Effect of turmeric tamarind solution on surface roughness of conventional glass ionomer cement

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Abstract. This study aimed to determine the effect of turmeric tamarind solution on the surface roughness of conventional glass ionomer cement. 20 specimens were immersed in packaged and nonpackaged turmeric tamarind solution (each n = 10) for 1, 3, 5, and 7 days. Results analyzed using two-way analysis of variance showed no significant difference (p > 0.05) between the packaged and nonpackaged turmeric tamarind solution but a significant difference in immersion duration between the two groups (p < 0.05). Surface roughness increased with longer immersion duration in turmeric tamarind solution.

1. Introduction
Turmeric tamarind is one of the most popular traditional drinks in Indonesia. It is available as packaged and nonpackaged solutions. The packaged solution is manufactured by Sido Muncul Company, Semarang, Indonesia, and the nonpackaged solution is self-made. The primary components in both the packaged and nonpackaged solutions are turmeric (Curcuma domestica Val.) and tamarind (Tamarindus indica L.) [1].

Indonesia medicinal plants and aromatic research centre reported that the pH value of turmeric and tamarind were 5.90 and 1.00, respectively. On the other hand, the pH value of packaged turmeric tamarind solution was 4.32 and that of nonpackaged solution was 4.50 [2]. Consuming foods and beverages with low acidity levels can cause erosion of dental hard tissue. The erosion occurs not only on the teeth but also on the dental restorative material. Exposure to low acidity solution can cause dissolution of restorative materials including conventional glass ionomer cement. Moreover, the surface of the conventional glass ionomer cement changes when exposed to acid in the oral environment [3].

Conventional glass ionomer cement is a dental restorative, adhesive, coating, luting agent, and pit and fissure sealant. Conventional type II glass ionomer cement was used as the restorative material in this study [4]. This type of material is used primarily because of its beneficial properties such as good adhesive bond strength to enamel and dentin. Furthermore, this material is remarkably biocompatible to teeth as it does not irritate the pulp, has great compressive strength, has good esthetics, and is anticariogenic because of its fluoride-releasing properties [5].
2. Methods
This was an experimental study conducted at the Dental Materials Laboratory, Faculty of Dentistry, Universitas Indonesia. Twenty conventional glass ionomer cement specimens were used in this study: 10 were immersed in packaged turmeric tamarind solution and the other 10 were immersed in nonpackaged solution. The immersion was performed for 1, 3, 5, and 7 days.

Specimens were made from conventional glass ionomer cement (Fuji IX GC Corp., Tokyo, Japan) composed of powder and liquid and manipulated based on the manufacturer’s instructions. The cement mixture was poured into a 6-mm diameter and 3-mm thick stainless steel mold until 20 specimens were there. The specimens were then coated with silicone oil, topped with cellulose matrix, and coated with microscope slide and a load of 1 kg was applied for 5 min. The load and the glass were retrieved, and the specimens were removed from the mold, inserted into plastic tubes filled with aqua dest, and stored in an incubator at 37 °C for 24 h. Initial surface roughness measurements were performed using a surface roughness tester (Surftest, Mitutoyo SJ-301, Kanagawa, Japan) device.

The first step in making the turmeric tamarind solution was to clean the turmeric. The clean turmeric was grounded, and the solution was extracted, boiled, and mixed with tamarind, brown sugar, and water. Plastic tubes of prepared specimens were then immersed in packaged and nonpackaged turmeric tamarind solutions for 1, 3, 5, and 7 days and stored in an incubator at 37 °C. Next, the specimens were removed, rinsed with water, and dried, and the solution was replaced once every 24 h.

Statistical data analysis was performed using two-way analysis of variance (ANOVA), followed by post hoc multiple comparison test with a significance of $\alpha = 0.05$, which was processed using SPSS Statistics, version 18.0 (PASW Statistics, SPSS, Inc., Chicago, IL, USA).

3. Results
The average surface roughness score (Ra) of conventional glass ionomer cement after immersion in turmeric tamarind solution is shown in Table 1. As shown, the surface roughness of conventional glass ionomer cement increased in a linear relationship with immersion durations of 1, 3, 5, and 7 days. Comparison with two-way ANOVA revealed an insignificant difference in the packaged and nonpackaged turmeric tamarind solution groups (Table 2); however, the difference was significant between the immersion durations.
Table 1. Average score of surface roughness (Ra) of conventional glass ionomer cement.

| Immersion Duration | Turmeric Tamarind Solution Group | Nonpackaged (n = 10) |
|--------------------|----------------------------------|----------------------|
|                    | Surface Roughness (Ra) ± SD (µm) |                      |
| Start              | 0.648 ± 0.071                    | 0.589 ± 0.131        |
| 1 Day              | 0.818 ± 0.121                    | 0.855 ± 0.141        |
| 3 Days             | 0.939 ± 0.125                    | 0.925 ± 0.117        |
| 5 Days             | 1.482 ± 0.112                    | 1.306 ± 0.202        |
| 7 Days             | 1.905 ± 0.152                    | 1.757 ± 0.188        |

Table 2. Results of two-way ANOVA on surface roughness score difference (Ra) of conventional glass ionomer cement between groups.

| Source               | Type III Sum of Squares | Df | Mean Square | F     | p value |
|----------------------|-------------------------|----|-------------|-------|---------|
| Corrected Model      | 1.890*                  | 5  | .378        | 77.000| .000    |
| Intercept            | 12.665                  | 1  | 12.665      | 2580.401| .000   |
| Group                | .011                    | 1  | .011        | 2.219 | .211    |
| Immersion duration   | 1.879                   | 4  | .470        | 95.695| .000    |
| Error                | .020                    | 4  | .005        |       |         |
| Total                | 14.575                  | 10 |             |       |         |
| Corrected Total      | 1.909                   | 9  |             |       |         |

a. $R^2 = .990$ (Adjusted $R^2 = .977$)

*p < 0.05  **(p > 0.05)

4. Discussion

In this study, surface roughness of conventional glass ionomer cement was increased after immersion in aqua dest at 37 °C for 24 h. Ra of glass ionomer cement that was previously immersed in packaged turmeric tamarind solution was 0.648 µm and that for the nonpackaged solution was 0.589 µm. These results were similar to those in a study by Bala et al. who reported that Ra after immersion in aqua dest at 37 °C for 24 h was 0.44–0.78 µm [9]. Tanthanuch et al. reported that Ra of 0.5 µm could change tongue perception and cause mouth discomfort [7].

There was no significant difference in the surface roughness score of conventional glass ionomer cement following immersion in either packaged or nonpackaged turmeric tamarind solution for 1, 3, 5, and 7 days, which is due to the insignificant difference in pH value between the packaged (4.32 µm) and nonpackaged (4.50 µm) turmeric tamarind solutions. The pH value of nonpackaged solution was higher than of the packaged solution because of the composition. The nonpackaged solution contained citric acid sourced from the tamarind, and the packaged solution contained less citric acid because of the additional citric acid added by the manufacturer (Sido Muncul). Citric acid increases the concentration of hydrogen (H+) ions, thereby decreasing the pH value in the packaged solution [10].

These results are also supported by a previous study by Zaki et al. who showed that the solution penetrated into the cement and caused the gel matrix to enlarge in size during immersion in the acid solution. The H+ ions diffused into the cement and switched places with the metal cation, which then diffused through the cement. When the glass ionomer cement and solution met, the ion bond was released from the cement to the solution, and the cement surface exposed by the H+ ion dissolved the glass particle. Thus, the dissolution process of the glass particles caused porosity on the cement.
surface [10]. Based on the study by Zaki et al., a pH value of 3.8 dissolution and degradation occurred on the cement material [10] and triggered the increasing surface roughness of the conventional glass ionomer cement [11].

This study illustrated a significant increase in the surface roughness score of conventional glass ionomer cement that had been immersed in packaged or nonpackaged turmeric tamarind solution for 1, 3, 5, and 7 days. Gao et al. reported that immersion of conventional glass ionomer cement for a long period could cause total dissolution of the filler particle, which was proven by the appearance of silica gel sedimentation in the acid solution [12]. Hamouda found a correlation between the increase in restorative material dissolved in acid solution and the increase in surface roughness [3], which was also supported by Ghanim, who found that dissolution of cement material could influence surface material degradation and biocompatibility [13]. Furthermore, dissolution played an important role in the dimensional change of cement, retention loss, discoloration, damage to the margin contour, and mechanical properties such as flexural strength and hardness.

In conclusion, the duration of immersion or exposure in acid solution could influence the surface roughness of the cement material [11]. Following the analysis, it can be said that, as the pH value becomes lower and the duration of exposure becomes longer, the H⁺ ions diffuse into the cement material, releasing the metal bond of glass ionomer cement, which eventually triggers the dissolution and degradation processes, thereby increasing the porosity of the cement surface. pH value, citric acid composition, and duration of immersion for 1, 3, 5, and 7 days, with an assumed 1–7 years of packaged or nonpackaged turmeric tamarind solution consumption, influenced the surface roughness of conventional glass ionomer cement, which was similar to that reported in the study by Miranda et al., who showed that surface roughness score could change not only restorative material but also teeth, directly correlating with pH value, solution composition, and duration of immersion or exposure [11].

5. Conclusion
According to the present study, immersion in turmeric tamarind solution caused a significant effect on the surface roughness of conventional glass ionomer cement. However, there was no significant difference in the surface roughness of conventional glass ionomer cement after being immersed in either packaged or nonpackaged turmeric tamarind solution.

6. References
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