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Effect Of 25% Castor Leaf (Ricinus Communis) Extract Disinfection On Candida Albicans Inhibition Zone And Impact Strength Of Heat-Polymerized Acrylic Resin Denture Base

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Abstract :
Background : *Heat-polymerized acrylic resin denture bases possess biological properties that can serve as a medium for* Candida albicans*, as well as mechanical properties such as impact strength. Denture disinfection can be performed using herbal disinfectants, such as castor (*Ricinus communis*) leaf extract. Alkaloids, flavonoids, triterpenoids, tannins, and phenolics in castor may reduce the impact strength of the denture base.*
Materials and Methods *The study involved disinfecting denture base samples in 25% castor leaf extract as the treatment group, with a simulation of 1 and 2 years. The inhibition zone of* Candida albicans *was measured, and the impact strength of the denture base was tested to assess any potential alterations.*
Results : *The findings demonstrated that 25% castor leaf extract disinfection significantly influenced the* Candida albicans *inhibition zone. However, the impact strength test results indicated no significant effect of disinfection on the impact strength of the denture base.*
Conclusion : *The study concluded that 25% castor leaf extract exhibits a strong antifungal effect against* Candida albicans *without affecting the impact strength of denture bases after simulated 1 and 2-year usage.*
Key Word: *Denture base; Heat polymerized acrylic resin, inhibition zone, impact strength, castor leaf extract*

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I. Introduction

The most common dental health issue among the elderly in Indonesia is tooth loss. Partial or complete tooth loss can lead to several disturbances, including phonetic, masticatory, and aesthetic impairments. In 2023, according to the Indonesian Health Survey, the proportion of dentulous patients aged 45-54 years was 65.4%, for those aged 55-64 years was 69.1%, and for those over 65 years was 68.2%. Meanwhile, the percentage of edentulous patients aged 45-54 years was 0.6%, for those aged 55-64 years was 3.4%, and for those over 65 years was 8.7%.[1] Partial or complete tooth loss can be addressed by using dentures. Generally, the components of dentures consist of artificial teeth and denture bases. One of the most widely used denture base materials is acrylic resin.[2]

Heat-polymerized acrylic resin is the most commonly used material for denture bases due to its advantages. However, heat-polymerized acrylic resin also has several drawbacks, including susceptibility to fracture due to material fatigue or accidental drops on hard surfaces, the presence of residual monomers, porosity, water absorption, and low abrasion resistance.[3] The porosity of heat-polymerized acrylic resin allows deposition of food and beverage residues, allowing microorganisms to grow and proliferate on the denture base. Plaque accumulation on the denture base increases the colonization of *Candida albicans* which is a significant factor in the occurrence of denture stomatitis.[4] Preventing denture stomatitis caused by *Candida albicans* can be achieved by routinely cleaning dentures.Chlorhexidine is the most commonly used solution for denture cleaning because it effectively inhibits *Candida*.[5] According to Sitorus (2024) the use of 0.2% chlorhexidine in soaking heat-polymerized acrylic resin denture bases resulted in higher surface roughness compared to a 25% lemongrass extract.[6] Increased surface roughness can lead to cracks or crazing, which in turn affects the reduction of the impact strength of heat-polymerized acrylic resin. Therefore, an ideal denture cleaning solution is needed. A safe alternative is the use of plant extracts.[7]

Plant extract such as *Ricinus communis/* castor plant can be used as an alternative disinfectant. This extract contains alkaloids, flavonoids, triterpenoids, tannins, and phenolics. These active compounds possess antibacterial and antifungal effects, making them suitable for disinfection purposes.[8] A study by Ritonga (2023) indicated that *Ricinus communis* leaf extract at 50% and 60% concentrations shows strong inhibition against

Candida albicans.[9] The phenolic content in *Ricinus communis* leaves can serve as an alternative disinfectant but also cause chemical degradation of the surface of heat-polymerized acrylic resin. Phenolic compounds directly interacting with acrylic resin react with the ester bonds of polymethyl methacrylate, disrupting its structure and weakening the physical and mechanical properties of the acrylic resin due to molecular expansion.[10] Ritonga (2023) reported a decrease in the impact strength of heat-polymerized acrylic resin soaked in *Ricinus communis* leaf extract at 50%.[11] Based on this, the research wanted to examine the effect of 25% castor leaf disinfection on heat-polymerized acrylic resin denture base with a simulation of one and two year of use.

II. Materials And Methods

Study Design: Laboratory experiment with post-test only control group design
Study Location: Sampling was carried out at the Prosthodontics Research Laboratory Faculty of Dentistry USU.
Study Duration: October-December 2024
Sample size: The sample in this study is heat-polymerized acrylic resin denture base measuring 65 x 10 x 2,5 ± 0,5 mm according to ADA specification no.12
Sample size calculation: Total samples in this study were 48 samples. The sample was divided into 4 groups, with each grup consisting 6 samples. Group 1 : samples soaked in clorhexidine 0,2% (4 days); group 2 : samples soaked in 25% castor leaf extract (4 days); group 3 : samples soaked in clorhexidine 0,2% (8 days); group 4 : samples soaked in 25% castor leaf extract (8 days). The immersion time for heat-polymerized acrylic resin denture base in this study is 4 and 8 days, it was assumed to soak denture for 15 minutes a day for one and two years.

Procedure Methodology

The fabrication of heat-polymerized acrylic resin samples began with the preparation of a gypsum mold using a 300 g:90 mL water ratio. The mixture was stirred manually for 30 seconds until homogeneous and poured into the lower flask while placed on a vibrator to eliminate air bubbles. The master model was positioned on the partially set gypsum and left to harden. The mold is coated with a cold mold seal for 20 minutes. The polymer and monomer were mixed in a porcelain pot according to the manufacturer's instructions at a weight ratio of 2 g:1 mL and a volume ratio of 3 g:1 mL until the dough stage was reached. The mold, previously coated with a separator, was filled with the acrylic resin mixture, covered with a plastic sheet, and compressed using a hydraulic press at 1000 psi (70 kg/cm²). The flask was reopened to remove excess resin before being reassembled and subjected to a final pressure of 2200 psi (154 kg/cm²). The curing process was conducted in a water bath at 70°C for 90 minutes, followed by heating at 100°C for 30 minutes. The flask was then cooled to room temperature before removing the sample, which was further trimmed and polished. To eliminate residual monomer, the samples were immersed in distilled water for 48 hours before further testing.

The ethanol extract of Jatropha leaves (Ricinus communis) was prepared following the Indonesian Herbal Pharmacopoeia (2017). The leaves were collected through purposive sampling, sorted to remove debris, washed, and reweighed before processing. The leaves were dried in a drying cabinet at 50–60°C for seven days until fully dehydrated, then ground into a fine powder using a blender and sieved for uniformity. The maceration method was employed for extraction, using 70% ethanol as a solvent. A total of 100 g of powdered simplicia was placed in a 1 L Erlenmeyer flask and mixed with 1 L of 70% ethanol. The mixture was stirred continuously for six hours, left to stand for 18 hours with occasional stirring, and filtered using Whatman No. 41 filter paper (20 µm). The maceration process was repeated to obtain additional filtrate, and both filtrates were combined and evaporated at 40°C using a rotary evaporator until a thick extract was obtained. A test solution with a concentration of 25% was prepared by dissolving 25 g of the thick extract in 100 mL of dimethyl sulfoxide (DMSO). The final extract was stored in a suitable container until further use in experimental procedures.

Statistical Analysis

Data was analyzed using SPSS version 25. The data normality test was carried out first by using the *Shapiro-wilk* test to find out whether the data was normally distributed. The results show that p value > 0,05, this states that the data is normally distributed. Homogenity test is carried out using the Levene test, the results shows that p values > 0,05 this states that the data are homogeneous. Because the data is normally distributed and homogenous, the test is continued using T test to ascertain the significance value of each variable. The p-value < 0,05 was considered as significant.

III. Result

Based on the measurements that have been carried out, the following results are obtained:

Table no 1: Effect of 25% castor leaf extract (*Ricinus communis*) on the *Candida albicans* inhibition zone of heat-polymerized acrylic resin denture base simulated 1 and 2 years

Group		*Candida albicans* inhibition zone (mm)		
		N	Mean ± SD	p
1	1 year simulation	6	12,56 ± 0,67	0,047*
2		6	11,61 ± 0,77	
3	2 year simulation	6	13,81 ± 0,62	0,001*
4		6	12,05 ± 0,67	

Table no 2: Effect of 25% castor leaf extract (*Ricinus communis*) on the impact strength of heat-polymerized acrylic resin denture base simulated 1 and 2 years

Group		Impact strength (J/m^2)		
		N	Mean ± SD	p
1	1 year simulation	6	1404,84 ± 344,81	0,449
2		6	1284,53 ± 145,73	
3	2 year simulation	6	1324,86 ± 447,17	0,544
4		6	1187,34 ± 295,60	

The t-test was used to assess the effect of disinfection with castor (Ricinus communis) leaf extract on the inhibition zone of Candida albicans and the impact strength of the denture base. Prior to conducting the t-test, data analysis began with the Shapiro-Wilk test to assess the normality of data distribution, which showed that the data were normally distributed with a p-value > 0.05. This was followed by Levene's homogeneity test, which indicated that the data were homogeneous with a p-value > 0.05. The t-test was applied as the data met the assumption of normal distribution.

Table 1 and 2 shows the difference in the inhibition zone and impact strength after immersion for 4 and 8 days. It can be concluded that after the T-test was carries out, the inhibition zone of *Candida albicans* values were significantly affected by clorhexidine and 25% castor leaf extract, it was known that the p value < 0.05. The result of the impact strength test shows that immersion in 25% castor leaf extract did not have a significant effect, it was known from the result of p value > 0.05.

IV. Discussion

Table 1 shows that there was a significant difference between the groups treated with 25% castor leaf extract and chlorhexidine for 4 and 8 days regarding the inhibition zone of Candida albicans on heat-polymerized acrylic resin denture bases ($p < 0.05$). In the groups treated with castor leaf extract for 4 and 8 days, the diameter of the inhibition zone was categorized as strong, indicating the absence of Candida albicans growth around the paper disk. This effect is attributed to the antifungal properties of castor leaf extract, which contains alkaloids, flavonoids, triterpenoids, tannins, and phenolics.

The antifungal mechanism of alkaloids involves damaging the cell membrane by binding to ergosterol, which ultimately leads to fungal cell death. Flavonoids exert their antifungal effect by inhibiting the growth of fungal conidia due to their lipophilic nature, which disrupts microbial membranes. The action mechanism of triterpenoids involves membrane damage through antifungal active compounds that interfere with cellular component integrity. Tannins exhibit antifungal properties by inhibiting ergosterol synthesis. Meanwhile, phenolics function as antifungal agents by interacting with the fungal cell wall, causing protein coagulation, which results in the death of Candida albicans.[12,13] This study is supported by research conducted by Rieuwpassa IE et al. (2018), which demonstrated that a 25% siwak leaf extract with similiar antifungal properties was effective in inhibiting Candida albicans growth, with the inhibition zone classified as strong.[14]

The chlorhexidine group exhibited a larger inhibition zone compared to castor leaf extract, as chlorhexidine is classified as a cationic bisbiguanide agent with broad-spectrum antibacterial activity, as well as some antiviral and antifungal properties. Chlorhexidine binds to fungal cell membrane components, leading to alterations in the integrity of the lipid-based fungal cell wall. This disruption in membrane integrity results in the loss of membrane function, ultimately causing fungal cell death.[15]

Table 2 shows that there was no significant difference between the groups treated with 25% castor leaf extract and chlorhexidine for 4 and 8 days in terms of the impact strength of heat-polymerized acrylic resin denture bases ($p > 0.05$). The castor leaf extract group experienced a decrease in impact strength due to the hydrophilic nature of acrylic resin, which makes heat-polymerized acrylic resin prone to absorbing fluids through diffusion. Additionally, the phenol compounds present in castor leaf extract influence the impact strength of acrylic resin. Phenol is a compound with a smaller molecular weight compared to heat-polymerized

acrylic resin, allowing it to penetrate the acrylic resin base and cause cleavage of the long polymer chains. This results in a reduction of intermolecular bonds, leading to decreased impact strength in heat-polymerized acrylic resin. Phenolic compounds, such as flavonoids and phenolics, have a more significant effect on the impact strength of heat-polymerized acrylic resin compared to tannins. Tannins have lower solubility than other phenolic compounds and possess antioxidant properties that can reduce polymer degradation rather than induce it.[16]

Another factor affecting the impact strength of the acrylic resin base is the acidic (H^+) content in the castor leaf extract. The excess H^+ ions in the extract solution lead to instability in the chemical bonds of the acrylic resin. H^+ ions degrade polymer bonds, causing the dissolution of acrylic resin monomers. As a result of this solubility, voids or pores form within the polymer matrix, facilitating interactions between the polymer matrix and the compounds present in the castor leaf extract. This study is supported by Sitorus (2024), who found that immersion of heat-polymerized acrylic resin in 25% lemongrass leaf extract for 4 and 8 days resulted in an increased number of cracks over time, leading to a reduction in impact strength.[6] Research by Muchtar (2018) also stated that the ester groups in the acrylic resin base react with H^+ ions in phenol. This exchange reaction causes polymer bond degradation, leading to chemical instability and the formation of cracks, which ultimately reduce the impact strength of heat-polymerized acrylic resin denture base material.[17]

The concentration level of castor leaf extract influences the extent of chemical interactions and their impact on the impact strength of heat-polymerized acrylic resin. At lower concentrations, fewer phenol molecules are available to interact with the polymer chains, resulting in minimal degradation of the material's structure. In contrast, higher concentrations lead to more significant bond cleavage due to the increased formation of hydrogen bonds between phenol and the polymer chains.[18]

This study is supported by Setyohadi (2017), which demonstrated a decrease in impact strength in acrylic resin plates immersed in siwak powder solutions at concentrations of 25%, 37%, and 50%. The study concluded that higher solution concentrations resulted in lower impact strength of acrylic resin.[18] Additionally, the penetration of phenol into acrylic resin at high concentrations leads to a more uniform softening of the polymer structure, whereas at lower concentrations, the softening effect is limited to the surface. This finding is further supported by Rudy (2023), who concluded that higher phenol content reduces the surface strength of heat-polymerized acrylic resin denture bases.[19]

The chlorhexidine group exhibited higher impact strength than the castor leaf extract group due to the presence of Cl^- ions and its acidic pH. Acidic solutions chemically react with heat-polymerized acrylic resin, leading to polymer bond degradation and increased solubility of its filler materials. The dissolution of acrylic resin monomers and filler components creates porosities within the polymer matrix, reducing the impact strength of heat-polymerized acrylic resin.[6] Additionally, the absorption of chlorine into the acrylic resin contributes to the degradation of ethylene glycol dimethacrylate, a cross-linking agent in acrylic resin, thereby affecting the physical properties of heat-polymerized acrylic resin. This study is supported by Ritonga (2023), who observed a decrease in impact strength, although not statistically significant, following immersion in 0.2% chlorhexidine for 4 and 8 days.[9]

V. Conclusion

Based on the results and discussion above, it can be concluded that the 25% concentration of castor leaf extract (Ricinus communis) exhibits a strong inhibition zone against Candida albicans and does not affect the impact strength of heat-polymerized acrylic resin denture bases under a one-year (4-day) and two-year (8-day) simulation. The limitations of this study include the manual stirring technique used, which trapped air within the acrylic resin matrix, leading to a reduction in impact strength due to porosity formation. Additionally, manual stirring was also applied during the maceration process, causing the solvent to become saturated in extracting the chemical compounds from castor leaves, thereby reducing the final volume of the extract obtained.

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