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THE EFFECTIVENESS OF CINNAMON BARK EXTRACT PASTE (*Cinnamomum burmanii*) IN ELIMINATING *Candida albicans* IN THERMOPLASTIC NYLON

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ABSTRACT

Background: One type of denture base that is widely used is thermoplastic nylon. Thermoplastic nylon not cleaned regularly will cause food residue to stick and give rise to fungi such as *Candida albicans*. Mechanical cleaning methods are more effective at removing microbes. However, regular toothpaste contains abrasive ingredients that can scratch dentures. Extracts from cinnamon bark can be used because they contain ingredients that can inhibit the growth of *Candida albicans* colonies. **Purpose:** To analyze the antifungal activity of using cinnamon bark (*Cinnamomum burmanii*) extract paste to eliminate *Candida albicans* on thermoplastic nylon. **Methods:** This research is purely experimental, using a pretest-posttest with a control group design. This study used 27 thermoplastic nylon plates measuring 65x10x3mm, which were divided into 3 groups, namely the cinnamon bark extract paste group with a concentration of 50%, Fresh 'n Brite paste as a positive control, distilled water as a negative control. **Results:** The results of the Kruskal-Wallis test show an effect based on treatment in each group. **Conclusion:** Fresh 'n Brite denture paste as a positive control is more effective in eliminating *Candida albicans* on thermoplastic nylon than cinnamon bark extract paste with a concentration of 50% and distilled water as a negative control.

Keywords: *Candida albicans*, *Cinnamomum burmanii*, Denture Paste, Thermoplastic Nylon

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INTRODUCTION

According to Basic Health Research (Riskesdas) in 2018, most oral and dental problems in Indonesia are caused by extraction or falling out on their own. Data from Basic Health Research in 2018 stated the percentage of the Indonesian population experiencing tooth loss is 19%, in South Kalimantan Province is 17.8%, and only 3.3% used dentures.¹

Tooth loss can reduce aesthetics, chewing function, nutritional status, speech function, and quality of life.² Tooth loss can be treated by making a prosthesis, usually known as dentures/artificial teeth. A denture is a tool to replace the function of teeth and protect the tissue around the teeth. Dentures can restore the chewing function, aesthetic function, and speech function lost due to teeth loss.³

One part of the denture is the base. Removable denture bases consist of three types of materials: acrylic, metal framework, and thermoplastic.⁴ Thermoplastic

nylon is a denture base with hypoallergenic properties and the largest monomer. This makes thermoplastic nylon a solution for patients sensitive to nickel, acrylic resin, and cobalt.⁵ Thermoplastic nylon is a hydrophilic polymer, so it is easy to absorb water and cause porosity.⁵ This can cause food residue to stick, which, if not cleaned regularly, will cause an increase of microorganisms in the oral, mainly *Candida albicans* fungi.⁶

Candida albicans is a fungus found in the oral cavity. This fungus has opportunistic properties and is one of the denture stomatitis pathogens.⁷ One of the studies found that *Candida* can increase the colonization in the palate and have a 50-60% risk of denture stomatitis in its use.⁸ However, colonization of *Candida albicans* is also influenced by the length of use, cleanliness, and user habit.⁹

One of the important factors in maintaining dentures is user behaviour. Denture care is carried out

chemically and mechanically and can be carried out simultaneously.¹⁰ Dental care using the mechanic method can be carried out by brushing teeth with an electronic brush and paste. This method does not require a lot of time, is easy to carry out, and is effective in cleaning dental plaque.¹¹ Denture is cleaned twice a day, after having breakfast and before going to bed. The type of denture cleaning paste that complies with ADA (American Dental Association) regulations is Fresh 'n Brite paste, produced by Allendale Pharmaceuticals Limited because it is effective in cleaning removable dentures. This denture-cleaning paste contains ingredients such as propylene glycol, purified water, methylparaben, sodium saccharin, sodium lauryl sulfate, polyethylene glycol, silicon dioxide, propylparaben, sorbitol, and flavour. Therefore, an herbal denture cleanser that can inhibit the growth of bacteria and fungi is required.¹²

The type of cinnamon plant that is widely found in Indonesia is *Cinnamomum burmanii*. This plant has a role in killing microorganisms or as an antifungal and antimicrobial. A study by Chaudry and Tariq found that the contents of cinnamon have an anti-microorganism effect.¹³ Essential oil contained in cinnamon is able to inhibit bacteria and has compounds called cinnamic acid and cinnamaldehyde compounds. These compounds are able to inhibit the development of *Candida albicans*. This is also because the 3-phenyl compound is able to bind enzymes and oxygen, which are the food for *Candida albicans*.¹⁴

The results obtained from the study by Rezky showed that the lowest concentration, namely 20% was able to exceed the positive control (Chlorhexidine 0.2%) and at a concentration of 50% it is an effective concentration to inhibit the growth of *Candida albicans*.¹⁵ Based on the background above, the researcher made a denture-cleaning paste preparation from cinnamon bark extract at a concentration of 50%, which has antifungal activity against *Candida albicans* in dentures with a thermoplastic nylon base.

METHODS

This study was true experimental with a post-test control group design. The research population used *Candida albicans* isolates with criteria of same size, cylindrical shape of 65 x 10 x 3 mm, smooth surface, and not porous. The number of samples was 27 and divided into 3 groups, the first treatment was brushing with *Cinnamomum burmanii* paste at a concentration of 50%, the second treatment was brushing with Fresh 'n Brite paste, and the third treatment was brushing with distilled water (control group).

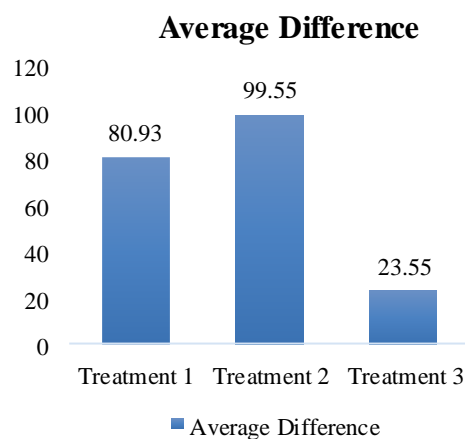
The research procedure was started by making dentures using thermoplastic nylon material. Cinnamon bark extract, basic paste, and extract paste were then made. The next stage was to create *Candida albicans* colonies on a thermoplastic nylon plate and eliminate the fungus on the thermoplastic nylon plate. Brushing

the intervention material into sample media was carried out for 3 minutes. The last stage was the calculation of the number of *Candida albicans* colonies before and after treatment. Data from the study were analyzed using SPSS software with the Kruskal-Wallis test and the Post Hoc Mann-Whitney test. The research was conducted in the primary laboratory of FMIPA ULM, the biomedical laboratory Faculty of Dentistry ULM, and the pharmacy laboratory of Sari Mulia University. This study has received ethical approval from the Ethics Committee of the Faculty of Dentistry ULM with Number 150/KEPKG-FKGULM/EC/XII/2023.

RESULTS

Figure 1 shows that there was a difference between the percentage difference in the mean number of colonies from the treatment of cinnamon (*Cinnamomum burmanii*) bark extract paste at a concentration of 50%, Fresh 'n Brite paste as positive control, and distilled water as negative control against *Candida albicans*. The figure above shows that Fresh 'n Brite paste as a positive control had a mean percentage difference of almost 100% or strongly effective in eliminating *Candida albicans* in thermoplastic nylon.

Figure 1. Percentage Difference in Average Cinnamon (*Cinnamomum burmanii*) Bark Extract Paste at a Concentration of 50%, Fresh 'n Brite Paste, and Distilled Water in Eliminating *Candida albicans*



According to Table 1, it can be found that there was significant difference between cinnamon bark extract paste at a concentration of 50% group and Fresh 'n Brite paste group as positive control, with a significance value of $0.048 < 0.05$; between cinnamon bark extract paste at a concentration of 50% group and distilled water as negative control, with a significance value of $0.048 < 0.05$; and between Fresh 'n Brite paste

group as positive control and distilled water group as negative control with a significance value of $0.000 < 0.05$.

According to Table 2, it can be found that the

Table 1. The Percentage Difference in Mean Number of Colonies and Standard Deviation of Number of *Candida albicans* Colonies in Thermoplastic Nylon

Treatment Groups	N	Mean (mm) \pm SD
Group 1	9	80.93 \pm 6.36
Group 2	9	99.55 \pm 0.37
Group 3	9	23.55 \pm 14.71

Table 2. Significance value of the effectiveness of cinnamon (*Cinnamomum burmanii*) bark extract paste in eliminating *Candida albicans* in thermoplastic nylon

	I	II	III
I	-	0.048*	0.048*
II		-	0.000*
III			-

highest percentage difference in the mean of *Candida albicans* colonies was in positive control group brushed using Fresh 'n Brite denture paste compared to the cinnamon bark extract paste at a concentration of 50% group and negative control group. Moreover, the lowest percentage difference in the mean of *Candida albicans* colonies was in negative control using distilled water of 23.55%. Cinnamon (*Cinnamomum burmanii*) bark extract paste at a concentration of 50% had a mean percentage difference of 80.93%, in which the difference in the number of colonies was lower than Fresh 'n Brite paste as positive control and higher than distilled water as negative control. Group brushed using Fresh 'n Brite paste is more effective in eliminating *Candida albicans* in thermoplastic nylon if compared to other groups.

DISCUSSION

The results of the study showed that the Fresh 'n Brite paste group as positive control is more effective, proven by the high difference in the mean number of *Candida albicans* colonies in thermoplastic nylon. The statistical results showed that the number of *Candida albicans* colonies in thermoplastic nylon plate brushed using Fresh 'n Brite paste as positive control had a decrease compared to cinnamon bark extract paste at a concentration of 50% group and distilled water group as negative control.

The results of the study regarding the effectiveness of *Cinnamomum burmanii* paste in eliminating *Candida albicans* in thermoplastic nylon show the percentage difference in the mean number of *Candida albicans* colonies in thermoplastic nylon brushed using Fresh 'n Brite denture paste as control positive of 99.55%. This result proves that Fresh 'n Brite paste is more effective in eliminating *Candida albicans* than cinnamon bark extract paste at a concentration of 50% group and negative control group. This is because Fresh 'n Brite denture paste contains several ingredients with antimicrobial activity, so it can reduce the number of *Candida albicans* colonies in thermoplastic nylon. Choosing Fresh 'n Brite denture paste is based on the standard recognized by ADA (American Dental Association), which is a very high level of denture cleanliness, such as no visible stains, deposits, or unpleasant odour. The product is also not dangerous to use and does not have a bad impact on denture material or harm oral tissue. Fresh 'n Brite denture paste contains propylene glycol, purified water, methylparaben, sodium saccharin, sodium lauryl sulfate, polyethylene glycol, silicon dioxide, silicon dioxide hydrate, FD&C Blue No.1, propylparaben, sorbitol, and corn flavour.

The ingredients of Fresh 'n Brite denture paste which has antimicrobial activity are propylene glycol. Propylene glycol in pharmaceutical preparations functions as a humectant, solvent, lubricant, and as an inhibitor of fermentation and fungal growth.¹⁶ Other ingredients with antifungal activity are methylparaben and propylparaben as preservatives, which aim to protect the preparations to avoid fungal, so the preparation does not spoil quickly. Methylparaben and propylparaben are effective antibacterial and antifungal ingredients. Propylparaben and methylparaben are often used as preservatives and antibacterials for cosmetic, food, and pharmaceutical products, which are also combined with other antibacterial/parabens.¹⁷ Propylparaben is effective as a preservative in the pH range of 4-8, in which an increase in pH can cause a decrease in microbial activity. The ability of methylparaben and propylparaben can be increased by adding propylene glycol.¹⁸ One type of surfactant used in Fresh 'n Brite denture paste is sodium lauryl sulfate (SLS). Sodium lauryl sulfate (SLS) is the most common detergent used in toothpaste. Sodium lauryl sulfate (SLS) has an antimicrobial effect that can last up to several hours in the mouth and an inhibitory effect on plaque formation.¹⁹

The results of the study in thermoplastic nylon brushed using cinnamon (*Cinnamomum burmanii*) bark extract paste showed a percentage difference in the mean number of *Candida albicans* colonies of 80.93%. This is supported by Paraskevas et al, which reported that the brushing method using paste removes at least 50% of accumulated biofilm.²⁰ The decrease in the number of *Candida albicans* colonies brushed using cinnamon (*Cinnamomum burmanii*) bark extract paste at a concentration of 50% is caused by the presence of cinnamaldehyde, which can change the cell wall of microorganisms, so the permeability increases and changes the pressure in the cell. This also causes the cells to lyse, allowing foreign substances to enter *Candida albicans* and damage them.²¹ Cinnamaldehyde can decrease tension and cause the protein to denature. This also can cause microorganisms to die.²² Other active components, such as flavonoid, can inhibit the fungal growth, while eugenol has the task of inhibiting the *Candida albicans* cell division process and inhibiting microbial enzymes¹³

According to the study by Syahdiana W et al, cinnamon (*Cinnamomum burmanii*) bark extract paste at a concentration of 50% cannot reduce the number of *Candida albicans* colonies maximally and evenly in the thermoplastic nylon because there is an interaction between solvent and polymer, causing each particle close together and forming crosslinking in each molecule. This can cause the mobility of the solvent to decrease.²³ The concentration in cinnamon bark extract can also affect the viscosity of the paste because high concentration causes the liquid in the paste to be trapped in the matrix.²⁴

The largest number of *Candida albicans* colonies was found in thermoplastic nylon brushed using distilled water with a mean percentage difference of 23.55%. Distilled water is pure distilled water with a pH of 7 or neutral. Based on Papadiochou et al, the brushing method can reduce the amount of biofilm in the dentures. However, brushing dentures using paste can reduce the amount of biofilm more than brushing teeth with a neutral pH.²⁵ The results of this study are in line with the study conducted by Lee H et al, which stated that the highest number of *Candida albicans* colonies is found in a plate brushed using distilled water.²⁰ This shows that thermoplastic nylon denture brushed using distilled water is less effective in eliminating *Candida albicans*.

Factors affecting the results of this study are the limitations of the study. The limitation of the study is that cinnamon (*Cinnamomum burmanii*) bark extract paste at a concentration of 50% was stored in a medicine pot at room temperature for a long period before the research was conducted, so extract paste cannot work maximally and is not equivalent to the Fresh 'n Brite paste as a positive control. The second constraint is the difference in surface roughness in each thermoplastic nylon plate, so the number of *Candida albicans* in the plate is also different. Furthermore, there is a difference in the number of *Candida albicans* in each group before brushing, so it is difficult to determine a better group then the data are required to be converted into percentages to determine which group is most effective in eliminating *Candida albicans* in thermoplastic nylon.

The conclusion is that the highest number of *Candida albicans* was found in thermoplastic nylon brushed using Fresh 'n Brite paste of 99.55%, and the lowest number was found in thermoplastic nylon brushed using distilled water of 23.55%. Moreover, the results of the analysis obtained a significant difference between the cinnamon bark extract paste group, the Fresh 'n Brite paste group as a positive control (p-value of 0.048), and the distilled water group as a negative control (p-value of 0.048).

A suggestion for further study is to conduct studies using other methods, such as diffusion, to determine inhibitory power or examine the effect of cinnamon bark extract on the physical properties of thermoplastic nylon with different concentrations.

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