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Dimensional Change of Resin Denture Base After Immersion of Cinnamomum burmannii Extract and Chlorhexidine Solution

Siti Wahyuni*, Femy Nawia

Department of Prosthodontics, Faculty of Dentistry, Universitas Sumatera Utara, Medan 20155, Indonesia
*Author: siti.wahyuni@usu.ac.id

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ABSTRACT

Heat-cured acrylic resin is the most commonly used denture base material due to its biological, mechanical, chemical, and physical properties. Denture cleaning, which is essential for successful denture use, can be facilitated by utilizing cinnamon extract *Cinnamomum burmannii* 20% and chlorhexidine 0.2% as effective cleaning agents. However, these materials can affect the physical properties of denture, such as a dimensional change. The design of this study is experimental laboratories, aimed at identifying the effect of immersing denture base in extract *Cinnamomum burmannii* 20% and chlorhexidine 0.2% for 1 year (92 hours) to dimensional change of heat-cured acrylic resin. The sample consists of 30 heat-cured acrylic resin with sizes 65 mm x 10 mm x 2.5 mm, divided into 3 groups of treatment. After the entire study design has been carried out, data was analyzed by Univariat and one-way Anova and the result showed the significant of p = 0,001 (p<0,05). In this study, it was seen the the value of the dimensional change that was immersed in extract *Cinnamomum burmannii* 20% resulted in a smaller dimensional change value compared to chlorhexidine 0.2%.

Key words: Heat Cured Acrylic Resin, Dimensional Change, *Cinnamomum Burmannii Extract*

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ABSTRAK

Resin akrilik polimerisasi panas merupakan bahan dasar basis gigi tiruan yang sering digunakan. Resin Akrilik Polimerisasi Panas memenuhi syarat karena memiliki sifat biologis, mekanis, kemis, dan sifat fisis. Pembersihan gigi tiruan merupakan salah satu parameter keberhasilan dalam penggunaan gigi tiruan. Ekstrak kayu manis *Cinnamomum burmannii* 20% dan klorheksidin 0,2% dapat digunakan sebagai bahan pembersih gigi tiruan, namun bahan tersebut dapat memengaruhi sifat fisis gigi tiruan seperti perubahan dimensi. Rancangan penelitian ini adalah eksperimental laboratoris, yang bertujuan untuk mengetahui apakah ada pengaruh perendaman basis gigi tiruan resin akrilik polimerisasi panas dalam ekstrak kayu manis *Cinnamomum burmannii* 20% dan klorheksidin 0,2% selama 1 tahun (92 jam) terhadap perubahan dimensi. Sampel terbuat dari resin akrilik berukuran 65 mm x 10 mm x 2,5 mm, sebanyak 30 sampel yang dibagi atas 3 kelompok. Setelah dilakukan seluruh rancangan penelitian, maka dilakukan pengumpulan data dan data tersebut dianalisis menggunakan uji statistik Univariat untuk melihat rata-rata dan Standar Deviasi, kemudian dilakukan uji ANOVA satu arah diperoleh signifikasi p = 0,001 (p< 0,05). Pada penelitian ini terlihat bahwa nilai perubahan dimensi yang di rendam pada ekstrak kayu manis *Cinnamomum burmannii* 20% menghasilkan nilai perubahan dimensi yang lebih

kecil dibandingkan dengan klorheksidin 0,2%.

Kata Kunci: Resin Akrilik Polimerisasi Panas, Perubahan Dimensi, Ekstrak Kayu Manis

1. Introduction

According to the specifications issued by the American Dental Association (ADA), Heat Polymerized Acrylic Resin (RAPP) is a resin that is often used in the manufacture of removable partial denture bases.[1],[2] RAPP has met the requirements as an ideal denture base material due to its biological, mechanical, and physical properties, such as not irritating the oral mucosa of the patient, high transverse strength, resistance to abrasion, high thermal conductivity, aesthetics, good color stability, and of course easy to clean.[3],[4],[5] Patients who use dentures may disturb the balance of the normal flora of the oral cavity. Moreover, inadequate denture hygiene can increase the accumulation of plaque, creating an ideal environment for the proliferation of the Candida albicans fungus. The infection caused by inadequate maintenance of denture hygiene can cause denture stomatitis. A commonly employed denture cleaning agent is 0.2% chlorhexidine gluconate, which is a bacteriostatic antiseptic against gram-positive and gram-negative, acting swiftly with a broad spectrum of efficacy. This compound has low toxicity and is highly effective.[6]

The World Health Organization (WHO) highly recommends the use of traditional medicine for the treatment and prevention of various diseases.[4] One alternative disinfectant that can be used by patients is cinnamon, which is a natural plant with strong-smelling bark. Generally, cinnamon is processed by distillation to become cinnamon oil and is proven to have nutritional content with pharmacological effects, such as pain relief (analgesic), antibacterial, and antifungal.[7] Some of the chemical constituents contained in cinnamon include cinnamaldehyde, eugenol, flavonoids in the form of catechins (polyphenols), terpenoids, tannins, saponins, alkaloids, and tanning substances. These chemical constituents are believed to inhibit the activity and growth of fungi, including Candida albicans. The most abundant ingredients in cinnamon are eugenol and cinnamaldehyde, which is phenylpropanoid and a derivative of phenolic compounds.[7],[8] Cinnamaldehyde in cinnamon oil has benefits as an antioxidant and sunscreen, effectively inhibiting free radical activity. In addition, organic compounds in cinnamon have the ability as reducing agents and have potential in the synthesis of environmentally friendly nanoparticles (green synthesis).

According to Khatimah et al. (2017), the concentration of 20% *Cinnamomum burmannii*, an extract of cinnamon exhibited superior antifungal inhibition compared to 0.2% chlorhexidine, with an average inhibition zone of 39.30 mm against Candida albicans.[9] Afandi (2012) investigated the antifungal potential of cinnamon extract against Candida albicans in vitro. The result of the study showed that the concentration of 10% cinnamon extract can form an inhibition zone of 7.17 mm. Furthermore, the inhibition zone continued to expand gradually, reaching 21.5 mm at the highest concentration of 100% cinnamon extract tested during the experiment. Rizki and Panjaitan (2018) showed that the smallest concentration (20%) of essential oil from *Cinnamomum burmannii* produced a clear zone diameter of 32.10 mm, which is larger than the positive control (ketoconazole) of 26.56 mm.[10]

The selection of a denture cleaning agent must consider factors that may affect the physical properties of the acrylic resin denture base, particularly in the case of heat-polymerized acrylic resins, which are prone to dimensional change. This dimensional change can affect the dexterity and stability of denture adaptation in the oral cavity of the patient. Based on the description above, it is necessary to investigate the potential effects of immersing denture bases made from heat-polymerized acrylic resin in a 20% *Cinnamomum burmannii* concentration and a 0.2% chlorhexidine solution. This immersion process would be performed for 15 minutes daily, over a calculated duration of 92 hours (3 days + 20 hours), to assess any dimensional change that may occur.

2. Materials and Methods

This laboratory experimental study obtained ethical clearance from the Ethical Committee of the Faculty of Medicine, Universitas Sumatera Utara, with decision letter 470/KEP/USU/2021. It was carried out to determine the effect of immersing denture base in heat-polymerized acrylic resin in cinnamon extract at a

concentration of 20% and chlorhexidine solution. The *posttest only control group* design was adopted and sampling was carried out at the USU FKG Dental Test Unit. *Cinnamomum burmannii*, an extract of cinnamon, at a concentration of 20% was prepared at the ASPETRI Medicinal Plant Research and Development Laboratory in Medan, and the dimensional change test was carried out at the Medan Industrial Chemical Technology Education Polytechnic (PTKI) Laboratory. This study was carried out from April to May 2021. Furthermore, the sample in this study used heat polymerized acrylic resin made from brass in the form of test rods measuring (65 mm x 10 mm x 2.5 mm) (according to ADA specification No.12). The total number of samples used in this study were 30 for 3 treatment groups.

The sample was made of hot polymerized acrylic resin, type polymethylmethacrylate with brand QC-20, which was polymerized by heating. First, the mold was created by preparing the gypsum mixture in the upper cuvette with a ratio of 200 grams of gypsum to 100 ml of water. Similarly, the ratio used for the gypsum mixture in the lower cuvette was 250 grams of gypsum to 150 ml of water. The dough was stirred with a spatula for 15 seconds until it was mixed homogeneously and was then placed in the cuvette that had been prepared above the vibrator. Afterward, the 3 main models were placed on the gypsum dough, which was starting to harden in one cuvette. After hardening, the plaster surface is smeared with Vaseline, then the top cuvette is attached and filled with hard plaster dough above the vibrator. After all the dough has hardened, the cuvette is opened and the main model is removed.

The acrylic resin-filling process involved the combination of polymer and monomer in a ratio of 2:1 until it is homogeneous and reached the dough phase. The mold that has been smeared with *cold mold seal* was filled with acrylic resin mixture and a cellophane was placed between the top and bottom cuvettes. Then the cuvettes were pressed with pressure reaching 1000 psi for 5 minutes. The cuvette was then opened and the excess acrylic was cleaned using a lekron, then the cuvette was closed again and pressed slowly to 2000 psi. The cuvette bolts are fixed and locked to maintain good adaptation between the upper and lower cuvettes. This is followed by the curing process which was carried out by inserting the cuvette into a water bath filled with water, at 70°C for 90 minutes and then the temperature was increased to 100°C for 30 minutes. The water bath is turned off and the water was allowed to cool until it reached room temperature, then the cuvette is opened. The sample underwent a preparation process to eliminate sharp parts using a Fraser bur and smoothed with waterproof sandpaper sizes 150, 400, 600, and 1000 under running water. The samples were then soaked in distilled water for 48 hours at 37°C using an incubator before the experiment to reduce residual monomer.

In this study, the type of cinnamon used is *Cinnamomum burmannii*. The cinnamon bark, weighing 0.5 kg was extracted and prepared by cutting it into small pieces. Subsequently, the bark pieces were dried using a freeze dryer for about 2 days and blended to achieve a texture that struck a balance between being neither excessively fine nor coarse. Then the blended cinnamon was weighed as much as 100 grams and macerated by soaking ± 1 liter of 96% ethanol while stirring occasionally and then left for 2 days in a closed storage container. After soaking for 2 days, the solution was percolated with filter paper through a percolator. A total of 40 grams of the thick cinnamon extract was obtained after separating the solvent and extract using a rotary evaporator.

The acrylic resin sample was placed in a measuring cup filled with solution. It was divided into three groups consisting of aquadest as the control, the 20% *Cinnamomum burmannii* cinnamon extract group, and the 0.2% chlorhexidine (Minosep) for 3 days + 20 hours, and the solution in each group was replaced daily. All specimens were measured using the vector method to identify dimensional changes using an Aarson brand Traveling microscope with an accuracy of 0.01 mm. Each sample is marked at the four corner-points A, B, C, and, D, which will be used as reference for measurement. The calculation of the measurement results is carried out using the vector formula. Furthermore, the change in dimensions was determined by taking the difference between the sample vector and the main model vector.

$$\text{Dimensional change} = \| V1\text{-}V0 \|$$

V1 = Model Vector

V0 = parent vector

The data from this study were analyzed using a descriptive Univariate test to determine the mean value and SD (standard deviation) of dimensional changes in each treatment group. To assess the potential impact of

immersing the denture base made from hot polymerized acrylic resin in a 20% cinnamon extract and 0.2% chlorhexidine solution, a one-way ANOVA test was conducted using distilled water as a control for a period of 1 year. This analysis aimed to identify significant effects as a result of the immersion process.

3. Results

Univariate test results showed that the mean change in dimensions for the three treatment groups, following a 92-hour soaking period, were significantly different. The cinnamon group was found to have the largest mean value compared to the 0.2% chlorhexidine and distilled water groups with a mean value of 0.234 ± 0.010 mm, as shown in Table 1.

Table 1. Mean and standard deviation of dimensional changes of acrylic resin denture base

Sample	Dimension change(mm)		
	Chlorhexidine Solution 0.2%	***Cinnamomum burmannii* cinnamon extract 20%**	**Aquades**
1	0.228	0.199	0.036
2	0.229	0.204	0.023
3	0.241	0.199	0.038
4	0.238	0.188*	0.047**
5	0.228	0.204	0.022
6	0.230	0.211**	0.021
7	0.241	0.205	0.040
8	0.256**	0.211**	0.024
9	0.229	0.205	0.031
10	0.220*	0.195	0.015*
$\bar{x} \pm SD$	0.234±0.010	0.202±0.007	0.030±0.010

Based on the results of the one-way ANOVA statistical test, a significance of p = 0.001 (p <0.05) was obtained. This showed that there was a significant effect after immersion in 0.2% chlorhexidine solution, 20% *Cinnamomum burmannii*, and distilled water for 1 year on the dimensional change of heat-polymerized acrylic resin denture base material, as shown in Table 2.

Table 2. One-way ANOVA test results on the effect of immersing acrylic resin denture bases heat polymerization to dimensional changes

Group	Dimensional Change Value (mm)		p.s
	n	X ± SD	
Chlorhexidine Solution 0.2%	10	0.234 ± 0.010mm	0.001*
Cinnamomum burmannii cinnamon extract 20%	10	0.202 ± 0.007mm	
Aquades	10	0.030 ± 0.010mm	

Note: *Significant

4. Discussion

In this study, the value of changes in the dimensions of the denture base of hot polymerized acrylic resin in 0.2% chlorhexidine solution, 20% *Cinnamomum burmannii*, and distilled water were still within tolerable limits. The dimensional changes that occurred ranged from 0.093 - 0.372 mm, which has no significant effect on the adaptation of dentures in the oral cavity. Therefore, they could still be tolerated by the compressibility of the mucosa.[8] The dimensional changes of heat-polymerized acrylic resin that occur due to

solution absorption can be influenced by the type of immersion solution used. In this study, the highest dimensional change value was found in the immersion of hot polymerized acrylic resin in 0.2% chlorhexidine for 1 year. Furthermore, chlorhexidine 0.2% is a denture cleaning agent that has an acidic pH.[12]

Previous studies have shown that the acidic nature of chlorhexidine can lead to a reduction in the resin barrier, resulting in damage to the polymer resin chain, causing porous and high-water absorption. This results in dimensional changes in hot polymerized acrylic resin.[12],[13] In addition to its acidic pH, chlorhexidine also contains specific chemical elements, such as chlorine. The chemical element penetrates the spaces between acrylic resin molecules, resulting in the weakening of its physical properties, leading to polymer damage and porosity, as well as increased water absorption. The increase in water absorption will interfere and cause the bonds between polymers to decrease and the acrylic resin macromolecules will expand. Consequently, dimensional changes occur in hot polymerized acrylic resins. [13],[14],[15] This result is consistent with the report of the study conducted by Rahim.

On soaking hot polymerized acrylic resin in cinnamon extract, 20% *Cinnamomum burmannii* for 1 year has a smaller dimensional change value because the acid in the extract is less than 0.2% chlorhexidine solution. This result is consistent with the report of Diansari et al (2015) that soaking acrylic resin in rosella tea containing acid for 1, 3, 5, and 7 days showed a dimensional change value that continued to increase compared to distilled water.[7],[17] Acidic compounds contain many H+ ions, which can reduce the surface tension of hot polymerized acrylic resin. Therefore, the molecules in the solution can easily enter between acrylic resin molecules, facilitating faster diffusion. In this case, the dimensional changes that occur are greater than with neutral distilled water (pH 7).

Based on the result of this study, which involved soaking hot polymerized acrylic resin in 0.2% chlorhexidine solution, 20% *Cinnamomum burmannii*, and distilled water. It can be concluded that the value of dimensional change observed in the 20% *Cinnamomum burmannii* extract group was smaller compared to the 0.2% chlorhexidine group. This result simulates the effect of using disinfectant for a period of 1 year.

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