

THE EFFECT OF SOAKING ARECA NUT (*Areca catechu Linn.*) SEED EXTRACT ON THE SURFACE ROUGHNESS OF NANOHYBRID COMPOSITE RESIN IN-VITRO STUDY

(PENGARUH PERENDAMAN EKSTRAK BIJI BUAH PINANG (*Areca catechu Linn.*) TERHADAP KEKASARAN PERMUKAAN RESIN KOMPOSIT NANOHIRID PENELITIAN IN-VITRO)

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JHDS.unjani.ac.id/jite
Doi: 10.54052/jhds.

Article History
Received: 16/12/2025
Accepted: 18/12/2025

ABSTRACT

The habit of chewing betel quid in the community is based on the belief that its consumption can strengthen teeth. However, this practice may have an impact on the dental restorative materials used. Nanohybrid composite resin is one of the restorative materials widely applied in current dental practice. This study was conducted to determine the effect of immersion in areca nut seed extract on the surface roughness of nanohybrid composite resin. This research was an experimental laboratory study with a pre-test and post-test group design. A total of 30 nanohybrid composite resin specimens were used as research samples and divided into three treatment groups, each of which was immersed in areca nut seed extract at concentrations of 2%, 4%, and 6%. Surface roughness was measured using a Surface Roughness

Tester, while data analysis was performed using the Wilcoxon statistical test. The results showed that the mean surface roughness values of nanohybrid composite resin before immersion in areca nut seed extract at concentrations of 2%, 4%, and 6% were 0.187 ± 0.015 , 0.192 ± 0.014 , and 0.202 ± 0.016 , respectively. After immersion, the surface roughness values increased to 0.362 ± 0.055 , 0.383 ± 0.048 , and 0.403 ± 0.019 . The Wilcoxon test indicated a statistically significant difference in surface roughness values before and after immersion in areca nut seed extract ($p = 0.005$; $p < 0.05$). Based on these findings, it can be concluded that immersion in areca nut seed extract at concentrations of 2%, 4%, and 6% has a significant effect on increasing the surface roughness of nanohybrid composite resin ($p < 0.05$).

Keywords: areca nut; composite resin; *in vitro*; surface roughness

ABSTRAK

Kebiasaan mengunyah sirih pinang di masyarakat didasari oleh keyakinan bahwa konsumsi sirih pinang mampu memperkuat gigi. Namun, praktik tersebut dapat memberikan dampak terhadap bahan restorasi gigi yang digunakan. Resin komposit nanohybrid merupakan bahan restorasi yang sering diaplikasikan dalam praktik kedokteran gigi saat ini. Penelitian ini dilakukan untuk mengetahui pengaruh perendaman ekstrak biji buah pinang terhadap kekasaran permukaan resin komposit nanohybrid. Penelitian ini merupakan penelitian eksperimental laboratoris dengan rancangan pre-test and post-test group design. Sebanyak 30 spesimen resin komposit nanohybrid digunakan sebagai sampel penelitian dan dikelompokkan ke dalam tiga kelompok perlakuan, yang masing-masing direndam dalam ekstrak biji pinang dengan konsentrasi 2%, 4%, dan 6%. Pengukuran kekasaran permukaan dilakukan dengan menggunakan Surface Roughness Tester, sedangkan analisis data menggunakan uji statistik Wilcoxon. Hasil penelitian menunjukkan bahwa rerata nilai kekasaran permukaan resin komposit nanohybrid sebelum perendaman pada konsentrasi ekstrak biji pinang 2%, 4%, dan 6% berturut-turut sebesar $0,187\pm 0,015$; $0,192\pm 0,014$; dan $0,202\pm 0,016$. Setelah perendaman, nilai kekasaran permukaan mengalami peningkatan menjadi $0,362\pm 0,055$; $0,383\pm 0,048$; dan $0,403\pm 0,019$. Uji Wilcoxon menunjukkan

adanya perbedaan yang bermakna antara nilai kekasaran permukaan sebelum dan sesudah perendaman ekstrak biji pinang ($p=0,005$; $p<0,05$). Berdasarkan hasil tersebut, dapat disimpulkan bahwa perendaman ekstrak biji buah pinang dengan konsentrasi 2%, 4%, dan 6% memberikan pengaruh yang signifikan terhadap peningkatan kekasaran permukaan resin komposit nanohibrid ($p<0,05$).

Kata kunci: biji pinang; *invitro*; kekasaran permukaan; resin komposit nanohibrid; *in vitro*

INTRODUCTION

Dental caries remains one of the most prevalent oral health problems globally, affecting the integrity of enamel, dentin, and cementum, and often requiring restorative intervention¹. Composite resin restoration, particularly nanohybrid composites, has become the preferred material due to excellent esthetics, ease of polishing, reduced surface roughness, and improved mechanical properties²⁻⁴. Surface roughness is a critical parameter determining restoration longevity, as higher roughness promotes biofilm accumulation, discoloration, soft tissue irritation, secondary caries, and structural degradation⁵⁻⁷.

Various dietary substances with acidic or chemically active components have been reported to alter composite surface characteristics, including beverages containing polyphenols, which destabilize resin matrices and increase surface

roughness^{8,9}. Parallel to this, traditional practices in several Indonesian ethnic groups—such as the Batak Karo community—include chewing betel quid, which commonly incorporates areca nut as a key component^{10,11}. Areca nut contains alkaloids, flavonoids, tannins, saponins, and polyphenols with reported antibacterial, anti-inflammatory, antiviral, and tooth-strengthening properties¹². Despite its abundant bioactive compounds, the effect of areca nut extract on modern dental restorative materials, particularly nanohybrid composite resin, remains underexplored. This knowledge gap highlights the need to investigate whether exposure to areca nut extract may affect composite resin surface stability, thereby contributing new insight into potential interactions between culturally relevant herbal substances and dental restorative materials. Therefore, this study intends to address the problem of whether areca nut

extract immersion can alter the surface roughness of nanohybrid composite resin and what concentration produces a measurable effect, providing novel scientific evidence relevant for dental practitioners and material researchers.

In this study, nanohybrid composite specimens were immersed in areca nut extract at varying concentrations to evaluate changes in surface roughness using standardized profilometric analysis. The research was conducted to test the hypothesis that areca nut extract exerts a measurable influence on the surface roughness of nanohybrid composite resin.

METHOD

This study was carried out *in vitro* using a pretest–posttest research design. The samples consisted of nanohybrid composite resin discs with a diameter of 10 mm and a thickness of 2 mm. A total of 30 composite resin samples were divided into three groups: Group A (samples 1–10) was immersed in 2% ethanol extract of areca nut seeds, Group B (samples 11–20) was immersed in 4% ethanol extract of areca nut seeds, and Group C (samples 21–30) was immersed in 96% ethanol extract of areca nut seeds. The samples were immersed for seven days, which is considered an adequate duration for composite resin to approach equilibrium in water sorption,

similar to that occurring in the oral environment. Following the immersion process, the surface roughness of each specimen was evaluated using a surface roughness tester. The data obtained were then analyzed using the Shapiro–Wilk and Levene tests, which indicated that the data were not normally distributed; therefore, analysis was continued using the Wilcoxon test. The processed data were subsequently presented in tabular form.

Instruments and Materials

Filling instruments, celluloid strips, glass slabs, droppers, a light-curing unit, a surface roughness tester, 25 mL containers, an air spray, and acrylic molds with a diameter of 10 mm and a thickness of 2 mm were utilized.

The materials included light-cured nanohybrid composite resin (3M ESPE Filtek Z250XT), areca nut seed extract, sterile distilled water, petroleum jelly, 96% ethanol, tissues, gloves, and masks.

Preparation of Areca Nut Seed Extract

1. A total of 500 grams of areca nuts were peeled, the seeds were collected, and washed thoroughly. The areca nut seeds were sliced thinly and dried at room temperature for one week.
2. The dried areca nut seeds were then ground using a blender until a fine

powder was obtained.

3. The areca nut seed powder was extracted using 96% ethanol by maceration for five days with occasional stirring. After the maceration process was completed, the extract was evaporated to remove the remaining ethanol solvent.
4. The ethanol extract of areca nut seeds was further concentrated by evaporation until a 100% thick areca nut seed extract was obtained.
5. The thick areca nut seed extract was diluted using a mixture of distilled water and CMC to obtain areca nut seed extract concentrations of 2%, 4%, and 6%, with a volume of 200 mL for each concentration.

RESULT

Based on Table 1, the results show that the mean surface roughness of nanohybrid composite resin before immersion in 2%, 4%, and 6% areca nut extract was 0.187 ± 0.015 , 0.192 ± 0.014 , and 0.202 ± 0.016 , respectively. After treatment, the surface roughness of the nanohybrid composite resin increased in each group, with mean values of 0.362 ± 0.055 , 0.383 ± 0.048 , and 0.403 ± 0.019 , respectively.

Table 1. Average surface roughness before

and after immersion on nanohybrid composite resin

Soaking Material Group	Sample	Surface roughness					
		Pre		Post			
		Skor	$\bar{x} \pm SD$	Skor	$\bar{x} \pm SD$		
Areca nut extract 2%	1	0.179		0.322			
	2	0.190		0.408			
	3	0.193		0.291			
	4	0.195		0.305			
	5	0.174	$0,187 \pm 0,015$	0.423	$0,362 \pm 0,055$		
	6	0.188		0.422			
	7	0.183		0.348			
	8	0.159		0.304			
	9	0.209		0.424			
	10	0.204		0.375			
Areca nut extract 4%	1	0.199				0.349	
	2	0.214				0.326	
	3	0.192				0.319	
	4	0.212				0.328	
	5	0.189	$0,192 \pm 0,014$	0.428	$0,383 \pm 0,048$		
	6	0.192		0.423			
	7	0.176		0.406			
	8	0.168		0.435			
	9	0.192		0.390			
	10	0.189		0.375			
Areca nut extract 6%	1	0.198				0.407	
	2	0.204				0.380	
	3	0.207		$0,202 \pm 0,016$		0.412	$0,403 \pm 0,019$
	4	0.214				0.410	
	5	0.201	0.407				
	6	0.197	0.430				
	7	0.224	0.427				
	8	0.216	0.386				
	9	0.165					
	10	0.192					

Table 2. Results of normality and homogeneity tests

Group	Observation	Shapiro-Wilk p-value	Levene Test p-value
Areca nut extract 2%	Pre	0,960	0,000
	Post	0,078	
Areca nut extract 4%	Pre	0,464	
	Post	0,048	
Ekstrak biji pinang 6%	Pre	0,351	
	Post	0,681	

Based on Table 2, the Shapiro–Wilk normality test and the Levene homogeneity test indicate that the data are not normally distributed and not homogeneous. Therefore, the data were analyzed using the Wilcoxon statistical test.

Table 3. Differences in surface roughness of nanohybrid composite resin before and after treatment

Group	Observation	$\bar{x} \pm SD$	Mean different	p-value
Areca nut extract 2%	Pre	$0,187 \pm 0,015$	0,175	0,005*
	Post	$0,362 \pm 0,055$		
Areca nut extract 4%	Pre	$0,192 \pm 0,014$	0,191	0,005*
	Post	$0,383 \pm 0,048$		
Areca nut extract 6%	Pre	$0,202 \pm 0,016$	0,201	0,005*
	Post	$0,403 \pm 0,019$		

Wilcoxon *Signifikan

Based on Table 3, the results of the

study can be stated that there is a significant difference in surface roughness before and after being given areca nut extract ($p < 0.05$). Soaking areca nut extract can increase the surface roughness of the nanohybrid composite resin.

Table 4. Differences in surface roughness after administration of areca nut

Group	$\bar{x} \pm SD$	<i>p-value</i>
Areca nut extract 2%	0,175±0,052	0,545
Areca nut extract 4%	0,191±0,058	
Areca nut extract 6%	0,201±0,027	

Based on Table 4, the research results can be stated that there was no significant difference in surface roughness after administration of areca nut extract ($p = 0.005$).

DISCUSSION

The areca nut seed extract was used in this study because it has been widely utilized in traditional medicine and cultural practices in Indonesia. Previous studies have reported the use of areca nut in herbal preparations and traditional health maintenance, indicating its frequent oral exposure in daily life¹³⁻¹⁵. The complex chemical composition of areca nut seeds, including polyphenols, alkaloids, and organic acids, suggests potential interactions with dental restorative materials.

Surface roughness is a critical parameter of composite resin restorations,

as increased roughness can promote bacterial adhesion, plaque accumulation, and subsequent caries development¹⁶. In this study, nanohybrid composite resin showed an increase in surface roughness after immersion in areca nut seed extract at all tested concentrations (2%, 4%, and 6%), with the highest roughness observed in the 6% group. Statistical analysis using the Wilcoxon test revealed a significant difference in surface roughness before and after immersion, indicating that areca nut seed extract affected the surface characteristics of the composite resin.

These results are consistent with findings that exposure to chemical solutions can alter the surface roughness of composite resins. Permatasari and Islamiah found that immersion of nanohybrid composite resin in different mouthwash solutions resulted in significant changes in surface roughness¹⁷. Similarly, studies have shown that the acidic or hydrophilic components of mouthwashes can significantly affect composite surface properties¹⁸. However, variations in the degree of change may depend on the filler composition, resin matrix, and exposure duration.

The increase in surface roughness may be explained by both intrinsic and extrinsic factors. Composite resins with higher hydrophilic monomer content tend to

absorb fluids, leading to potential hydrolytic degradation and weakening of the filler–matrix interface ¹⁹. In addition, phenolic compounds such as gallic acid present in areca nut extract may contribute acidic ions (H⁺), which could disrupt polymer crosslink stability within the resin matrix, resulting in polymer chain degradation and increased surface roughness.

Notably, surface roughness values exceeding 0.2 μm have been associated with increased plaque retention and compromised restoration aesthetics²⁰. Studies also report that increased surface roughness can accelerate discoloration and reduce the clinical longevity of composite resin restorations, further underscoring the importance of controlling surface changes following exposure to dietary or chemical agents ¹.

In conclusion, immersion in areca nut seed extract at concentrations of 2%, 4%, and 6% increased the surface roughness of nanohybrid composite resin. These findings, supported by previous studies, suggest that exposure to herbal substances containing acidic and polyphenolic compounds may adversely affect the surface integrity of composite resin restorations, emphasizing the importance of material resistance to commonly used traditional herbal products.

CONCLUSION

There is a significant effect of immersion in 2%, 4%, and 6% areca nut extract on the surface roughness of nanohybrid composite resin. The 2% concentration produces the smallest increase in surface roughness.

CONFLICT OF INTEREST

The authors declare that there are no conflicts of interest associated with this study.

ACKNOWLEDGEMENT

The authors are grateful to the Faculty of Dentistry, Universitas Prima Indonesia, and all my friends who have accompanied me in writing this final assignment.

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