Surface roughness of composite resin veneer after application of herbal and non-herbal toothpaste

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Abstract. The aim of this study was to find out the surface roughness of composite resin veneer after brushing. In this study, 24 specimens of composite resin veneer are divided into three subgroups: brushed without toothpaste, brushed with non-herbal toothpaste, and brushed with herbal toothpaste. Brushing was performed for one set of 5,000 strokes and continued for a second set of 5,000 strokes. Roughness of composite resin veneer was determined using a Surface Roughness Tester. The results were statistically analyzed using Kruskal-Wallis nonparametric test and Post Hoc Mann-Whitney. The results indicate that the highest difference among the Ra values occurred within the subgroup that was brushed with the herbal toothpaste. In conclusion, the herbal toothpaste produced a rougher surface on composite resin veneer compared to non-herbal toothpaste.

1. Introduction
A good-looking appearance is important for most of society, especially women. One factor that influences physical appearance is the smile. Research studying physical appearance has reported that 87.7% of respondents consider that an aesthetic smile enhances facial appearance. Well-aligned anterior teeth seen while smiling could also affect appearance. Therefore, a problem affecting the teeth could interfere not only with the function but also the aesthetics of the teeth [1-2].

Nowadays, the use of laminate veneer has become popular among society because it could present a desired teeth color and morphology [2]. Laminate veneer is a technique to improve the function and aesthetics of teeth by covering the surface of the teeth with a thin layer of restoration material [3]. Widely used veneer materials are porcelain and composite resin; however, composite resin is believed to wear more quickly through brushing compared with porcelain veneers [4]. Nanofilled composite resin is a composite resin type that could be used as composite resin veneer material because of its good mechanical and aesthetic properties [5].

As restoration materials such as composite resin veneer will always come into contact with foods and saliva, it is important to maintain good hygiene of the restoration materials to prevent plaque retention. Tooth brushing is needed to remove the dental plaque that attaches to restorative materials. One ingredient of toothpaste is an abrasive material that serves to remove plaque, calculus, and stains from the teeth’s surface [6]. When the abrasive material is applied to the teeth or restorative material surface, these two surfaces will slide across each other and the rougher material will produce grooves or cuts in the other material, called abrasive wear [7]. Abrasions on a restorative material could result in a rough surface that influences oral hygiene because the plaque and food debris will attach more easily to the surface of the teeth.
Nowadays, many types of toothpaste with different brands and ingredients are available, including herbal toothpaste, which is made from plant products. Herbal toothpaste aims to protect the teeth and gingiva, and to strengthen the teeth without causing irritation. The typical plant product that is added to herbal toothpaste is siwak, which is useful for preventing oral cavities. Siwak serves as an active agent containing antibacterial and anticariogenic effects and could release fluoride. Siwak also contains silicate compounds and sodium bicarbonate, which act as abrasive materials to remove plaque and stains from the teeth’s surface [8, 9].

A previous study has shown that herbal toothpaste could lower the plaque index better than non-herbal toothpaste. Different from non-herbal toothpaste, herbal toothpaste uses natural ingredients [8-10]. Until now, the effect of herbal toothpaste on surface roughness of a nanofilled composite resin that is used as composite resin veneer has not yet been studied. Therefore, this study examines the surface roughness of composite resin veneer after applying herbal and non-herbal toothpastes to allow those who use composite resin veneers to choose a suitable toothpaste.

2. Materials and Methods
This study is a laboratory experiment performed in FKG UI Dental Material Laboratory. In this study, 24 specimens of composite resin veneer were divided into three subgroups. The first specimen group was a control group that was brushed without a toothpaste medium, the second group was brushed with Ciptadent® toothpaste, and the third group was brushed with HPAI® herbal toothpaste. All groups were brushed with an RoHS Electric Toothbrush®.

The tools and materials used in this study were a Mitutoyo SJ 301 surface roughness tester, an incubator, plastic pots, an RoHS Electric Toothbrush® soft brush (0.16 mm), AA batteries, plastic filling, a light-curing unit (LEDMAX-Hilux) with 700 mW/cm² irradiance, cylinder molds 4 mm in diameter and 2 mm tall, glass slides, a ruler, a mixing slab, an ultrasonic cleanser, aquadest, herbal toothpaste HPAI, Ciptadent® toothpaste, composite resin veneer (3M ESPE shade A2 nanofilled light-cured composite resin, batch no. N662388), silicon oil, and Mylar strips.

Cylinder molds 4 mm in diameter and 2 mm tall were used to make 24 composite resin veneer specimens, which were then soaked in the aquadest pot inside an incubator at 37 °C for 24 hours. The initial surface roughness of the composite resin veneer was measured using the Mitutoyo SJ 301 surface roughness tester at three different points on each specimen [11]. Each specimen from the three subgroups was brushed with an electric toothbrush for 10,000 strokes divided into two cycles [12]. In the first brushing session, specimens were brushed with an electric toothbrush for the first 5,000 strokes, the second brushing session continued with the additional 5,000 strokes. The brushing process was performed with a 200-g load. The toothpaste applied to each specimen was mixed with aquadest, with a 1:1 weight-based ratio [12]. At the end of each brushing session, the specimens were rinsed with water, put into ultrasonic cleanser for five minutes, dried, soaked in aquadest, and stored inside an incubator at 37 °C for 24 hours before measuring the surface roughness [11]. The roughness measurement was performed three times: before brushing, after the first brushing session, and after the second brushing session. The result of the surface roughness measurement was analyzed using SPSS software, Kruskal-Wallis test, and the Post Hoc Mann Whitney test.

3. Results and Discussion
3.1 Results
Table 1 shows the results of the surface roughness value on the composite resin veneer specimens before and after brushing.

Table 1 shows the changes in the surface roughness values of the composite resin veneer in each variable subgroup. In subgroup A, the control group, which was brushed without a toothpaste medium, the surface roughness increased from 0.30±0.05 µm to 0.32±0.00 µm after the first 5,000 strokes brushing session and to 0.33±0.00 µm after the second brushing session. Based on the results, the
mean surface roughness of the composite resin veneer in the control group (subgroup A) increased from $\Delta R_a=0.02$ µm after the first brushing session to $\Delta R_a=0.03$ µm after the second brushing session.

### Table 1. Composite resin veneer mean of surface roughness value

| Sub-Group | Toothpaste type                  | Before brushing mean (µm) | After first brushing mean (µm) | After second brushing mean (µm) |
|-----------|----------------------------------|---------------------------|-------------------------------|---------------------------------|
| A         | Aquadest                         | 0.30±0.05                 | 0.32±0.00                     | 0.33±0.00                      |
| B         | Ciptadent® toothpaste            | 0.30±0.05                 | 0.35±0.09                     | 0.42±0.07                      |
| C         | HPAI® Herbal Toothpaste          | 0.30±0.05                 | 0.39±0.07                     | 0.46±0.07                      |

In subgroup B, which was brushed using Ciptadent® toothpaste, the surface roughness increased from $0.30\pm0.05$ µm to $0.35\pm0.09$ µm after the first brushing session and to $0.42\pm0.07$ µm after the second brushing session. Based on the results, the mean surface roughness in subgroup B increased from $\Delta R_a=0.09$ µm after the first brushing session to $\Delta R_a=0.16$ µm after the second brushing session.

In subgroup C, which was brushed using HPAI® herbal toothpaste, the surface roughness increased from $0.30\pm0.05$ µm to $0.39\pm0.07$ µm after the first brushing session and to $0.46\pm0.07$ µm after the second brushing session. Based on the results, the mean surface roughness in the subgroup C specimens increased from $\Delta R_a=0.09$ µm after the first brushing session to $\Delta R_a=0.16$ µm after the second brushing session. An inter subgroups mean comparison test was performed using the Kruskal-Wallis nonparametric test. Table 1 shows the results of the Kruskal-Wallis test. Table 2 presents the surface roughness value, analyzed by performing the Post Hoc Mann-Whitney test.

### Table 2. Post Hoc Mann-Whitney test result

| Experiment                  | Subgroup A – Subgroup B | Subgroup A – Subgroup C | Subgroup B – Subgroup C |
|-----------------------------|--------------------------|--------------------------|--------------------------|
| Before brushing             | .380                     | .613                     | .792                     |
| After the first brushing    | .090                     | .009                     | .597                     |
| After the second brushing   | .008                     | .000                     | .428                     |

The Mann-Whitney analysis test result showed that no statistically significant differences existed for the before brushing surface roughness value among the three subgroups ($p>.05$). After the first brushing, no significant differences were found between the no toothpaste subgroup and the Ciptadent® toothpaste subgroup, or between the Ciptadent® toothpaste subgroup and the HPAI® herbal toothpaste subgroup; however, a significant difference was found in the surface roughness value between the no toothpaste brushing subgroup and the HPAI® herbal toothpaste subgroup. The Mann-Whitney analysis test result also showed that, after the second brushing session, significant differences existed between the surface roughness values of the no toothpaste subgroup and the Ciptadent® toothpaste subgroup, and between the no toothpaste brushing subgroup and the HPAI® herbal toothpaste subgroup; however, no significant difference existed between the Ciptadent® toothpaste subgroup and the HPAI® herbal toothpaste subgroup.

In addition, the before and after treatment surface roughness values were compared using the Mann-Whitney test. Table 3 presents the results.
Table 3. Analysis results of surface roughness values before and after brushing

| Experiment                                      | A  | B  | C  |
|------------------------------------------------|----|----|----|
| Before brushing – After the first brushing     | .001| .141| .015|
| Before brushing – After the second brushing    | .000| .013| .001|
| After the first brushing - After the second brushing | .013| .058| .057|

*significantly different when \( p < .05 \).

The data analysis results for subgroup A show that statistically significant differences existed between the surface roughness value before and after the first brushing session, before and after the second brushing session, and after the first and second brushing sessions. In subgroup B, the \( p \)-values show that no statistically significant difference existed before and after the first brushing session and after the first and second brushing sessions (\( p > .05 \)); however, a statistically significant difference was evident in subgroup B before and after the second brushing sessions (\( p < .05 \)). In subgroup C, the data analysis results show that a statistically significant difference existed before and after the first brushing session, and before and after the second brushing session (\( p < .05 \)); however, no statistically significant difference existed after the first and second brushing sessions (\( p > .05 \)).

3.2 Discussion

Increased roughness on the composite resin veneer surface could occur because of the abrasive wear process, a mechanism that happens when two surfaces—the toothpaste and the composite resin—slide across each other; the rougher material creates grooves or cuts in the other material, producing scratches that create a rougher surface [7]. The same mechanism occurs on composite resin veneers brushed with different kinds of toothpastes. Subgroup B used non-herbal Ciptadent® toothpaste with silica and calcium carbonate as abrasive agents, while subgroup C used HPAI® herbal toothpaste with the same silica and calcium carbonate as abrasive agents and added siwak as a herbal ingredient containing silica and sodium bicarbonate [9]. The abrasive ingredients in the toothpaste produced friction on the composite resin veneer surface, thus increasing the surface roughness value.

The abrasive property of toothpaste is affected by many factors such as abrasive particle types, morphology, size, abrasive particle quantity inside the toothpaste, and the amount of toothpaste applied. The different characteristics of the abrasive agents affect the degree of abrasion on the composite resin veneer surface.

Initially, the composite resin surface was quite smooth and shiny because of its contact with the Mylar strip while being set. The composite resin initially contained a lot of resin matrix, and very little filler particle was exposed to the surface [13]. Brushing with a toothpaste medium causes abrasion on the composite resin surface. In the abrasion process, abrasive agents inside the toothpaste scratch the composite resin matrix, resulting in erosion to the matrix on the restoration material surface. The abrasion produced a rougher surface because the resin matrix became worn and the filler particles became loose or more prominent [14-15].

To measure whether the roughness increased after brushing with different toothpaste mediums, a control subgroup (without toothpaste brushing) was used. In this study, a statistically significant difference was found in the surface roughness value in the control group, which was 0.02 \( \mu \)m after the first 5,000 strokes brushing and 0.03 \( \mu \)m after the second 5,000 strokes brushing. These values indicate an increase in the composite resin surface roughness, even though no toothpaste medium was used. This increase happened because of the abrasive effect of the toothbrush, and thus supports the findings of a study showing that brushing alone could increase the composite resin surface roughness value [16].

The surface roughness value of the composite resin veneer increased significantly in the experiment that used toothpaste containing abrasive agents. This finding showed that abrasive agents
could increase surface roughness, and thus confirmed a theory stating that abrasive agents in toothpaste could abrade composite resin and increase the surface roughness value [15].

When using the Ciptadent® toothpaste for brushing, a significant increase in surface roughness value was found after the second set of 5,000 strokes brushing (0.12 µm). However, when using the HPAI® herbal toothpaste for brushing, a significant increase was found in the surface roughness after the first 5,000 strokes (0.09 µm) and after the second 5,000 strokes (0.16 µm). However, no statistically significant difference was found in the surface roughness value between the Ciptadent and HPAI® herbal toothpastes after both the first and second brushing sessions.

Abrasive agents contained in the Ciptadent® toothpaste consist of silica, calcium carbonate, and sodium monofluorophosphate as active agents that serve to decrease the bacterial ability to produce acid and support the teeth remineralization process. However, the abrasive agents contained in HPAI® herbal toothpaste comprise silica, calcium carbonate, and siwak. Siwak contains silica and sodium bicarbonate as active agents that have been known from a previous study to serve as abrasive agents [9]. This abrasive agent is most likely why the HPAI® herbal toothpaste could increase the surface roughness value of the composite resin veneer after only the first 5,000 strokes of brushing, which was faster than the Ciptadent® toothpaste.

4. Conclusion

After comparing non-herbal toothpaste (Ciptadent® toothpaste) and herbal toothpaste containing siwak (HPAI® toothpaste), this study found that HPAI® herbal toothpaste produced a rougher surface on composite resin veneer after the first 5,000 strokes of brushing. Further studies should evaluate the composition of the size, morphology, and particle quantity of the abrasive agents in each toothpaste. The antibacterial and anticariogenic effects of herbal toothpastes could also be studied in the future.

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