. Glass ionomers are formed based on the reaction of silicate glass powder and polyacrylic acids [4]. Components of GIC are water soluble acid, basic glass and water. These are commonly presented as an aqueous solution of poly-

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meric acid and finely divided glass powder, which is mixed by an appropriate method to form viscous paste that sets rapidly. The benefits of glass ionomer cement is it adheres to the tooth structure, protecting the pulp, eliminating secondary caries and preventing leakage at margins [5]. Glass ionomer cements are primarily used in the prevention of dental caries. It acts as good adhesive material because it forms a tight bond between the internal structures of the tooth and the surrounding environment [6]. Initially glass ionomer cements were recommended for restoring class III and class V cavity preparations and were intended for the cosmetic restoration of anterior teeth. Further changes to the material structure have now been made in order to enhance its properties. Due to the flexible nature and easy preparation, glass ionomer cements are widely used.

Acid-base reaction occurring in the setting reaction of GIC explains that it is hydrolytically unstable in its early stages of setting. For at least one hour after mixing, they were extremely vulnerable to water loss and uptake. If the cement is left exposed to air during this period, it can dehydrate. If the materials are exposed to water, significant water absorption and elution of critical ions can occur. Despite its disadvantages, it has many benefits. Secondary caries inhibition is provided by fluoride released by GICs into the surrounding tissues [7]. Surface roughness is a feature of surface texture. In restorative procedures, one of the fundamental purposes is to obtain restorations with smooth surfaces without porosity, resulting in better aesthetics and minimising the accumulation of dental plaque [8]. Roughness is an important property of a restoration surface, as it can affect friction, wear, optical properties and mechanical attachment of foreign materials on the surface. Carbide burs, diamond burs, white abrasive stones and special aluminium oxide disc are used in finishing and polishing procedures. The use of a rotatory instrument to finish and polish glass ionomer cement restoration prematurely is one of the key causes of increased surface roughness [9].

GICs have been used in dentistry for a variety of purposes, including restoring incipient carious lesions, particularly in primary teeth. When selecting GICs as a restorative material, it is critical to understand the physical and mechanical properties of various brands and new products. Our study is aimed to assess the variation in the surface roughness of two different glass ionomer cements before and after immersion in different fizzy drinks.

## Materials and Methods

**Sample Preparation:**

Two different brands of GIC were chosen for this study. One was D-tech and the other one was pyrax. A total of 12 pellet shaped samples were prepared, 6 from each brand. The sample was prepared by dispensing the powder and the solution in proper proportion as per the manufacturer's instructions. Then they are loaded into Polytetrafluoroethylene (PTFE) mould and allowed to set. They were removed from the moulds after they had hardened, and the excess GIC was trimmed to about 2.5 mm before polishing with a polishing kit and a micromotor. The specimens were tested for their smoothness. Only selected samples were processed in the experiment. The samples were numbered for easy identification.

**Initial Surface roughness measurement:**

Initial surface roughness was measured before immersion into beverages. It was measured for each specimen using a stylus profilometer-Mitutoyo SJ310, 2µm tip/60 degree angler (Figure:1) . Measurements were obtained by placing a stylus attached to the device on the surface of the sample and the results were observed on the monitor screen. Measurements were taken twice from various sample categories.

**Immersion method:**

The measured samples were immersed into three different glass beakers containing coca cola, 7 up and distilled water. Two samples from each brand were immersed separately in coco cola, 7 up and distilled water separately. The sample immersed in distilled water was taken as control. The samples were immersed in the solutions for 6-7 days.

**Final surface roughness measurement:**

The surface roughness of each sample was analysed again using a stylus profilometer- Mitutoyo SJ310, 2µm tip/60 degree angled.

**Statistical Analysis:**

The readings obtained from the device were tabulated. Ra, Rq, and Rz each had their mean pre- and post-immersion surface roughness measured separately. Statistical analysis and graphs were made using SPSS version 23.0. The p value was calculated by an independent sample t test.

## Results

The Ra, Rq and Rz values of D tech and pyrax GIC before and after immersion in fizzy drinks is represented in (Table: 1). The statistical value obtained from the independent t test for Rz is p=0.097 (>0.05) statistically insignificant (Table: 2) Mean value of pre immersion is 0.006 and mean value of post immersion is 0.005. The standard deviation value was found to be 0.000 (Figure: 2). Mean value of pre immersion is 0.008 and mean value of post immersion is 0.007. The standard deviation value was found to be 0.000 (Figure: 3). Mean value of pre immersion is 0.074 and mean value of post immersion is 0.065. The standard deviation value of pre immersion is. The standard deviation value of post immersion (Figure: 4). Mean value of pre immersion is 0.006 and mean value of post immersion is 0.005. The standard deviation value was found to be 0.000 (Figure: 5). Mean value of pre immersion is 0.008 and mean value of post immersion is 0.007. The standard deviation value was found to be 0.000(Figure: 6). Mean value of pre immersion is 0.006 and mean value of post immersion is 0.005. The standard deviation value of pre immersion is 0.070 and post immersion is 0.06 (Figure: 7).

## Discussion

Our team has extensive knowledge and research experience that has translated into high quality publications [10-29]. Results show that the Ra, Rq and Rz value of both types of GIC used got reduced after immersion in Coca cola, 7 up and distilled water. Ra and Rq values of all the six samples for each group before immer-

**Figure 1. The surface roughness of different brands of GIC was measured using stylus profilometer-Mitutoyo SJ310, 2µm tip/60 degree angled.**

**Table 1. Represents the mean value of Ra, Rq and Rz among groups.**

| SAMPLES | IMMERSION MEDIUM | BEFORE IMMERSION | | | AFTER IMMERSION | | |
|---|---|---|---|---|---|---|---|
| | | Ra | Rq | Rz | Ra | Rq | Rz |
| D-tech-1 | Coke | 0.006 | 0.008 | 0.073 | 0.005 | 0.007 | 0.064 |
| D-tech-2 | Coke | 0.006 | 0.008 | 0.074 | 0.005 | 0.007 | 0.062 |
| D-tech-3 | 7up | 0.006 | 0.008 | 0.07 | 0.005 | 0.007 | 0.067 |
| D-tech-4 | 7up | 0.006 | 0.008 | 0.079 | 0.005 | 0.007 | 0.069 |
| D-tech-5 | Distilled water | 0.006 | 0.008 | 0.073 | 0.005 | 0.007 | 0.072 |
| D-tech-6 | Distilled water | 0.006 | 0.008 | 0.08 | 0.005 | 0.007 | 0.066 |
| Pyrax-1 | Coke | 0.006 | 0.008 | 0.071 | 0.005 | 0.007 | 0.067 |
| Pyrax-2 | Coke | 0.006 | 0.008 | 0.071 | 0.005 | 0.007 | 0.068 |
| Pyrax-3 | 7up | 0.006 | 0.008 | 0.068 | 0.005 | 0.007 | 0.066 |
| Pyrax-4 | 7up | 0.006 | 0.008 | 0.071 | 0.005 | 0.007 | 0.068 |
| Pyrax-5 | Distilled water | 0.006 | 0.008 | 0.075 | 0.005 | 0.007 | 0.069 |
| Pyrax-6 | Distilled water | 0.006 | 0.008 | 0.071 | 0.005 | 0.007 | 0.068 |

**Table 2. This table represents the mean, standard deviation and p value for D tech and Pyrax in different fizzy drink mediums.**

| Groups | Immersion medium | Mean | Standard deviation | Significance |
|---|---|---|---|---|
| Ra | D-tech | 0.001 | - | - |
| | Pyrax | 0.001 | - | |
| Rq | D-tech | 0.001 | - | - |
| | Pyrax | 0.001 | - | |
| Rz | D-tech | 0.0085 | 0.0038730 | 0.097 |
| | Pyrax | 0.003 | 0.0008165 | |

Independent sample t test was done. $p \leq 0.05$ is considered to be statistically significant.

**Figure 2. The bar graph represents the mean and standard deviation Ra value of pre and post immersion of D-tech. X axis represents the groups and Y axis represents mean value. Red colour represents the pre immersion value of D-tech and blue colour represents the post immersion value of D-tech. Mean, standard deviation value of pre immersion is 0.006, 0.000 and mean value, standard deviation of post immersion is 0.005, 0.000 respectively.**

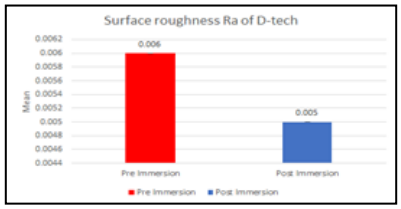



**Figure 3. The bar graph represents the mean and standard deviation Rq value of pre and post immersion of D-tech. X axis represents the groups and Y axis represents mean value. Red colour represents the pre immersion value of D-tech and blue colour represents the post immersion value of D-tech. Mean value, standard deviation of pre immersion is 0.008, 0.000and mean value, standard deviation of post immersion is 0.007, 0.000 respectively.**

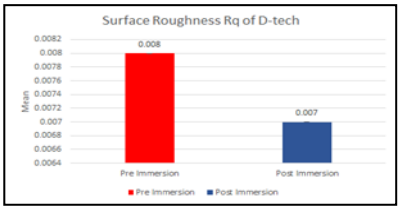


**Figure 4. The bar graph represents the mean and standard deviation Rz value of pre and post immersion of D-tech. X axis represents the groups and Y axis represents mean value. Red colour represents the pre immersion value of D-tech and blue colour represents the post immersion value of D-tech. Mean value, standard deviation of pre immersion is 0.074, 0.0037 and mean value, standard deviation of post immersion is 0.065, 0.0031 respectively.**

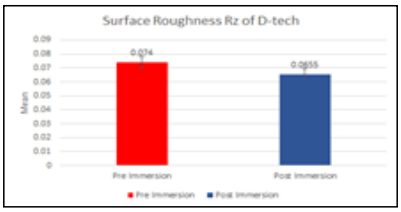



**Figure 5. The bar graph represents the mean and standard deviation Ra value of pre and post immersion of pyrax. X axis represents the groups and Y axis represents mean value. Yellow colour represents the pre immersion value of pyrax and green colour represents the post immersion value of pyrax. Mean value, standard deviation of pre immersion is 0.006,0.000 and mean value, standard deviation of post immersion is 0.005,0.000 respectively.**

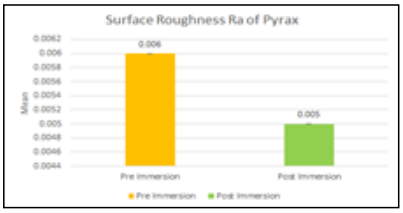



**Figure 6. The bar graph represents the mean and standard deviation Rq value of pre and post immersion of pyrax. X axis represents the groups and Y axis represents mean value. yellow colour represents the pre immersion value of pyrax and green colour represents the post immersion value of pyrax. Mean, standard deviation value of pre immersion is 0.008, 0.000 and mean value of post immersion is 0.007, 0.000 respectively.**

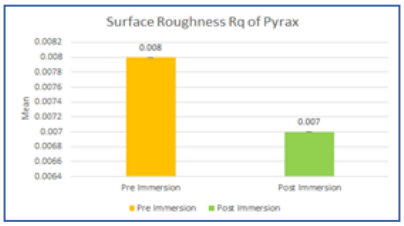
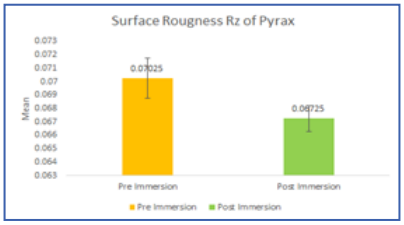



**Figure 7. The bar graph represents the mean and standard deviation Rz value of pre and post immersion of pyrax. X axis represents the groups and Y axis represents mean value. Yellow colour represents the pre immersion value of pyrax and green colour represents the post immersion value of pyrax. Mean value, standard deviation of pre immersion is 0.006, 0.070 and mean, standard deviation value of post immersion is 0.005, 0.06 respectively.**




sion remain constant and Ra and Rq values of all the six samples of each group after immersion also remain constant. But the Rz values of both the brands of GIC showed variations. In addition, as compared to other soft drinks, the storage medium coke/ Coca-cola in D-tech products has a lower surface roughness. It showed less surface roughness(Rz) value in both D-tech and pyrax brands. The critical surface roughness for bacterial colonisation is 0.2µm [30]. Surface roughness value above 0.2µm is likely to induce increased bacterial adhesion and can be a major cause for increased dental plaque. Glass ionomer cements are useful in atraumatic restorative treatment. They are used as tooth repair material. The technique of incorporation of GIC into ART was done by the world health organisation. One of the latest advances in GIC is nanofiller. They are used because they contain nano-sized powder and fluorapatite [31].

There are a variety of roughness parameters in use, but the most common is arithmetic mean roughness. To describe the surface, each roughness parameter is determined using a formula. The arithmetic average of all frames of the profile filtered by calculating the length from the line of the reference profile is referred to as arithmetic mean roughness (Ra). Ra has a threshold value of 0.2m below which no plaque formation (supra- and subgingival) is observed. Below this threshold, no further reduction in bacterial accumulation is required. Any increase in surface roughness above 0.2 m leads to an increase in plaque accumulation and, as a result, a higher risk of caries and periodontal inflammation [32].

Previously studies were done assessing the surface roughness of GIC comparing the thickness of the samples before and after polishing [33]. For finishing and polishing, there were several brushes used like fluted carbide bur, diamond bur, white abrasive stone and aluminium oxide disc. Many former articles stated that aluminium oxide burs have better surface properties of Glass

ionomer cement [34]. Surface roughness of the GIC can be increased by a variety of factors such as using rotary instruments. Particle size of the samples also plays an important role in material smoothness. Many previous studies stated that high values of critical surface roughness value were observed for the samples with larger thickness and particle size [35].

In our present study, Surface roughness before immersion in the soft beverages was high compared with the surface roughness after immersion. This shows that storage media of GIC specimens can affect the surface roughness [36]. They prepared a distilled medium as a storage medium for specimens. The chemical dissolution process can produce an increase in surface roughness. Other factors like the GIC liquid component, polishing process might influence the surface roughness. Water mixed GIC has low viscosity in the earlier stages of preparation and also improves the shelf life because there is no possibility of gelation occuring in its liquid. Inclusion of resin into the sample preparation does not improve the microhardness of GIC. Contradictory findings observed in Maganur et al study [37]. The study concludes that marginal integrity and surface texture of the GIC and composite analysed was directly linked to repeated exposure to low pH fruit beverages. In the mild, moderate, and extreme immersion regimes, the erosive effect of both Cola drink and fresh fruit juice produced substantial surface roughness on both flowable composite and RMGIC restorative materials. A study conducted by Sharafeddin et al also suggests that Zirconomer was found to be more resistant to carbonated beverages than GIC [38]. There was a positive correlation between the length of immersion time in the carbonated beverages and the surface roughness of GIC and Zirconomer. Our research had a few drawbacks, including a small sample size and the possibility of including more than two glass ionomer cements to provide a better commercially available GIC content. Only the surface roughness was detected; the analysis should have included more variables. Furthermore studies should concentrate on different parameters of commercially available composite which can be useful for consumers in dental health durability.

## Conclusion

Immersion of GIC restorative material in fizzy drinks such as coca cola and 7 up affected the surface roughness, it reduced the surface roughness of both D Tech and Pyrax brand glass ionomer cements.

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