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Research Article

Effects of Green Tea and Lemon Essential Oil Mouthwashes on Surface Roughness of Resin-Modified Glass Ionomer Cement

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ABSTRACT

Introduction: Resin-modified glass ionomer cement (RMGIC) is a restorative material developed with aim to overcome the weaknesses of GIC which has poor physical properties that can affect the surface roughness. A rough surface is a contributing factor to the accumulation of plaque and development of secondary caries. One of the factors that cause surface roughness is the use of mouthwash. **Objective:** To determine the effect of two essential oil mouthwashes on the surface roughness of RMGIC. **Methods:** Fifteen samples of RMGIC (cylindrical, 2 mm high and 10 mm in diameter) were divided into three treatment groups (n = 5 in each group). In group I, the samples were immersed in green tea essential oil mouthwash for 30 seconds. In group II, the samples were immersed in lemon essential oil mouthwash for 60 seconds. In group III, the samples were immersed in distilled water (control group). All the samples were immersed for 21 days at room temperature (37°C), with two repetitions. The surface roughness was then tested using a surface roughness tester (Taylor Hobson S100 Series; AMETEK Inc; United States of America). **Results:** The data were analyzed using one way ANOVA with Tukey's Post Hoc test ($p < 0.05$). Statistical analysis with One Way ANOVA test indicates a significant change in the value of surface roughness between the three groups. Tukey's Post Hoc test with $p=0.009$ shows a significant difference in testing the effect of green tea essential oil mouthwash. **Conclusion:** Green tea essential oil mouthwash affected the surface roughness of RMGIC compared to lemon essential oil mouthwash. However, both did not have a significant difference with control groups.

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INTRODUCTION

Dental restoration materials are continually being developed with the aims of improving their aesthetics, hardness, and adhesion strength to tooth structures.[1,2] Surface characteristics and wear resistance of restorative materials are both important criteria affecting the surface roughness of restorative materials.[3] Increasing in roughness is a predisposing factor for microbial colonization, which has the potential to increase the risks for oral disease, gingival inflammation due to plaque formation, and caries.[4] Thus, restorative materials are needed to maintain low surface roughness values over time.[5]

The commonly used tooth-coloured restoration material is resin modified glass ionomer cement (RMGIC) which contains resin hydroxyethyl methacrylate (HEMA) in its liquid composition.[6] HEMA is hydrophilic which causes greater water absorption and affecting surface roughness.[7] The main advantage of RMGIC is its ability to release fluoride. The use of fluoride has become popular in the community because it is believed to prevent cavities, including the use of mouthwash containing fluoride.[8,9] However, one previous study broke the myth and proved that no correlation was found between the release of fluoride from GIC with surface roughness.[10]

Green tea and lemon essential oil mouthwashes are non-alcoholic. There are four types of green tea essential oil mouthwash (eucalyptol, menthol, methyl salicylate, and thymol). and six varieties of lemon essential oil mouthwash (lemon, orange, grapefruit, bergamot, lime, and spearmint).[11,12] There is a study that compared the surface roughness of conventional GIC, giomer, and compomer immersed in chemical mouthwash (pH 5.3) and herbal mouthwash-containing essential oils (pH 4.7), it was found that conventional GIC has the highest surface roughness, followed by the compomer and giomer.[13] To determine whether the physical properties of RMGIC are better than those of conventional GIC, we investigated the effect of immersion in non-alcoholic essential oil mouthwashes on the roughness of RMGIC.

MATERIALS AND METHODS

In this study, laboratory experiments were conducted with post-test only control design. The research was performed at the Dental Material Testing and Center of Research (DMT Core), Faculty of Dentistry, Trisakti University. The sample for this research is Equia Forte RMGIC; GC, Tokyo, Japan shade A3 (LOT 1912201) was formed using a stainless-steel mould with a diameter of 10 mm and a height of 2 mm. Samples were made by taking one capsule of RMGIC and get activated by pressing the capsule applier once. One capsule RMGIC consists of 0.40 grams of powder and 0.10 mL of liquid. One capsule was put into the GIC Mixer for 10 seconds. After 10 seconds, the capsule was removed from the GIC Mixer and placed the capsule into the GC capsule gun applicator. The sample was placed into the stainless-steel mould by pressing the capsule tube using the GC capsule gun applicator. The samples were light cured for 20 seconds. After that, the sample is removed from the mould and trimmed.

The samples (n=15) were divided into three experimental groups (n=5 in each): immersion in green tea essential oil mouthwash (group I), immersion in lemon essential oil mouthwash (group II), and immersion in distilled water (control group). The green tea essential oil mouthwash used was Listerine (PT Johnson & Johnson, Indonesia) and the lemon essential oil mouthwash used was Oxyfresh (PT Ohawe, Indonesia). The pH measurements of the green tea essential oil, lemon essential oil, and distilled water were 4.7, 6.8, and 7.0, respectively. The samples in group I were immersed in 20 ml of the mouthwash for seconds, and the samples in group II were immersed in 20 ml of the mouthwash for 60 seconds, with two repetitions. Before the second repetition, the sample was immersed in distilled water following the immersion time of each mouthwash. After immersion in the mouthwash again, each sample was immersed in 20 ml of distilled water and incubated at 37°C. The distilled water in the control group was replaced every day, then followed by incubation at 37°C. After 21 days, surface roughness was measured using a surface roughness tester (Hobson Tester Surtronic S-100 Series AMETEK Inc, Berwyn, Pennsylvania). Measurements were made 3 times and the average value was taken.

Statistical Analysis

Data were analyzed by the Shapiro–Wilk normality test, followed by the Barlett test to investigate the homogeneity of variance. Next, each group was analyzed by one-way ANOVA and Tukey's Post Hoc test to determine differences in surface roughness between the three groups. $p < 0.05$ was set as significant level.

RESULTS

The surface roughness test results showed that the average roughness values in group I immersed in the green tea essential oil mouthwash was 1.79 µm, group II immersed in lemon essential oil mouthwash was 0.94 µm and group III immersed in distilled water was 1.41 µm (Table 1).

One way ANOVA analysis in 3 sample groups shows the p value was 0.012 it was concluded that there was a significant difference ($p<0.05$) in testing the effect of the green tea essential oil mouthwash and lemon essential oil mouthwash ($p=0.012$) (Table 2). Tukey's Post Hoc test results revealed a p value of 0.009 which means there is a significant difference between samples immersed in green tea essential oil mouthwash and samples immersed in the lemon essential oil mouthwash, but there was no significant difference with control group (Table 3).

Table 1. Mean surface roughness value (Ra, µm)

No. Sample	Essential Oil Green Tea	Essential Oil Lemon	Control
1	2.07	0.60	1.27
2	1.43	1.03	1.77
3	1.47	0.83	1.43
4	2.03	1.37	0.67
5	1.93	0.87	1.90
Mean	1.79	0.94	1.41

Table 2. One-way ANOVA test for 3 sample groups

Group	N	p-value
I	5	.012*
II	5	
III	5	

*p<0.05: Statistically significant difference

Table 3. Post hoc Tukey's test for 3 sample groups

Surface Roughness	Surface Roughness	p-value
Control	EO green tea	.278
	EO lemon	.156
EO green tea	EO lemon	.009*

*p <0.05: Statistically significant difference
EO: Essential Oil

DISCUSSION

The surface roughness of restorative material is an important factor related to the quality and durability of the material.[9] One of the factors that cause surface roughness is the use of mouthwash routinely.[14] Green tea essential oil mouthwash has a pH of 4.7 which makes it an acidic oral rinsing solution. Acidic compounds contain H+ ions which have the potential to cause dissolution and degradation on the surface of a restorative material. This is due to the H+ ions that will diffuse into the glass ionomer components and replace metal cations in the matrix.[15] When the metal ion decreases, more GIC dissolution occurs which causes the outer surface hollow and increases the surface roughness of the RMGIC.[16] Surface roughness is also influenced by the frequency and duration of using mouthwash. The condition of the oral cavity that is exposed to various kinds of food and beverages as well as chemicals will also affect the surface of the restoration material.[17,18]

As noted earlier, the HEMA component of RMGIC makes the material prone to water absorption, as well as matrix loss due to degradation of the bond between the filler and the matrix via hydrolysis.[19] The water absorption process causes degradation due to the hydrolysis process between the filler bond and the matrix.[16] Surface roughness occurs when water enters the polymer chain through porosity and intermolecular space resulting in expansion accompanied by the loss of several components such as filler particle oligomers which cause surface roughness of the restoration material. Surface roughness affects the attachment of microorganism which can easily lead to secondary caries.[20]

Green tea mouthwash contains sodium fluoride whereas RMGIC itself also capable to release fluoride so that the use of fluoride simultaneously can cause surface roughness. Setting reaction of RMGIC is an acid base reaction. This reaction will destroy the glass particles and release cations such as Al and Ca. These released cations form chelates with the carboxylate groups of the polymers resulting in cross-linking in the polymer network and forming a poly-salt matrix.[10] Selective attack by alkali metal fluoride will enter the poly-salt matrix between the glass particles. The degradation of the RMGIC surface when exposed to fluoride is the result of chemical erosion due to the disintegration of the poly-salt matrix between the glass particles. This chemical erosion occurs in fluoride containing glass and is influenced by cement composition, fluoride solution concentration, time and frequency of immersion. This cross-linking is essential for the hydrolytic stability of this cement, and when in contact with a fluoride solution, the fluoride concentration in the cement gradually increases, while fluoride ions compete with the carboxylate groups. Sodium fluoride will slowly disintegrate so that the filler particles will be exposed and the RMGIC matrix will be destroyed which results in a roughness topography (surface texture).[21]

Lemon essential oil mouthwash has a pH of 6.8, which is the normal pH in the oral cavity. Saliva has a normal pH range of 6.2–7.6, with an average pH in the oral cavity of 6.7. The neutrality of lemon essential oil mouthwash enables a balance (homeostasis) of microbes

in the mouth which results in healthy teeth and periodontal conditions.[22,23] Plaque formation is closely related to the characteristics of the surface of restoration material because a rough surface will increase the area for plaque formation.[24] Using mouthwashes with a normal pH can extend the longevity of RMGIC restorations by preventing increases in the surface roughness values of these materials.[25]

CONCLUSION

In conclusion, there is a significant difference between 3 groups after the samples were immersed, their surface roughness increases. Green tea essential oil mouthwash provided a higher surface roughness value of RMGIC than lemon essential oil mouthwash. However, both did not have a significant difference with control groups.

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Conflict of Interest

The authors declare that there are no conflicts of interest.

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