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RESEARCH ARTICLE

Impact of immersion in papaya juice on color and surface roughness of nanohybrid composite resin

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ABSTRACT

Nanohybrid composite resin is well-known because of its good aesthetic properties. It has high water sorption, allowing various coloring substances such as papaya juice to penetrate. Papaya juice enzymes may also cause a rougher composite resin surface. This study determined the effect of papaya juice on color and surface roughness of nanohybrid composite resin using laboratory experiment. This study used posttest with control group design containing 27 samples of nanohybrid composite resin (B & E Korea XS-FIL A3.5) with diameter of 10 mm and thickness of 2 mm. The samples were divided into 3 groups: immediate, control, and treatment group. The samples of immediate group were tested directly for color and surface roughness. The treatment group was immersed in papaya juice for 3 hours followed by 21 hours in distilled water, while the control group was immersed in distilled water for 24 hours. All samples were immersed in an incubator at 37 °C for 4 days. Changes in color and surface roughness were tested using a VITA Easyshade V spectrophotometer and a Taylor Hobson surface roughness tester, respectively. ANOVA and post hoc Tukey showed a significant ($p < 0.05$) change in color ($p = 0.003$) and surface roughness ($p = 0.000$); significant ($p = 0.033$) color change was obtained between the immediate group (E = 6.933) and the treatment group (E = 7.959). In terms of surface roughness, significant ($p = 0.000$) results were obtained between the treatment group (Ra = 1.974 µm) with the immediate group (Ra = 1.411 µm) and the control group (Ra = 1.404 µm). In conclusion, papaya juice causes changes in color and surface roughness of nanohybrid composite resin.

Keywords: color change; nanohybrid composite resin; papaya juice; surface roughness

INTRODUCTION

Papaya has been widely cultivated because it is easy to grow and has high nutritional content.[1] One of the world's top producers of this fruit is Indonesia.[2] In recent years, the consumption of papaya in Indonesia has increased.[3-5] Additionally, papaya fruit contains the proteolytic enzyme called papain.[6] This proteolytic enzyme may prevent plaque formation on teeth which helps in teeth whitening by breaking down proteins and disrupting protein pellicles.[5]

Composite resin is one of the most well-known dental restorative materials due to its strength and aesthetic properties.[7] It is often used in replacing missing tooth structures and in improving aesthetics. Composite resins can be classified based on their filler size distribution. Modern composite resins, known as nanohybrids, are made up of both nano (< 100 nm) and submicron (≤ 1 µm, usually averaging 0.5-1.0 µm) sized particles.[8]

The surface roughness of composite resin is important to guarantee its aesthetics. Papaya fruit contains a degradative enzyme (papain) which may cause changes on the surface of composite resin.[7] In a study by Kamadi and Liliany, immersion in pineapple juice, which also has proteolytic enzymes like papaya, has an effect on the surface roughness of nanohybrid resin, whether preheated or non-preheated.[9]

In addition, according to research by Münchow et al, stain removal gels containing papain enzyme have significant clinical potential as an active ingredient for hydrogen or carbamide peroxide-free stain removers.[10] Moreover, research by Ribeiro et al also indicates changes in color of the enamel surface during bleaching using gels containing papain enzyme.[11] The aim of this study was to evaluate the color and surface roughness of composite resin after immersion in papaya juice. This study may also confirm the effect of excessive exposure to papaya fruit on composite resin.

MATERIALS AND METHODS

This posttest with control group design was conducted at Dental Material Testing Center & Center of Research (DMTCore), Faculty of Dentistry of Universitas Trisakti. Federer's formula was used to calculate the number of samples in a group, which amounted to 9. The samples were made by placing the nanohybrid composite resin (B&E Xs-FiL A3.5 shade LOT XF3523005) using a plastic filling into a stainless-steel mold measuring 10 mm in diameter and 2 mm in thickness that was set on a glass to ensure no trapped air bubbles. A glass slide was applied to the composite resin's upper surface, followed by exposure to light for 20 seconds using an LED light curing device, positioned at 1 mm from the nanohybrid composite resin surface and pointed in a direction perpendicular to the surface. The samples were removed from the mold after being cured.

The immersion solution was distilled water and papaya juice. The papaya fruit (250 g) was cut into pieces and juiced using a Hurom slow juicer for ± 2 minutes to produce 130 mL of 100% real papaya juice. Nanohybrid composite resin's disk samples were divided into 3 groups: Group 1 (immediate), with 9 samples, was directly tested for initial color and surface roughness. Group 2 (control), with 9 samples, was immersed in distilled water for 24 hours x 4 days in an incubator (37 °C). Group 3 (treatment group), with 9 samples, was immersed in papaya juice for 3 hours/day and followed by immersion in distilled water for 21 hours/day in an incubator (37 °C) for 4 days. The duration of immersion was based on the cumulation of papaya juice exposure for one year. The immediate group was evaluated in terms of the color and surface roughness of composite resin without any exposure to water and papaya juice. Color and surface roughness measurements on all samples from groups 2 and 3 were carried out on the 4th day.

All surface roughness measurements were carried out using a Taylor Hobson surface roughness tester S-100 series (Leicester, United Kingdom) and all color measurements were carried out using a VITA Easyshade V spectrophotometer. The color was measured by placing the tip of the spectrophotometer at a 90° angle to the surface of the sample in triplicate, and the average values of E (deviation in color), L (color brightness or darkness), C (color intensity) and H (subjective interpretation of color) were calculated and written down. A higher L value indicates a brighter color, while a lower L value indicates a darker color. A higher C value indicates a more concentrated color, while a lower C value indicates a lighter color. A higher H value indicates a yellowish color, while a lower H value indicates a reddish color. The surface roughness of each sample was measured by placing the stylus tip of the surface roughness tester at a 90° angle to the surface of the sample in triplicate. The average Ra value was then calculated and written down. The data were analyzed using SPSS 27 software. The normality of the data was tested using the Shapiro-Wilk test ($n < 50$). A one-way ANOVA test was used, followed by the post hoc Tukey test since the data were normally distributed ($p > 0.05$). The data of group 3 and group 2 were compared to group 1, as the immediate group.

RESULTS

The highest E value for deviation in color was obtained by the control group. Meanwhile, the treatment group obtained the highest value for surface roughness, namely 1.97 µm. The results of the normality test for the color and surface roughness using the Shapiro-wilk method showed a significance value of $p > 0.05$ for all the groups. This means that the data were normally distributed, so the one-way ANOVA test was then conducted. The ANOVA test showed there was a significant ($p < 0.05$) change in color ($p = 0.003$) and surface roughness (p = 0.000). Tukey's post hoc test showed that group 1 (immediate) was significantly different ($p < 0.05$) from all the other groups in terms of E value. However, there was no significant difference between group 2 (control) and group 3 (treatment). There was no significant difference between all the groups for L value. For C value, a significant difference was obtained between group 1 and the other groups, but no significant difference was identified between group 2 and group 3. For H value, however, group 2 was significantly different from the other groups. In terms of surface roughness, significant (p = 0.000) results were obtained between treatment group (Ra = 1.974 μm) with immediate group (Ra = 1.411 μm) and control group (Ra = 1.404 μm). The result of mean value and statistical analysis is shown in Figure 1.

DISCUSSION

This experimental laboratory research used a posttest design, with Group 1 assumed as the pre-treatment group (pretest). The samples from

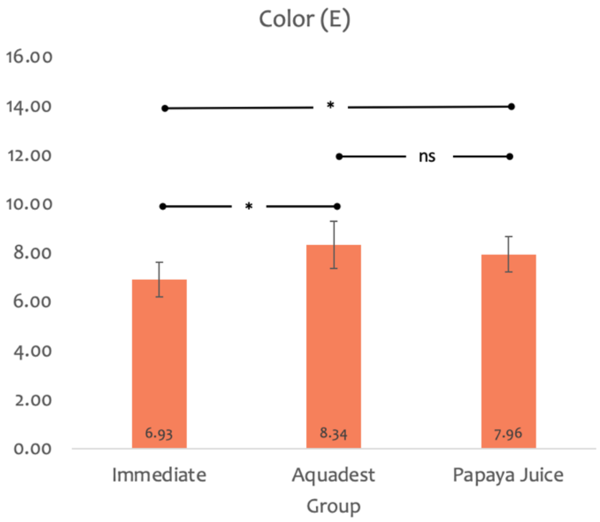

Figure 1. The mean and standard deviation of E from each group. (*$p < 0.05$; ns: non significance)

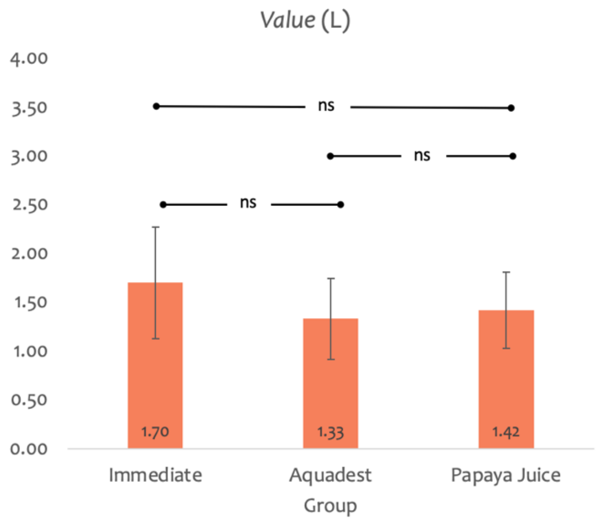

Figure 2. The mean and standard deviation of L from each group. (*$p < 0.05$; ns: non significance)

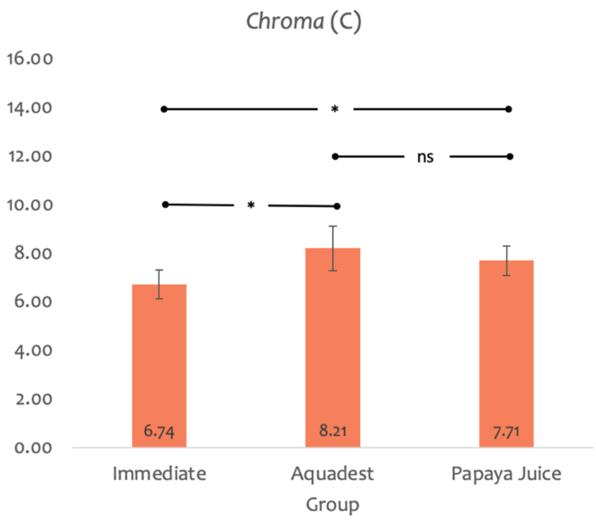

Figure 3. The mean and standard deviation of C from each group. (*$p < 0.05$; ns: non significance)

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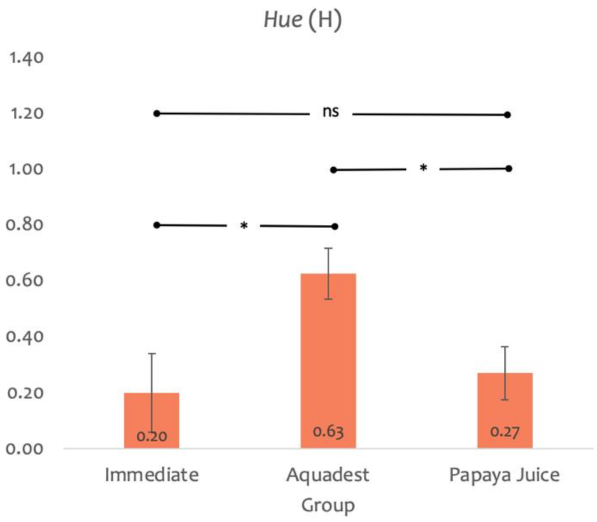

Figure 4. The mean and standard deviation of H from each group. (*p < 0.05; ns: non significance)

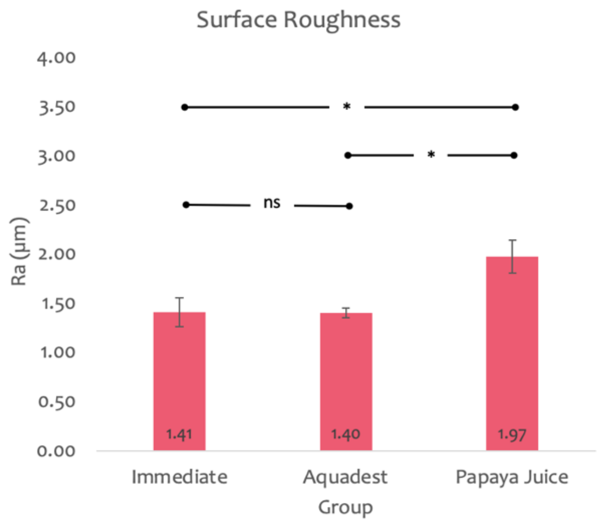

Figure 5. The mean and standard deviation of E from each group. (*p < 0.05; ns: non significance)

each group were subjected to color test using the VITA Easyshade V. The color deviation of the nanohybrid composite resin samples was represented by the ΔE value; the larger the ΔE value, the more pronounced the color change. A significant difference between Groups 2 and 3 compared to Group 1 was found using post hoc Tukey testing. Thus, it can be said that when the samples were immersed in papaya juice followed by immersion in distilled water, the overall color changed. Compared to Group 3, Groups 1 and 2 showed larger ΔE values, indicating that distilled water led to a more noticeable color change than papaya juice.[12] In this investigation, neither distilled water nor papaya juice (ΔE < 3.3, as compared to the immediate control group) generated clinically perceptible color changes.[13]

The L value represents the sample's color brightness level. A greater (positive) L value denotes a brighter color.[13] The control group had the lowest L value although the L values decreased in both the treatment and control groups. This implies that the samples immersed in distilled water had the lowest brightness.

The color intensity of an object is represented by its C value. A lighter color is indicated by a lower C value.[13] Significant variations in C levels were found by the post hoc analysis following immersion in papaya juice and distilled water. When compared to the immediate control, the papaya group's C value showed increasingly higher values, but the control group's C value was noticeably higher. This implies that, immersing the nanohybrid composite resin in distilled water caused the color to become less saturated than immersing it in papaya juice.

The dominating color in the red to bright yellow spectrum is indicated by the H value. More yellowish color is indicated by a higher positive H value.[13] The data obtained suggested that the samples immersed in distilled water and papaya juice turned more yellow.

The results of the color change test in this study indicated a color change in the nanohybrid composite resin after being immersed in papaya juice. In comparison to the immediate group, the treatment group's color changed to be brighter, more saturated, and yellowish. Intrinsic and extrinsic factors that are frequently exposed to restorations, such as inadequate polymerization, water absorption, food staining from the patient, and cleanliness practices, can cause color changes in composite resin.[14]

Water has a major role in the occurrence of color change in composite resin because it serves as a medium for the color pigment found in papaya juice, called carotenoids, to permeate into the matrix of the composite resin.[15,16] Papaya juice's major pigment, carotenoids, give its dark yellow color.[16] Additionally, water can seep straight into the matrix of the composite resin.[15] No water was used in the juice-making procedure in this research as papaya fruit itself already contain water. However, this causes a higher viscosity than that of distilled water. As a result, papaya juice absorbs less quickly than distilled water. This could account for the treatment group's color change results, which were smaller than those of the distilled water control group. Papaya juice's enzymes can also break down the pellicle layer, which helps brighten the surface and prevent plaque from forming.[10]

The surface roughness test showed a significant difference between Group 3 and Group 1, according to the post hoc Tukey test results. Consequently, it can be said that the immersion of the nanohybrid composite resin in papaya juice affected its surface roughness. The samples in this investigation had not been polished at the beginning, so their initial roughness values were higher than the essential threshold for surface roughness in the oral cavity (0.200 µm). According to a study by Numan Aydin et al (2021), polishing nanohybrid composite resin can offer a smoother surface.[17] The ester hydrolysis in the polymer matrix results in changes in the surface roughness of composite resin.[18] Enzymes can speed up the continuous breakdown of composite resin that occurs in the wet oral environment. Proteolytic enzymes called papain and chymopapain have been found in papaya juice.[19] Our findings are consistent with a study conducted in 2022 by Kamadi and Liliany, which also used pineapple juice, which contains papaya-like proteolytic enzymes.[9] Moreover, surface roughness is also influenced by acidity concentrations. Nanohybrid composite resins constantly exposed to acidic foods and drinks over time can undergo polymer chain breakdown.[20,21] Since the pH test was not done in this study, more research is required to determine how papaya juice's pH affects variations in the surface roughness of nanohybrid composite resin. Increased abrasiveness, wear from kinetic forces, and plaque buildup can all result from an increase in composite resin's surface roughness. This may increase the likelihood of periodontal inflammation and tooth cavities. The resistance of composite resin to discoloration is also influenced by surface roughness.[22]

The present study concludes that continuous consumption of papaya juice can change the color of the nanohybrid composite resin and make its surface rougher. Oral health and appearance may be affected by this.

CONCLUSION

Immersion in papaya juice can change the color of nanohybrid composite resin, giving it a brighter, more intense, yellowish hue, and also raise its surface roughness value.

CONFLICT OF INTEREST

The authors declare no competing interests.

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