

**SURFACE ROUGHNESS IMPROVEMENT OF POLYAMIDE RESIN DENTURE AFTER SOAKING IN 50% CINNAMON (*Cinnamom burmanii*) SOLUTION**  
**(PENINGKATAN KEKASARAN PERMUKAAN GIGI TIRUAN POLIAMNIDA SETELAH PERENDAMAN PADA LARUTAN 50% KAYU MANIS (*Cinnamom burmanii*))**

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**ABSTRACT**

Polyamide resin is widely used in dentistry as a denture base material. *Cinnamom burmanii* has been proven to have antibacterial and antifungal substances. Therefore, it is the potential to be used as a nature denture cleanser. This study aimed to examine the effect of soaking 50% cinnamon extract solution on the surface roughness of polyamide resin. This study used 16 polyamide resin samples soaked in 50% cinnamon extract solution and 16 samples soaked in distilled water as the control group. It examined the surface roughness before and after immersion for four days and seven days. Data were analyzed using paired T-test and independent T-test. The results showed a significant difference in the surface roughness of polyamide resin before and after immersion in

cinnamon solution for four days and seven days. The surface roughness change is due to the polyphenol's reaction on the polyamide resin surface, which has destroyed the polymer chain of polyamide resin.

**Keywords:** cinnamon; cleanse; denture; polyamide; resin

### **ABSTRAK**

*Resin poliamida banyak digunakan dalam kedokteran gigi sebagai bahan dasar gigi tiruan. Kayu manis burmanii telah terbukti memiliki zat antibakteri dan antijamur, sehingga berpotensi untuk digunakan sebagai pembersih gigi tiruan alami. Penelitian ini bertujuan untuk menguji pengaruh perendaman larutan ekstrak kayu manis 50% terhadap kekasaran permukaan resin poliamida. Penelitian ini menggunakan 16 sampel resin poliamida yang direndam dalam larutan ekstrak kayu manis 50% dan 16 sampel yang direndam dalam aquades sebagai kelompok kontrol serta diperiksa kekasaran permukaannya sebelum dan sesudah perendaman selama 4 hari dan 7 hari. Data dianalisis menggunakan uji T berpasangan dan uji T independen. Hasil penelitian menunjukkan terdapat perbedaan yang signifikan pada kekasaran permukaan resin poliamida sebelum dan sesudah perendaman dalam larutan kayu manis selama 4 hari dan 7 hari. Perubahan kekasaran permukaan ini disebabkan oleh reaksi polifenol pada permukaan resin poliamida yang telah merusak rantai polimer resin poliamida.*

*Kata kunci: kayu manis; pembersih; poliamida; resin*

### **INTRODUCTION**

A denture base resin is required in dental fields as a removable prosthesis. It can be used as a denture for the partial or complete prosthodontic appliance to replace some missing teeth or full missing teeth in the arch jaw. It also can be used as a denture for removable orthodontic as an active

appliance or as a base to connect and hold the active orthodontic wire.

In the dental clinic, denture base resin has been widely used for many reasons. It is easy to manipulate, clean, and repair. Patients are comfortable with the aesthetic and feel the typical taste and thermal perception when using resin

dentures. Part of the resin denture is contacted to the oral tissue. It should be biocompatible, non-toxic, stable in the oral fluid, oral temperature change, and occlusal mastication process. It should be lasting for a long time without staining, plaque accumulation, and deformation.

Conventional resin denture is rigid, and the flexural strength is low. Recently, in the development of resin base denture, a flexible nylon thermoplastic has been manufactured. The nylon thermoplastic denture is classified as *acetal resin*, *polyester*, *polycarbonate resin*, and *polyamide resin*. *Polyamide resin* was introduced as a denture base material in the 1950s. Since then, the application of polyamide resin has been increased.<sup>1-3</sup>

This denture could fit and retain the alveolar and oral tissue without using clasps wire (non-metal clasp dentures) and cause superiority of polyamide resin because clasp wire is unfavorable for patients aesthetically and psychologically. It is similar to the oral tissue, pinkies semitransparent that can hardly be distinguished to the gum. The polyamide resin is indicated for a patient with metal or methyl methacrylate allergy. The polyamide resin composition is 99,9% *polylauro lactam* (nylon 12;  $\text{CO}(\text{OH}_2)_{11}\text{NH}_n$ , without monomer methyl

methacrylate. No concern about metal chemical composition in this denture. The flexural strength and flexural modulus are high; therefore, it is soft and elastic. This material has lower solubility, higher thermal resistance, and higher elasticity than conventional heat-cured acrylic resin.

This material has some drawbacks, such as surface roughness, water sorption, bacterial contamination, and color change. The water sorption is related to the hygroscopic and hydrophilic properties of this material. The water sorption could lead to the crack, discoloration, and surface roughness of the denture. Color change of polyamide resin is caused by consumption of coffee, tea, wine, curry, etc.<sup>3-6</sup>

Polyamide resin has a lower hardness value due to lower amounts of cross-linking agents, affecting surface hardness. Rougher surfaces are susceptible to color staining and bacterial cumulation.<sup>7-8</sup> Therefore, oral conditions, including denture cleaning procedures, should be carefully considered.<sup>9</sup>

*Cinnamon burmanii* is a medicinal plant widely cultivated in Indonesia and used by the community as a cooking spice and traditional herbal ingredients. Cinnamon oil has been proven to have bacterial and antifungal pharmacological effects. Cinnamon contains

cinnamaldehyde, eugenol, flavonoid, terpenoid, tannins, saponin and, alkaloids.<sup>10-11</sup>

Based on the benefits and the availability of cinnamon in Indonesia, in this study, we proposed cinnamon extract as a nature denture cleanser of polyamide resin.<sup>12</sup>



**Figure 1.** *Cinnamomum burmanii* as traditional herbal medicine.

The effect of cinnamon extract solution on the surface roughness of



polyamide resin was evaluated for four days and seven days, which is simulated to the one year and two years of regular use of the denture.<sup>13</sup>

**Figure 2.** *Cinnamomum burmanii* plant.

## METHOD

This research is experimental research, with a research design that is *Pre and Post Test Only Control Group Design in Vitro*. The purpose of this research is to determine the effect of soaking cinnamon extract (*Cinnamomum burmanii*) on the surface roughness of polyamide resin. The object of this research is 65 mm x 10 mm x 2.5 mm (n=16) polyamide resin material and then soaked in cinnamon extract (*Cinnamomum burmanii*) for four days and seven days. The control group was soaking in the distilled water (DW) solution (n=16).

The cinnamon extract solution was prepared by ethanol extraction and sterilized by UV-ray for 1 hour. Then the 100ml of the cinnamon extract was mixed with 100 ml DW to make a 50% cinnamon solution.



**Figure 3.** Experimental setup of polyamide resin soaked in the cinnamon extract.

The surface roughness data were obtained using a surface roughness tester machine (Mituyo, type 301, Japan) at three points on each sample, and the average±standard deviation (SD) was calculated.

The data obtained will be processed and analyzed statistically. The data were tested for normality by using the Shapiro-Wilk test. A paired T-test and independent T-test will be performed if the data is typically distributed to determine group changes.

## RESULT

Group	Before immersion (µm)	4d (µm)	7d(µm)
DW	0.229±0.056	0.321±0.059	0.345±0.057
CNM	0.232±0.058	0.362±0.088	0.418±0.079

**Table 1.** The surface roughness average of polyamide resin and control group

\*CN: cinnamon solution

DW: distilled water

The average surface roughness measurement of polyamide resin before and after immersion in cinnamon extract for four days and seven days is shown in Table 1. The control group of polyamide resin immersed in the DW is indicated for the comparison.

Shapiro-Wilk Normality Test continued statistical analysis to calculate the data distribution in this study. Table 2 showed the p-value of all data was normally distributed ( $p>0.05$ ).

**Table 2.** Data of the normality test of the surface roughness average of polyamide resin and control group

Group	N	Shapiro-wilk	p-value
Before in DW	16	0.950	0.483
4d in DW	16	0.908	0.108
7d in DW	16	0.894	0.065
Before in CNM	16	0.961	0.678
4d in CNM	16	0.964	0.741
7d in CNM	16	0.902	0.088

Table 3 shows the result of the paired

T-test analysis to calculate the p-value of the group samples before and after immersion in the DW. The p-value obtained before and after immersion for four days was significantly different ( $p < 0.05$ ). The p-value obtained before and after seven-day immersion was also very different ( $p < 0.05$ ). This result indicated that immersing polyamide resin in DW for four days and seven days increases the surface roughness significantly.

**Table 3.** Paired T-test analysis data of the surface roughness average of polyamide resin before immersing in DW and after four days and seven days

	DW		differences ( $\mu\text{m}$ )	<i>p</i> - value**
	before immersion ( $\mu\text{m}$ )	after immersion ( $\mu\text{m}$ )		
	4d	0.229 $\pm$ 0.056		
7d	0.229 $\pm$ 0.056	0.345 $\pm$ 0.057	0.116	0.000

**Table 4.** Paired T-test analysis data of surface roughness average of polyamide resin before immersing in cinnamon solution and after four days and seven days.

	CNM		Differences ( $\mu\text{m}$ )	<i>p</i> - value**
	before immersion ( $\mu\text{m}$ )	after immersion ( $\mu\text{m}$ )		
	4d	0.232 $\pm$ 0.058		
7d	0.232 $\pm$ 0.058	0.418 $\pm$ 0.079	0.186	0.000

Table 4 showed the result of the paired T-test analysis to calculate the p-value of the group samples before and after JHDS 2021

immersion in 50% cinnamon extract solution. The p-value obtained before and after immersion for four days was significantly different ( $p < 0.05$ ). The p-value obtained before and after seven-day immersion was also very different ( $p < 0.05$ ). This result indicated that immersing polyamide resin in 50% cinnamon solution for four days and seven days increases the surface roughness significantly.

Table 5 showed the differences of immersion polyamide resin in the cinnamon solution for four days and seven days. The independent T-test analysis obtained the  $p$ -value  $> 0.05$ , which indicated no significant difference in the surface roughness of polyamide resin for four days and seven days.

**Table 5.** Independent T-test data of the surface roughness average of polyamide resin after immersing in cinnamon solution for four days and seven days

Group	Average $\pm$ SD	<i>p</i> -value**
4d	0.363 $\pm$ 0.0884	0.070
7d	0.418 $\pm$ 0.079	

## DISCUSSION

The hygroscopic nature of polyamide resin, which quickly absorbs water and changes the surface roughness, was confirmed in this study.<sup>14</sup> Currently used denture materials would be increasing the

surface roughness over time. After immersion in DW, the surface roughness of polyamide resin significantly increased after four days and seven days (Table 3). Since the 50% cinnamon extract was performed in the solution containing water, this study's result also confirmed the same phenomena. After immersion in 50% cinnamon solution for four days and seven days, the surface roughness of polyamide resin was significantly increased (Table 4).

The need for a good denture cleanser for polyamide resin should be considered carefully. A wider area of oral tissue was covered by polyamide resin denture because of the extending of resin clasp and abutment in the denture design. Inadequate denture hygiene could impart to the overall oral hygiene, leading to periodontal disease or caries.<sup>15</sup> On the other hand, the denture cleanser chosen should not cause the degradation of resin materials since it will increase the adherence of dental plaque and candida, thus worsening the denture hygiene.

The efficacy of the component of resin base materials are shown in the surface characteristic included surface roughness and surface hardness. Some commercial chemical denture cleansers containing sodium perborate immersed in polyamide were reported. It can cause lower hardness and higher roughness surface than

polymethyl methacrylate (PMM) base polymers. Even though, in this study, the polyamide had higher initial surface roughness and increased after the immersion. The surface characteristic was decreased due to the chemical denture cleanser procedure, which liberated oxygen and broke down the fibrous structure in the polyamide resin.<sup>16</sup>

The water infiltrates the resin matrix of polyamide and breaks the polymer chains caused the increase in surface roughness by immersion. Even though the surface roughness of polyamide resin was not significantly different between 4 days and seven days immersion in the cinnamon solution (Table 5), this might be due to the degradation of the cinnamaldehyde, which gradually interacts with the surface of polyamide resin. There are no more H ions of the cinnamaldehyde released from the cinnamon solution that would break the polymer chain of polyamide resin after four days of immersion.<sup>17</sup>

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Another study suggested that natural antimicrobials from the plant could aid in the management of biofilm-associated infection, including denture-induced stomatitis caused by candida biofilm on the poorly cleaned dentures. Cinnamon essential oil is one of the candidates to be used as daily anticandidal denture cleansing.<sup>18</sup>

Cinnamon essential oil is reported to have an excellent level of safety dan tolerability as anti-candida and has no adverse effect on the physical properties of the acrylic resin.<sup>19</sup> Since the polyamide also has a similar constituent to the acrylic resin. Still, more fibrous and lower hardness supports the result in this study that immersion of polyamide to cinnamon solution impart to the surface roughness.

Among the variety of cinnamon plants globally, almost 250 species, it has beneficial effects as an analgesic, antiseptic, antispasmodics, astringent, insecticidal, and antimicrobial. Using cinnamon solution as a denture cleanser would have a broader

beneficial impact on oral health. The effective concentration for daily use is expected to minimize the side effect on the surface roughness of polyamide resin.

Indonesia had been the world's largest producer of cinnamon and had a share of 24.33% in the world's market of cinnamon in 2014. This study results suggested worldwide more significant production of cinnamon for denture cleanser application that would increase the demand and beneficial trade.

Further studies can be conducted to investigate the differences in surface characteristics of polyamide immersed in cinnamon solution as a denture cleanser and other chemical denture cleansers.

## **CONCLUSION**

The surface roughness of polyamide resin before and after immersion in 50% cinnamon extract solution for four days and seven days was significantly different. However, there was no significant difference in the surface roughness between 4 days dan seven days immersion in 50% cinnamon extract solution.

## **CONFLICT OF INTEREST**

We declare that there is no conflict of interest in the scientific articles.

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