

## Research Report

# Effects of different saliva pH on hybrid composite resin surface roughness

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### ABSTRACT

**Background:** Currently, hybrid composite resin is the mostly used filling material to restore esthetic and function. During function, this material is in contact with various pH from food consumption, which is acidic and alkali which may effect the physical properties of composite resin, including surface roughness. **Purpose:** The research was conducted to determine the effect of pH in saliva on surface roughness of hybrid composite resin. **Methods:** This research used artificial saliva and composite resin samples divided into 3 groups based on different pH of immersion (pH 4, pH 7 and pH 10) for 30 days. **Results:** There were significant differences ( $p > 0.05$ ) among those three treatment groups of hybrid composites soaked in artificial saliva with different pH for 30 days. And, with LSD test it is also known that there were significant differences between the artificial saliva with pH 4 and pH 7, whereas there was no significant difference between pH 4 and pH 10 and between pH 7 and pH 10. **Conclusion:** It can concluded that the changes of salivary pH affect the surface roughness of the hybrid composite resin. Acidic pH has increase the surface roughness of hybrid composite resin, whereas alkaline pH has no effects on the surface roughness of hybrid composite resin.

**Key words:** Hybrid composite resin, acid, alkali, surface roughness

### ABSTRAK

**Latar belakang:** Saat ini tumpatan komposit merupakan bahan tumpatan yang paling sering digunakan untuk memperbaiki estetik dan fungsi. Dalam rongga mulut, bahan ini kontak dengan berbagai macam pH dari konsumsi makanan, baik asam maupun basa yang dapat mempengaruhi perubahan sifat fisik resin komposit, diantaranya yaitu kekasaran permukaan. **Tujuan:** Penelitian ini dilakukan untuk mengetahui tentang efek pH saliva terhadap kekasaran permukaan tumpatan resin komposit hybrid. **Metode:** Penelitian ini menggunakan saliva buatan yang dibagi dalam 3 kelompok sampel yaitu masing-masing dengan perendaman pH yang berbeda (pH 4, pH 7 dan pH 10) selama 30 hari. **Hasil:** Terdapat perbedaan yang bermakna ( $p > 0,05$ ) antara kelompok perlakuan komposit hybrid yang telah direndam saliva buatan dengan berbagai pH selama 30 hari. Uji LSD menunjukkan adanya perbedaan yang signifikan antara perendaman pada saliva buatan antara pH 4 dengan pH 7, sedangkan perbedaan yang tidak signifikan antara pH 4 dengan pH 10 dan pH 7 dengan pH 10. **Kesimpulan:** Dapat disimpulkan bahwa perubahan pH saliva berpengaruh terhadap kekasaran permukaan resin komposit hybrid, pH asam meningkatkan kekasaran permukaan resin komposit hybrid, sedangkan pH basa tidak berpengaruh terhadap kekasaran permukaan resin komposit hybrid.

**Kata kunci:** Resin komposit hybrid, asam, basa, kekasaran permukaan

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## INTRODUCTION

As the public demand for the services of aesthetic composite restoration increases, people are affected with their diet, especially various fast foods that are widely available. This condition, as a result, impact on rapid changes in acidic and alkaline condition in mouth which can affect the physical properties of composite resin filling materials including surface roughness changes.

There are several factors that can cause the damage of composite resin filling materials. One of them is the effect of low saliva pH caused by diet and tooth brushing. The low pH in the saliva can increase the occurrence of polymer erosion.<sup>1</sup> If the surface of the composite is rough due to the low pH in the saliva, it may cause discoloration, plaque, and finally secondary caries.<sup>2</sup>

At neutral pH, such as water, the degradation of the physical properties of composite resin can still occur.<sup>3</sup> The degradation occurs when water enters polymer chains through porosity and intermolecular space so that there is an expansion accompanied by the loss of unreacted components, such as polymerization promoters and oligomers of filler particles causing both the decreasing of the hardness and other properties, such as diametric pulling power tensile, and the roughness of the cast surface roughness.<sup>1,3,4</sup> Surface roughness affects the attachment of debris and bacteria on the surface of the composite cast. As a result, it can easily trigger secondary caries. Salivary fluid actually consists of 99.5% water with inconstant pH in the oral cavity. The changes of pH can be caused by the influence of bacteria, enzymes, hormones and other factors.

When restorative materials are immersed in oral fluid, there may be degradation process, because there are separation of particles in the restoration between the matrix which will contribute to the mechanical and physical properties, one of which is the surface roughness.<sup>4</sup> Composite roughness can also be caused by the effects of acid produced by bacteria, as a result, it can damage composite base materials (BIS-GMA) and the significant reduction of the composite mechanical properties after 30 days of storage in artificial saliva with acidic pH.<sup>4,5</sup> Alkaline environment can increase the dissolution of barium filler particle, exfoliation of resin, and destroy resin structural surface.<sup>6</sup> Therefore, it is needed to know the influence of acidic and alkaline of artificial saliva towards the surface roughness of hybrid composite resin.

This research is aimed to analyze whether the hybrid composite resin have greater roughness when immersed in the artificial saliva with low pH than that with high pH. The results of this research is to prove and provide information to dentists about the changes of surface roughness of the hybrid composite resin cast after immersed in the artificial saliva with low pH (acidic) and with high pH (alkaline).

## MATERIALS AND METHODS

This research is considered as a laboratory experimental research with post-test design conducted only for control groups.

The total samples is 18 samples, and were divided into three groups 6 samples each. Group I is hybrid composite immersed in artificial saliva with pH 4 for 30 days; group II is hybrid composite immersed in the artificial saliva with pH 7 for 30 days; group III is hybrid composite immersed in the artificial saliva with pH 10 for 30 days.

The samples are hybrid composite resin tablet with 5 mm in diameter and 3 mm in height. The samples were made of plastic rings with 5 mm diameter and 3 mm in height. Next, by using the tube hybrid composite was inserted into the plastic rings about 1.5 mm (half of the plastic rings) and light cured for 40 seconds. After polymerized, the rings were filled again, and acetate celluloid strip was put on the top of it in order to make the surface of the composites flat and smooth. Afterwards, the irradiation was conducted for 24 hours.

The samples were stored in Erlenmeyer tubes containing artificial saliva (pH 7) in a room at  $\pm 25^{\circ}$  C for 30 days. After 24 hours these samples were divided into 3 groups according to the pH of each, and then stored in a room at  $25^{\circ}$  C. Then, the samples were removed with tweezers, and dried with tissue paper and dryers for one minute.<sup>4</sup>

The composites were fixed with paraffin, and their surface roughness measured areas were then marked. Afterwards, unit surfestest was applied on driving shaft and drive unit, and the tip of the needle was placed on the composites that would be measured. After the set meter indication was green, the tool was run with 2000x magnification on the graph. Then, the graph result could be calculated. The data was analyzed using ANOVA test.

## RESULTS

The results of this research concerning on the effects of acid and alkali of artificial saliva on the surface roughness of the hybrid composite resin can be seen in table 1. The normality test was conducted on the results using One-Sample Kolmogorov-Smirnov test. The test result showed normal distribution. Next, variance homogeneity test was conducted in those three groups. The result then indicated the above data was homogeneous, ( $p > 0.05$ ). Afterwards, One-Way ANOVA statistical test with  $\alpha = 0.05$  was conducted in order to determine the differences among the groups.

The result showed significant difference, ( $p = 0.01$ ), between those treatment groups soaked in various pH of artificial saliva for 30 days. It indicates that the 30-day immersion of hybrid composites affects the composite

**Table 1.** The average of the surface roughness of the hybrid composite resin cast that has been soaked in the artificial saliva with pH 4, 7, 10 (in  $\mu$  mm)

pH	N	$\bar{X}$
4	6	3.5
7	6	1.25
10	6	2.15

Note:

pH: The acidic concentration of the artificial saliva;  $\bar{X}$ : the average; N: the number of samples

**Table 2.** The result of LSD test to compare the differences of the surface roughness among the treatment groups with various pH of artificial saliva

pH	Significant level
4 and 7	0.003*
4 and 10	0.058
7 and 10	0.175

Note: \*) there is significant difference,  $p < 0.05$

surface roughness. After that, LSD test was conducted to compare the differences of the surface roughness among those sample groups. And, the result then shows that there was significant difference between pH 4 and pH 7, meanwhile there was no significant difference between pH 4 and pH 10 and between pH 7 and pH 10 (Table 2).

## DISCUSSION

Currently, resin composites are more widely used than amalgam and glass ionomer cast materials since they can aesthetically restore the teeth. Besides that, the composite cast materials have already been used for anterior and posterior tooth fillings for years.<sup>5</sup> Though the superior composite is aesthetically stronger than glass ionomer, this composite is susceptible to low pH (acid). In the saliva with low pH (acid), the composite is susceptible to damage as the increasing of erosion on polymer.<sup>5</sup> Some factors, often causing both the damages of the composite resin materials and the changes of the pH of saliva in the oral cavity, are eating and tooth brushing patterns. It can be indicated by the fact that low pH used to soak the composite can increase erosion on polymers.

It is also known that water can cause degradation of physical properties of composites by entering polymer chains through porosity and inter-molecular space, so the bond of the polymer chains gets hydrolysis. The separation of the polymer chains by molecules which do not form principal chemical bond chains can cause the reducing of physical properties of the composites, such as diametric pulling power.<sup>9</sup>

Catalyst is a substance that can accelerate the reaction rate at a certain temperature without changing or being

used by the reaction itself. In other words, catalyst can have a role in reaction, but not as a reactant or product. The catalyst can also either make the reaction faster or allow the reaction at lower temperatures due to changes triggered on the reagent by providing an optional pathway with lower activation energy, thus, it can reduce the energy required for the reaction progress.<sup>7</sup> However, the effect of pH of the saliva on the composite surface roughness is only as catalyst, so pH does not react with the saliva or composite, but affects reaction rates.

The separation process of bonding at low pH is caused by the heterogeneous erosion of poly or lactic acid that causes anti catalyst. The results of the formation of monomer is carboxylic acid which can accelerate polymer degradation by lowering the pH, so the acidity is influenced not only from outside, but also from inside. The degradation process occurs in the components of TEGDMA or Bis-GMA causing the breaking of polymer chains into monomer ones, so it can reduce the physical power of the materials.

The effects of alkaline medium on the composite materials can be described through the interaction with OH-ions during the hydrolysis process. Actually, alkaline pH can give more million times of hydroxyl ions than in the saliva with neutral pH. Besides the possibility of breaking ties, there is also the possibility of the hydrolysis occurrence in filler.<sup>1</sup>

The use of composite resins cast with hybrid type is because this type is not only more oftenly used for both anterior and posterior casts, but it also has better physical, mechanical and aesthetic properties than those in conventional ones (macrofilled and microfilled).<sup>11</sup>

Surface roughness was measured in this research since it is the important mechanical properties in many dental restorative materials. Restorative materials degraded due to the influence of pH changes in the oral cavity can cause rougher surface. This roughness can not only cause the atmosphere become acidic, but can also make the degradation progress faster. The use of low pH (acidic) in this research is because the acidic pH is considered to be the lowest pH found mostly in plaque.<sup>3</sup>

The composites resin immersed in the artificial saliva with low pH are rougher than that with high pH due to the influence of pH as a catalyst which character in high pH is better than that in low pH. Low pH can accelerate the hydrolysis reaction of the composite to be faster than the high pH, while the surface of the cast becomes rougher than immersed in the high pH.

It can be concluded that the change of salivary pH can affect the surface roughness of the hybrid composite resin. Acidic pH increase on the surface roughness, whereas the alkaline pH has no effect on the surface roughness of hybrid composite resin.

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