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Color Stability of Resin Dentures Base after Immersion in *Cinnamomum Burmannii* Extract and Chlorhexidine Solution

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ABSTRACT

Heat cured acrylic resin is a widely known dentures base material, which is often cleaned using *Cinnamomum burmannii*. Therefore, this study aims to determine the effect of soaking heat cured acrylic resin dentures base on color stability. The study procedures were carried out using a laboratory experimental method with pretest and posttest control group design. The test samples comprised 24 heat cured acrylic resins divided into 6 groups, namely soaking in *Cinnamomum burmannii* 20%, chlorhexidine 0.2%, and distilled water for 1 and 2 years. Color stability assessement was then carried out using a colorimeter. The results showed that the average color change in the samples after soaking in *Cinnamomum burmannii* 20% for 1 year was 2.12 and 2.20 for 2 years. Meanwhile, the average color change after being soaked in chlorhexidine was 2.53 and 3.05 after 1 and 2 years, respectively. The results of One-way Analysis of Variance (ANOVA) showed that soaking the samples in *Cinnamomum burmannii* 20%, chlorhexidine 0.2%, and distilled water for 1 year and 2 years had a significant effect on color stability. The results of LSD (least significant difference) analysis after 1 year of immersion revealed a significant difference in the effects of soaking in chlorhexidine 0.2% compared to distilled water. After soaking for 2 years, a significant difference was observed in the effects of the treatment groups on color stability.

Keywords: Heat Cured Acrylic Resin, Color Stability, *Cinnamomum Burmannii*, Colorimeter

ABSTRAK

Resin akrilik polimerisasi panas merupakan bahan basis gigi tiruan yang sering digunakan. Saat ini telah berkembang pembersih gigi tiruan alami, diantaranya kayu manis Cinnamomum burmannii. Tujuan penelitian untuk mengetahui pengaruh perendaman basis gigi tiruan resin akrilik polimerisasi panas terhadap stabilitas warna. Jenis penelitian eksperimental laboratoris dengan pre and post test with control group design. Sampel adalah resin akrilik polimerisasi panas 24 sampel dibagi 6 kelompok yaitu perendaman ekstrak kayu manis Cinnamomum burmannii 20%, klorheksidin 0,2% dan akuades selama 1 dan 2 tahun. Pengujian stabilitas warna dengan kolorimeter. Rerata perubahan warna resin akrilik polimerisasi panas setelah direndam ekstrak kayu manis Cinnamomum burmannii 20% 1 tahun adalah 2,12 dan 2 tahun sebesar 2,20. Rerata perubahan warna resin akrilik polimerisasi panas setelah direndam klorheksidin 1 tahun adalah 2,53 dan 2 tahun sebesar 3,05. Hasil One-way ANOVA dinyatakan ada pengaruh signifikan perendaman resin akrilik polimerisasi panas direndam ekstrak kayu manis Cinnamomum burmannii 20%, klorheksidin 0,2%, dan akuades 1 tahun dan 2 tahun terhadap stabilitas warna. Hasil LSD, perendaman 1 tahun menunjukkan ada perbedaan pengaruh perendaman yang signifikan klorheksidin 0,2% dengan akuades, Perendaman 2 tahun menunjukkan ada perbedaan pengaruh bahan perendaman yang signifikan seluruh kelompok perlakuan terhadap stabilitas warna. Kesimpulan adalah ada pengaruh bahan perendaman dan tidak ada pengaruh lama perendaman terhadap stabilitas warna

Keyword: Resin Akrilik Polimerisasi Panas, Stabilitas Warna, Ekstrak Kayu Manis, Colorimeter

1. Introduction

Dentures are tools that function to replace missing natural teeth, restore aesthetics, chewing function, speech function, as well as protect the supporting tissue under the artificial teeth [1]. Several studies have shown that 56.3% of patients use these tools for a period of 0-5 years and 18.8% for 6-10 years. Despite the potential, microorganisms have a high potential for adhering to acrylic resin surfaces, which serve as their base material. In addition, more than 95% of denture bases are made from acrylic resin [2]. Acrylic resin has several advantages, namely it is not toxic, does not irritate tissue, does not dissolve in oral fluids, has good physical and aesthetic properties, and is relatively cheap [3].

Extended periods of wearing dentures can lead to the attachment of microorganisms, including Candida albicans. This attachment can be reduced through the use of cleaning materials, which kill microorganisms up to 99% after soaking for 10 to 20 minutes [4]. An alternative natural-based dentures cleaning agent that can inhibit the growth of Candida albicans is *Cinnamomum burmannii*. According to Khatimah et al (2017), *Cinnamomum burmannii* at concentrations of 20%, 30%, 40%, and 50% showed inhibitory power that was more effective compared to the standard drug commonly used, namely Chlorhexidine 0.2% [5].

Previous studies have shown that acrylic resin has the weakness of absorbing water slowly over a certain period of time through diffusion of water molecules [6]. In addition, the absorption of liquid dyes in acrylic resin is one of the major factors causing color changes. Kusumawati et al (2020) identified various intrinsic and extrinsic factors that can cause discoloration of denture bases. Intrinsic factors are chemical changes in the material, namely an imperfect polymerization process. Meanwhile, extrinsic factors include adhesion or penetration of dyes from external sources, such as coffee, tea, and nicotine [7]. Zulkarnain and Angelyna (2018) also showed that there was a significant difference in the color change of hot polymerized acrylic resin after soaking in 40% roselle flower extract for 1 year (61 hours), 2 years (122 hours), and 3 years. (183 hours) [8]. Puspitasari et al (2016) stated that there was a change in the color of hot polymerized acrylic resin after being soaked in 75% celery leaf extract for 1 year and 3 years [1]. Therefore, this study aims to examine the effect of soaking heat cured acrylic resin dentures base in *Cinnamomum burmannii* 20 % and chlorhexidine 0,2% for 1 year (61 hours) and 2 years (122 hours) on color stability.

2. Materials and Methods

This laboratory experimental study obtained ethical clearance from the Ethical Committee of Universitas Sumatera Utara, with decision letter 189/UN5.2.1.6/SSA/2021. The current sudy was carried out to determine Color Stability of Resin Dentures Base after Immersion of *Cinnamomum Burmannii* and Chlorhexidine Solution. Pretest and posttest with control group design and sampling were carried out at the Dental Laboratory Faculty of Dentistry. *Cinnamomum burmannii* at a concentration of 20% was prepared at the ASPETRI Medicinal Plant Study and Development Laboratory in Medan. Color stability test was carried out at the Computer Numerically Controlled (CNC) Laboratory of Mechanical Engineering Polytechnic Medan which was from May to June 2021. Furthermore, the sample in this study used heat polymerized acrylic resin-type crosslinked merk “Stellon” made from test plates with a diameter of 20 mm and a thickness of 3 mm (according to ADA specification No.12). The total number of samples used in this study were 24 for 6 treatment groups.

The acrylic resin-filling process comprised combining a polymer and monomer in a 2:1 ratio until a homogeneous mixture was achieved, reaching the dough phase. The mold, pre-coated with a cold mold seal, was filled with the acrylic resin mixture. A cellophane sheet was then placed between the upper and lower halves of the mold (cuvettes) before applying a pressure of 1000 psi for 5 minutes. Subsequently, the cuvette was opened, and any excess sample was removed using a lekron. The cuvette was resealed and pressed again, with the pressure being gradually increased to 2000 psi. To ensure proper adaptation between the upper and lower cuvettes, the bolts were tightened and locked securely.

The procedure was then continued with the curing process, during which the cuvette was immersed in a water bath. Initially, the water temperature was maintained at 70°C for 90 minutes, and it was increased to 100°C for an additional 30 minutes. After the curing process was completed, the water bath was turned off and allowed to cool to room temperature. The sample underwent a preparation process to refine its surface. Sharp edges were removed using a Fraser bur, and the surface was smoothed with waterproof sandpaper of progressively finer grits (150, 400, 600, and 1000), all under running water. Finally, it was immersed in

distilled water at 37°C for 48 hours in an incubator before testing. This step was carried out to minimize residual monomer.

In this study, the type of cinnamon used was *Cinnamomum burmannii*. 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 neither excessively fine nor coarse. A total of 100 grams of blended cinnamon was macerated by soaking in ± 1 liter of 96% ethanol with occasional stirring, and the sample was 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. In addition, to get a cinnamon extract concentration of 20%, a total of 6 grams of thick cinnamon extract was used and then dissolved in DMSO to 30 ml.

The samples were soaked in distilled water for 48 hours at 37°C using an incubator to reduce residual monomers. Samples were divided into 6 groups, namely samples soaked in *Cinnamomum burmannii* 20% for 1 year (61 hours), *Cinnamomum burmannii* 20% for 2 years (122 hours), chlorhexidine 0.2% (positive control) for 1 year (61 hours), chlorhexidine 0.2% (positive control) for 2 years (122 hours), samples soaked in distilled water (negative control) for 1 year (61 hours), and samples soaked in distilled water (negative control) for 2 years (122 hours). The measurement of color changes in this study was with a colorimeter and the monitor or screen of a colorimeter test equipment that showed the values of ΔL, Δa, and Δb on the sample measured.

Data analysis used in this study was univariate analysis to determine the average value and SD (standard deviation). Analysis of Variance (ANOVA) test was carried out to determine the effect of immersing hot polymerized acrylic resin in *Cinnamomum burmannii* 20%, chlorhexidine 0.2 %, and distilled water. Furthermore, an LSD (least significant difference) posthoc test was carried out to determine the difference in the effect of soaking hot polymerized acrylic resin dentures base in *Cinnamomum burmannii* 20%, chlorhexidine 0,2%, and distilled water. Independent t-test to determine the effect of soaking dentures base in the hot polymerized acrylic resin in *Cinnamomum burmannii* 20%, chlorhexidine 0,2%, and distilled water for 1 year and 2 years on color stability

3. Results

The results of measuring color stability value of the hot polymerized acrylic resin dentures base after soaked in *Cinnamomum burmannii* 20%, chlorhexidine 0,2%, and distilled water for 1 year and 2 years were obtained from sample measurements using a colorimeter. Based on the results, color stability value of the hot polymerized acrylic resin dentures base after soaked in *Cinnamomum burmannii* 20% for 1 year, the smallest value was 1.73 and the largest value was 2.78, and for 2 years the smallest value was 2.05 and the largest value is 2.30. The mean and SD value of the hot polymerized acrylic resin dentures base group after soaked in chlorhexidine for 1 year was 2.53 ± 0.525 and for 2 years was 3.05 ± 0.195. The mean and SD value of the hot polymerized acrylic resin dentures base group after immersion in distilled water for 1 year was 1.52 ± 0.468 and 2 years was 1.62 ± 0.485 (Table 1).

Table 1. Mean and standard deviation of color stability of acrylic resin dentures

No Sample	Soaking Time					
	I Year			2 Year		
	Cinnamomum burmannii 20%	Chlorhexidine Solution 0.2%	Aquades	*Cinnamomum burmannii* 20%	Chlorhexidine Solution 0.2%	Aquades
1	2.78**	2.70	0.98*	2.24	3.09	1.95
2	2.19*	3.25**	1.58	2.20	3.26**	1.01*
3	2.08	2.14	1.71	2.05*	2.91*	2.13**
4	1.73*	2.13*	2.30**	2.30**	3.15	1.50
X ± SD	2.12±0.436	2.53±0.525	1.52±0.468	2.20±0.103	3.05±0.195	1.62±0.485

Based on the results of One-way ANOVA analysis in (Table 2), the test results for immersion for 1 year were found to be significant at p=0.044 (p<0.05), while for immersion for 2 years was found to be significant at p=0.0001 (p<0.05). This showed that there was a significant effect of soaking in *Cinnamomum burmannii* 20%, chlorhexidine 0.2%, and distilled water for 1 year and 2 years on color stability.

Table 2. One-way ANOVA test results on the effect of immersing acrylic resin dentures base heat polymerization to color stability

1 Year	*Cinnamomum burmannii* 20%	0.044*
	Chlorhexidine Solution 0.2%	
	Aquades	
2 Year	*Cinnamomum burmannii* 20%	0.0001*
	Chlorhexidine Solution 0.2%	
	Aquades	

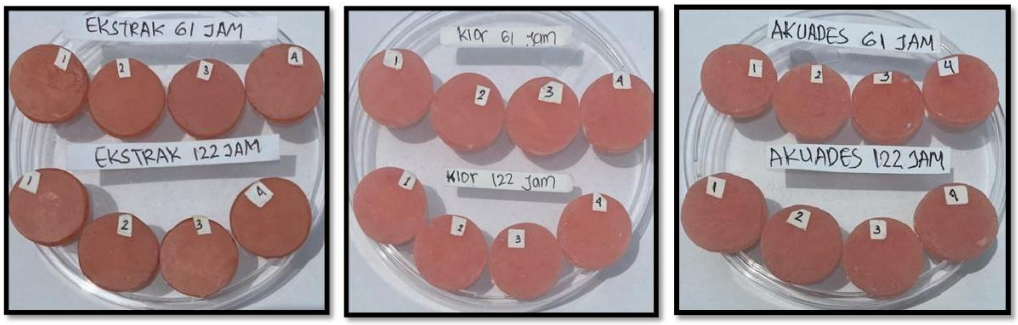
Note: *Significant

Based on the results of the LSD post hoc analysis presented in Table 3, after one year of soaking, there was a significant difference in the effect of soaking solutions on color stability between chlorhexidine 0.2% and distilled water (p = 0.015; p < 0.05). However, no significant differences were observed between Cinnamomum burmannii extract at 20% concentration and chlorhexidine 0.2% (p = 0.253; p > 0.05), or between Cinnamomum burmannii extract at 20% and distilled water (p = 0.112; p > 0.05). These results suggested that while the type of soaking solution impacted color stability, the specific effect varied depending on the solution used. The results also showed that after soaking for 2 years, there was a significant difference in the effect of soaking ingredients between *Cinnamomum burmannii* 20% and chlorhexidine 0.2% (p=0.003; p<0.05), chlorhexidine 0.2% and distilled water (p=0 .0001; p<0.05), as well as *Cinnamomum burmannii* 20% with distilled water (p=0.027; p<0.05) on color stability.

Table 3. Analysis of LSD posthoc test results on the effect of immersing acrylic resin dentures base heat polymerization to color stability

Soaking Time	Sample		P
1 Year	*Cinnamomum burmannii* 20%	Chlorhexidine Solution 0.2%	0.253
	Chlorhexidine Solution 0.2%	Aquades	0.015*
	Aquades	*Cinnamomum burmannii* 20%	0.112
2 Year	*Cinnamomum burmannii* 20%	Chlorhexidine Solution 0.2%	0.003*
	Chlorhexidine Solution 0.2%	Aquades	0.0001*
	Aquades	*Cinnamomum burmannii* 20%	0.027*

Note: *Significant



A B C

Figure 1. (A) Sample after soaking *Cinnamomum burmannii* 20%, (B) Sample after soaking in chlorhexidine, (C) Sample after soaking in equates.

4. Discussion

In this study, *Cinnamomum burmannii* demonstrated a significant effect on heat-cured acrylic resin after soaking for 1 and 2 years. Cinnamon was known to contain high levels of cinnamaldehyde and eugenol [9]. Cinnamaldehyde, a phenylpropanoid compound, was a derivative of phenol, while eugenol was an acidic phenolic compound with high polarity. Meanwhile, heat-cured acrylic resin was a long-chain polyester polymer composed of repeating methyl methacrylate units with low polarity. The interaction between the ester groups in the resin and the acidic phenolic compounds, such as cinnamaldehyde and eugenol, led to chemical reactions. Specifically, the hydrogen ion (H^+) in the phenol could be released and bonded with the methoxy group (CH_3O^-) released from the ester. In addition, the benzene ring in the phenol could form bonds with the carbonyl group (RCO) of the ester [10]. This ion exchange reaction disrupted the chemical bonds within the heat-cured acrylic resin, potentially leading to the formation of numerous cavities on its surface. The increased porosity on the surface of the acrylic resin significantly enlarged the surface area, leading to higher water absorption. This increase in water uptake could negatively impact the physical properties of the resin, particularly its color stability [11].

According to Nugrahini (2020), phenol compounds were acidic [12]. This was because phenol were homopolar compounds that were known to contain a lot of H+ ions and acid molecules more easily released ions (H+) in solution [13]. Dara (2012) stated that color change in acrylic resin dentures elements became darker due to immersion in coffee drinks which were also acidic and had a pH of 5.5 [14]. According to Anusavice, color change that occurred in resin could vary, this was caused by several factors, including the length of contact between the materials [15]. The length of contact between the resin and the soaking solution containing the dye was directly proportional to color change, meaning that the longer the material was soaked, the higher color change that occurred followed by physical and chemical bonds between the dye and the resin [12].

According to Ibrahim et al, chlorhexidine could affect color change of heat-cured acrylic resin when soaked for 30 to 45 minutes. This was proven that there was a significant change in chroma, causing color of the hot polymerized acrylic resin to become more faded [16]. In this study, the duration of immersion of the hot polymerized acrylic resin dentures based in *Cinnamomum burmannii* 20% for 1 year had color stability value that was smaller than chlorhexidine 0.2% immersion group but greater compared to the distilled water immersion group. This was in line with Kasuma et al. stating that coffee could affect color stability of the hot polymerized acrylic resin [17,18].

Based on the results of this study, it could be concluded that *Cinnamomum burmannii* 20% was recommended as an alternative dentures cleaning agent because it had a smaller color change value compared to chlorhexidine. In addition, even though it had an acceptable color stability value, chlorhexidine, which was hydrolyzed in an aqueous and acidic environment, could form parachloroaniline (PCA) and its degradation products, which were toxic and carcinogenic compounds. The lack of influence on the duration of immersion of the hot polymerized acrylic resin dentures based in this study was caused by the saturation phase. The saturation phase in acrylic resin caused acrylic resin to no longer absorb the ingredients contained in the soaking ingredients, namely cinnamon extract and chlorhexidine [19][20].

5. Conclusion

In conclusion, *Cinnamomum burmannii* 20% was recommended as an alternative dentures cleaning agent because it had a smaller color change value compared to chlorhexidine, according to LSD and ANOVA results.

6. Conflict of Interests

The authors declare no conflict of interest concerning the publication.

7. Ethical Clearance

Applicable and approved by the committee of ethics with the letter No: 189/UN5.2.1.6/SSA/2021.

8. Acknowledgements

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