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Research Article

Effect of Pineapple Juice (*Ananas comosus*) on Surface Roughness of Preheated and Non-Preheated Nanohybrid Composite Resins

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KEYWORDS

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non-preheated;
surface roughness;
pineapple juice;
acidic pH

ABSTRACT

Introduction: Nanohybrid composite resins is a type of composite consisting 2 different filler sizes, where one filler ranges in nanoparticles 0.01-0.05µm. Pineapple juice (*Ananas comosus*) is a widely consumed drink by Indonesian with pH range 3.5-4.6. Surface roughness may be affected by extrinsic factors such as low pH from pineapple juice. Rough surface can cause bacterial adhesion and plaque accumulation on restorative material which cause secondary caries, gingivitis and staining. Preheating is a preparation method of composite which improve composite physical and mechanical properties. **Objective:** To analyze the difference in surface roughness of preheated and non-preheated nanohybrid composite resins after immersion in pineapple juice. **Methods:** This research was a laboratory experimental with post-test and control group design. Thirty-three cylindrical sample of nanohybrid composite resin Filtek Z250 XT A2 shade (3M ESPE) (10 mm x 2 mm) were divided into 3 groups: Preheated, Non-preheated and control. Preheated and non-preheated group were immersed in 10 mL pineapple juice for 2 hours for 12 days, control group were immersed in 10 mL distilled water for 24 hours for 12 days. Surface roughness was measured after immersion using surface roughness tester Taylor Hobson, Subtonic S-100 Series-S128) and analyzed using one way ANOVA followed by Post Hoc Tukey. **Results:** Statistical analyze with one way ANOVA test indicates significant differences between surface roughness in 3 groups with $p = 0.034$, average surface roughness of pre-heated group was calculated in 0.73 µm, non-preheated group in 0.81 µm and control group in 0.55µm. Tukey's Post hoc with $p = 0.03$ shows significant difference in surface of non-preheated composite resin with control group. **Conclusion:** Pineapple juice increases surface roughness of nanohybrid composite resins after 2 hours immersion for 12 days in comparison with control group.

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INTRODUCTION

Pineapple (*Ananas comosus*) is one of the common fruits in Indonesia, because they are suitable in Indonesia tropical climate.[1] Pineapple is mostly consumed by eating directly or processed into drinks and Indonesian generally consume 40-107 mL of juice on daily basis.[2] Consumption of pineapple juice itself is a very good source of nutritional content which are good for digestive system and health and a source of antioxidant against free radicals and can help increase immunity. In addition, pineapple also contains the enzyme bromelain, which is a proteolytic enzyme that can help break down protein into amino acids and reduce inflammation in the body.[3] Aside from the benefits pineapple juice contain a high content of glucose and acids, which are potentially cariogenic substances. According to Food and Drug Administration (FDA) 2008, the pH of pineapple juice is in the range of (3.5-4.6).[4] Clinical manifestation and diagnosis caused by low pH in oral environment include abrasion, erosion, and dental caries. Daily exposure to acidic solution can affect the physical properties of restorative material, such as increasing its surface roughness.[5] Rough surface of restorative material such as composite resin can increase adhesion and growth of biofilms which can increase retention of bacteria on tooth surfaces, the retention of these bacteria can cause oral health problems such as dental caries and gingivitis if not cleaned properly.[6]

Resin composite is a restorative material that is widely used in dentistry to replace dental structure damaged by caries with possibility of colour modification, repair of dental anatomy and improvement of aesthetics.[7] Hybrid composite resin, is a type of composite containing mixture of 2 different filler sizes, this mixture is carried out to achieve an optimal balance of physical and mechanical properties of each composite resin such as strength, shrinkage, polymerization, wear resistance, hardness and surface roughness. Nanohybrid composite resin itself have a combination of filler with different sizes where one of the fillers has nanoparticles size ranging (0.01-0.05 µm).[8]

Preheating is a preparation method of composite resin which can improve composite physical and mechanical properties, with the increase in temperature, the polymers in composite turns more fluid making material more flowable,[9] thus reducing stress in the extrusion from syringe giving a better reaction resulting better cross link and polymerization that will lead to increase in mechanical strength and wear resistance.[10] The heating of composite resin is recommended by using Composite Heating Conditioner Micerium S.p.A Heater (Ena Heat, Micerium S.p.A., Avegno GE, Italy) which is designed with two temperature options 39°C and 55°C, with 39°C usually used to heat composite for restoration and 55°C for cementation.[11]

Previous research by Valinoti, showed that immersion of nano filed composite resin in Claritin medicine with acidic pH 2.57 with pH-cycling method 4 times a day for 12 days show significant increase in nano filled composite resin surface roughness.[12] Another research by Vanya Violetta (2020) also shows significant increase in surface roughness of nanohybrid composite resin after immersion in soft drink with acidic pH for 15 days.[4] However from research regarding immersion of nano filled composite resins in artificial saliva with acidic pH 4 by Selvy Amalia Puspitasari (2016) no significant differences was found in surface roughness of nano fill composite soaked for 7 days compared to 10 days. The researches here shows that all composite resins show an increase in surface roughness after immersions in acidic fluids after a period of time, with an exception in the last research where another extra immersion for 3 days don't show any significant difference with the surface roughness of the previous result.[13]

MATERIALS AND METHODS

In this study, laboratory experiments were conducted with post-test and control group design to see the differences in surface roughness of preheated and non-preheated nanohybrid composite resins. The research was performed at the Dental Material Testing Center & Center of Research (DMTCore), Faculty of Dentistry, Trisakti University. The Filtek Z250 XT A2 shade LOT NA78180 nanohybrid composite resin (3M, Saint Paul, Minnesota, USA) was used as the sample. Each group comprised 11 sample, the number of which was calculated using Lemeshow formula.[14]

Sample Preparation

The preheated sample was prepared by inserting the nanohybrid composite resin into the Ena Heat composite heating conditioner (Micerium S.p.A., Avegno GE, Italy) and heated at 39°C. Then, the preheated composite resin was placed in a stainless-steel mold (Fig. 1) by using a plastic filling, condensed using a cement stopper, subjected to curing under light for 20 s (Fig. 2), and then removed from the mold. The non-preheated composite resin was prepared by the same procedure, but without preheating. The samples were cylindrical, with a diameter of 10 mm and a height of 2 mm.

Surface Roughness Measurement

Surface roughness was measured using Subtonic S-100 Series-S128 optical profilometer (Taylor Hobson, Leicester, England) with a calibrated transverse length of 2.40 mm, interval (cut-off length) of 0.80 mm, and

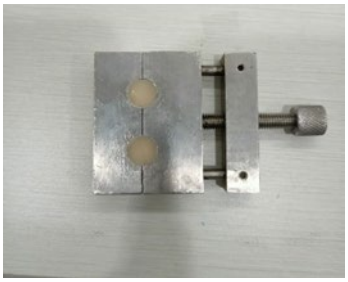

Figure 1. Sample on the stainless-steel mold

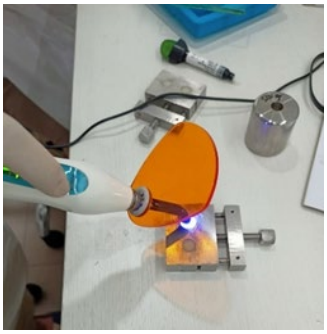

Figure 2. Nanohybrid composite resin sample under light cure

a gauge range of 400 µm. Each sample was first immersed in ice tray container with 10 mL distilled water for 24 hours.

Immersion in pineapple juice with pH range (3.5-4.6) was performed 2 hours per day to show consumption of 4 minutes every day for a month (4 minutes × 30 days = 120 minutes = 2 hours). For the next 22 hour, the preheated and non-preheated composite resins was immersed into 10 mL of distilled water. While the control group was immersed in distilled water for 24 hours. This immersion was performed for 12 days in incubator. After 12 days, all samples were rinsed with distilled water. Each of the preheated, non-preheated and control composite resin samples was immersed in an ice tray with tight closable lids for 12 days.

Later, the surface roughness was measured using the surface roughness tester after twelve days of immersion simulated as 12 months (a year) of pineapple juice consumption in real life. All samples were also rinsed with distilled water after 12 days. This measurement was carried out by placing the surface roughness tester on the working table, with the sample placed in the transverse position, and the tip of the measuring needle freely touched the sample surface. The measurement was performed in triplicate, and the mean value was calculated. The value used for this study was roughness average (Ra).

Statistical Analysis

Data were analysed by the Shapiro–Wilk normality test, followed by the Levene test to investigate the homogeneity of variances. Next, each group was analysed with one-way ANOVA to determine differences in the surface roughness between preheated, non-preheated and control group and followed by Post Hoc Tukey to find difference between one sample group with other groups. P<0.05 was set to be significant. Statistical analysis was performed using IBM SPPS Statistics for Windows Version 20 (IBM, New York, USA).

RESULTS

Results revealed from surface roughness test revealed average surface roughness of the three groups of samples, with value of pre-heated group of 0.73 µm, non-preheated group 0.81 µm and control group immersed in distilled water 0.55 µm (Fig. 3). One way ANOVA statistical analysis in 3 sample groups shows the p value was 0.034 (Table 1). It was concluded that there was a significant difference (p<0.05), thus it concludes there is a significant difference in surface roughness between preheated, non-preheated and control groups. Tukey's Post Hoc test result revealed p value of 0.03 between non-preheated group and control group which mean there is a significant difference (p=0.03, p<0.05) between sample which are not preheated with Micerium S.p.A and immersed in pineapple juice with control sample which are only immersed in distilled water (Table 2).

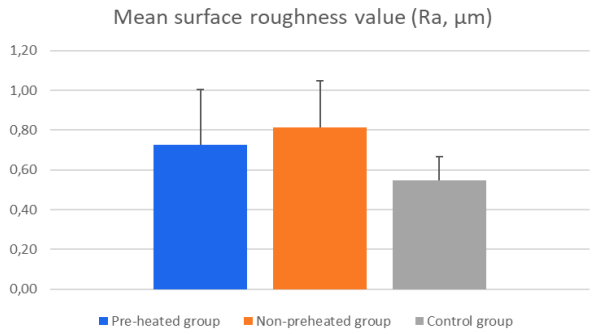

Figure 3. Mean surface roughness value (Ra, µm)

Table 1. Results of one-way ANOVA test for the three sample groups

Group	Sum of Square	F	p
Between groups	0.408	0.204	0.034*
In groups	1.621	0.504	
Total	2.029		

*p>0.05 (Statistically significant difference)

Table 2. P-values of the three sample groups based on post-hoc Tukey test

Group (I)	Group (J)	p
Preheated	Non-preheated	0.672
Non-preheated	Control	0.034*
Control	Preheated	0.176

* p>0.05 (Statistically significant difference)

Results also show that control group had the lowest average mean surface roughness at 0.55 µm compared to preheated group which have the average surface roughness of 0.73 µm while non-preheated group show highest average surface roughness at 0.81 µm. The result shows about average surface roughness of each group show that control group had lowest surface roughness with 0.55 µm. The control group have the lowest surface roughness considering it is only immersed in distilled water which have neutral pH of 5.5-5.7.4 The significant difference surface roughness of control group and non-preheated composite also shows that immersion in low pH can have determinant impact to increase in surface roughness.

DISCUSSION

Pineapple (*Ananas comosus*) is a very good fruit to be consumed regularly because it has a high nutritional content and can be eaten directly or processed into drinks such as juice.[14] According to the FDA (Food and Drug Administration) in 2008 pineapple juice has a pH in the range of 3.5-4.6 which is included as acidic in pH.[5] The presence of acidic pH from extrinsic sources such as pineapple juice can damage the organic resin matrix in the composite resin and cause chemical bond instability and reduce the physical properties of the composite resin. As more frequent and prolonged exposure to environment with acidic pH, will increase degradation of the organic matrix, causing the surface of the composite resin to become irregular resulting in higher surface roughness.[9] With the increase in the surface roughness of the composite resin, there will be accumulation of biofilm in teeth surfaces resulting in the retention of cariogenic bacteria such as *Streptococcus mutans* on the restoration surface in the cavity.[15]

Research also shows that preheating of composite before polymerization using Micerium S.p.A is a new method for composite restoration which shows improvement in physical and mechanical properties of composites.[16] From Post Hoc Tukey analysis it is found out that regular consumption of pineapple juice can cause damage to restorative materials such as composite, thereby increasing its surface roughness. In addition, it was also found that there was no significant difference given by preheating composite resin with the resistance of composite to erosion although the preheated group was found to have lower surface roughness than the non-preheated group. Similar to research by Vanya Violetta (2020) where preheated nonhybrid composite resin immersed in soft drink with acidic pH continue to experience increase in surface roughness alike non-preheated group.[5]

CONCLUSION

In conclusion, after non-preheated samples are immersed in pineapple juice with pH (3.5-4.6) their surface roughness increases significantly compared to control group. Nevertheless, preheated composite resins does not show significant decrease in the roughness of resin composite surface.

CONFLICT OF INTEREST

The authors declare that there are no conflicts of interest.

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