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The Effect of Immersion of 12,5% Basil Leaves and 25% Mauli Banana Stem Mixture Extracts on Surface Hardness, Surface Roughness and Discoloration of Acrylic Resin

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ABSTRACT

Background: The most used denture base is heat-cured acrylic resin. It can causes denture stomatitis. The action taken to prevent denture stomatitis is by cleaning the denture. Chemical denture cleansers can reduce surface hardness, increase the degree of surface roughness and may cause discoloration of acrylic resin surfaces. Alternative natural denture cleanser is used to minimize this effects. The natural denture cleanser is using 12,5% Basil leave and 25% Mauli banana stem extracts which are known to have antifungal effectiveness against Candida albicans. The combination of these two extracts is expected to have better effectiveness against Candida albicans without changing the nature of the acrylic resin base in surface roughness, hardness and color.

Objective: This study aimed to analyze the comparison in surface hardness, surface roughness, and discoloration of a heat-cured acrylic resin which immersed in 12.5% Basil leave and 25% Mauli banana stem extracts with alkaline peroxide and distilled water.

Methods: This study was a true experimental study with pre and posttest with control group design. Study on surface hardness used 24 cylindrical type heat-cured acrylic resin samples with a diameter of 30 mm and 5 mm thickness. Study on surface roughness used 24 acrylic resin rectangular 65 x 10 x 3.3 mm. Study on discoloration used 24 acrylic resin sized 15mm in diameter x 2mm thick; n=8/group. The study used 3 treatment groups: 12.5% Basil leaves and 25% Mauli banana stem extracts, alkaline peroxide, and distilled water. Hardness testing was measured using Vickers Hardness Testing and surface roughness measurement was performed using surface roughness tester. The value of discoloration was measured before and after the immersion for five days with the CIELab system using digital analysis tools.

Result: The mean of the decrease in surface hardness value of heat-cured acrylic resin which was immersed in extract solution, alkaline peroxide, distilled water are 1.40, 1.38, and 0.60 respectively. The mean results of surface roughness increase in 12,5% Basil leave and 25% Mauli banana stem extracts, alkaline peroxide, and distilled water group were 0.0613 µm, 0.0663 µm, and 0.0425 µm respectively. Statistical tests on discoloration showed significant differences ($p<0.05$) between the immersion groups in the 12,5% Basil leave and 25% Mauli banana stem extracts (3.77 ± 0.44), alkaline peroxide (2.78 ± 0.32) and distilled water (2.09 ± 0.23). Data were analyzed using One Way ANOVA and Bonferroni Post Hoc test.

Conclusion: The decrease in surface hardness value of heat-cured type acrylic resin immersed in 12.5% Basil leave and 25% Mauli banana stem extracts is higher than those immersed in alkaline peroxide and distilled water. The 12,5% Basil leave and 25% Mauli banana stem extracts have the effect of the discoloration heat-cured acrylic resin.

Keywords: Basil leave and Mauli banana stem extracts, Discoloration, Hardness surface, Heat-cured acrylic resin, Surface roughness

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INTRODUCTION

Dentures are prosthetic devices that have a function to replace missing teeth. Some types of dentures are fixed dentures and removable dentures. In dentistry, denture base material that is still used today is heat-cured acrylic resin because it is easily manipulated and economic, and also it has a color resembling the surrounding tissue. The deficiencies of heat-cured acrylic resins include the ability to absorb water and porosity properties that can affect the nature of acrylic resins for example hardness, surface roughness, and discoloration within a certain period.[1,2]

Dentures can be a place of plaque buildup which causes the accumulation of the fungus Candida albicans to increase. The excessive proliferation of Candida albicans can cause denture stomatitis. Denture stomatitis is inflammation of the mucosa of denture wearers. Denture stomatitis is characterized by erythema and edema under the denture. Denture stomatitis is caused by food debris, plaque buildup and accumulation of microorganisms such as the fungus Candida albicans. Actions that are taken to prevent the occurrence of denture stomatitis is by performing maintenance and cleaning of dentures. Mechanical denture cleaning uses a toothbrush and chemically using a denture-cleaning agent or combining the two methods both mechanically and chemically. One of the denture cleaners that are often used by the public is alkaline peroxide.[4,5,6,7,8]

Alternative natural denture cleaning comes from plants used in this research, namely basil leaf extract (Ocimum sanctum L) and Mauli banana stem (Musa acuminata). Basil leaves have the main content of essential oils in the form of 43.7%. According to the results of research conducted by Ornay et al (2017) basil leaf extract (Ocimum sanctum L) can inhibit the growth of Candida albicans at a concentration of 12.5%.

Candida albicans can penetrate acrylic resin with a depth of 1 to 2 μm, so it is necessary to have denture cleaners that can remove biofilms without destroying the properties of acrylic resins.[18]

Another alternative to natural denture cleaning that is effective in reducing the number of Candida albicans colonies found on the stem of the Mauli banana (Musa acuminata). Banana plants are abundant agricultural products, one type of banana used as a basic ingredient of treatment is the Mauli banana. Mauli banana is a type of banana typical from South Kalimantan. Banana Mauli stem (Musa acuminata) has the largest active compound content, 67.6% tannin as an antifungal which works by shrinking the fungal cell wall so that it interferes with the permeability of the fungal cell. Based on the results of research from Septianoor et al (2013) Mauli banana extract (Musa acuminata) effectively inhibits the growth of the.[15,16,17]

This study used a combination of basil leaf extract and banana Mauli stem as a denture cleaning. The combination of the two extracts is expected to be more effective in inhibiting the growth of Candida albicans. Another benefit of basil leaves is that it can refresh and eliminate odors so that the combination of the two extracts can be accepted by the public through the aroma they have. [18,19,21]

The tannin content of the Mauli banana stem and the essential oil content of the basil leaves are phenol compounds. Chemicals such as phenols, when in contact with acrylic resins, can cause chemical damage that significantly impacts the physical properties of acrylic resins such as hardness, surface roughness, and discoloration.[20]

Based on the above background it is necessary to research the effect of soaking a mixture of basil leaves and banana stems Mauli extract on hardness, surface roughness, and color change.

MATERIALS AND METHODS

The study began with the preparation of a research permit and ethical clearance test issued by the Faculty of Dentistry, Lambung Mangkurat University No.105/KEPKG-FKGULM/EC/I/2019, No.152 /KEPKG-FKGULM/EC/I/2019 and No.155/ KEPKG-FKGULM/EC/I/2019.

The method used in this study is true experimental with pre and posttest with control group design. The sampling technique uses simple random sampling and the total sample in this study were 72 samples contained 24 surface hardness samples, 24 surface roughness samples, and 24 color change samples. The sample was divided into 3 groups, with each group consisting of 8 samples. Group 1: samples immersed in a mixture of basil leaf extract 12.5% and banana stems Mauli 25%; group 2: samples immersed in alkaline peroxide; group 3: samples soaked in distilled water. The immersion time of the heat-cured acrylic resin type in this study is 5 days because it is assumed to be soaking 20 minutes a day for a year.

The making of acrylic resin samples was carried out at the Laboratory of the Faculty of Dentistry, Lambung Mangkurat University, Banjarmasin. First, making mold space using red wax, with a diameter of 30 mm and a thickness of 5 mm for surface hardness samples, size 65 x 10 x 3.3 mm for surface hardness samples and a diameter of 15 mm and thickness of 2 mm for color change samples. The cast dough is made by mixing the cast with water in a rubber bowl, then stir using a spatula. The cast dough is put into the bottom cuvette that has been prepared and then vibrated so that air bubbles come out of the cuvette. The red night is placed on the dough cast until the setting. The surface of the cast on the bottom cuvette is smeared with vaseline and the top cuvette is filled with the cast dough and then re-calibrated so there are no air bubbles. After setting the cast, the disposal of the red night is done by cuvette doused with hot water.

CMS surface that has been cleaned from the red night is first smeared with CMS (could be seal). Heat cured acrylic resin dough is stirred in a stoned pot with a monomer and polymer ratio of 3: 1 according to the manufacturer's instructions, acrylic resin is stirred until the dough stage phase. The dough is put into a mold until it is fully loaded. Put the plastic bag in the bottom cuvette and cover it with the top cuvette. Press using a hydraulic press with a pressure of 1000psi (70 kg/cm^2), then the cuvette is opened and cut the excess acrylic then the cuvette is closed again and does the final press with a pressure of 2200psi (154 kg/cm^2). The cuvette is placed on a manual press and attaches the bolts to keep the top and bottom cuvettes tight. The acrylic filled cuvette is then soaked in boiling water for 30 minutes, then the cuvette is allowed to cool to room temperature and the sample is removed from the cuvette.

Samples that have been removed from the cuvette are trimmed using a Fraser bur to remove if there are sharp parts, then the surface of the sample is smoothed using a bur stone. Polishing the sample using a rotary grinding machine and followed by using sandpaper under running water to produce a flat and smooth surface. The final stage of polishing is using pumice and kryt powder to get a shiny surface.

Making a mixture of basil leaf extract 12.5% and 25% mauli banana stems done with maceration techniques. Basil leaves used in this study are basil leaves that are already in full flower and have begun to form seeds and the lower leaves have started to turn yellow. Mauli banana stems used in the study were 12 months old and have been bearing fruit before. Mauli banana stems taken are 10 cm from the root hump.

Basil leaves and banana stems Mauli then washed with running water to clean the dirt attached to the leaves then cut into small pieces and dried using an oven with a temperature of 40-50^{o}C. Drying basil leaves and banana stems Mauli done for 3 days. The dried basil leaves and banana Mauli stems are then mashed to a powder and then stored in a dry and covered place. The powder is then mixed with 70% ethanol solvent in a ratio of 1: 2 in a closed container and stirred several times in the 5 day immersion period. The results of the immersion are filtered using filter paper and stored in glass bottles. The solution is allowed to stand for 2 days to precipitate the solute. The extraction results were then evaporated using a rotary evaporator with a temperature of 40^{o}C to obtain a basil leaf thick extract of 3.75 grams and a thick extract of pp Mauli banana stem of 7.5 grams. A mixture of banana Mauli stem extract mixture and basil leaves is a combination of extracts that have been diluted with a volume of 1: 1.

Before measuring, acrylic resin samples are first soaked in saline solution and put into an incubator at 37°C for 24 hours to adjust to the state of the oral cavity. Measurements of hardness, surface roughness and discoloration were done before and after immersion in a mixture of basil leaf extract 12.5% and 25% mauli banana stems, alkaline peroxide and distilled water.

Stages of measurement of surface hardness value are heat-cured type acrylic resin samples placed on the object table, then adjust the position of the objective lens to focus on the sample. Then determine the amount of indentation to be given and the length of load given, then indent by pressing the start button on the machine and wait until the indentation time is over. Measure the diagonal of the indentation result and the machine will process and issue the hardness value in VHN units.

Stages of surface roughness measurement are that the sample is given three points using a marker then place the sample on a flat plane and the stylus at the first point on the surface of the sample. The tool is activated when the stylus is moved along a straight line along the surface and back again. Measurements were made three times at each of the previously marked points. The measured surface roughness value of the sample will be printed on the monitor screen in µm units.

Stages of measurement of color change are samples photographed with a Microsoft Lifecam Studio camera to measure the color of the sample before immersion (pre-test), then the results are read through the MATLAB application according to the CIELab system. The acrylic sample is placed in a dark box that is placed right in the middle of the box. The distance between the acrylic resin sample and the camera is 40cm after the sample is in the right position then the picture is taken and saved in JPG format. Acrylic resin samples were then soaked in each solution for 5 days and photographed again to measure the color (post-test). The color change value (ΔE) will be obtained by the calculation formula:

$$\Delta E = [(\Delta L)2 + (\Delta a)2 + (\Delta b)2]1/2$$

Information:

- L: brightness coordinates
- a: red-green chromatic coordinates
- b: yellow-blue chromatic coordinates
- L_t, a_t, b_t: before immersion
- L_o, a_o, b_o: after immersion
- ΔL: $L_o - L_t$
- Δa: $a_o - a_t$
- Δb: $b_o - b_t$

The data were statistically evaluated by conducting the Shapiro-Wilk normality test and the Levene homogeneity test. The data obtained were analyzed parametrically using the One Way ANOVA hypothesis test and continued by the Post Hoc Bonferroni test.

RESULTS

Based on the research that has been done, the average value of the decrease in surface hardness, increase in surface roughness and color change of heat-cured acrylic resin in the immersion of each group are presented in Table 1.

Table 1: Mean (mean) and Standard Deviation of Decreased Surface Hardness, Increased Surface Roughness and Discoloration of Acrylic Resin Heat Cured Type

	Mean ± SD (VHN)	Mean ± SD (ΔRa)	Mean ± SD (ΔE)
Extract	1,40±0,17	0,0613 ± 0,0083	3,77 ± 0,44
Alkalin Peroxide	1,38±0,14	0,0663 ± 0,0091	2,78 ± 0,32
Distilled water	0,60±0,19	0,0425 ± 0,0071	2,09 ± 0,23

Based on table 1, it can be seen that the highest value of surface hardness reduction and color change of the highest heat cured acrylic resin are found in the mixture of basil leaf extract 12.5% and mauli banana stem 25%, the highest increase in surface roughness of the heat cured acrylic resin type is highest in the group soaking alkaline peroxide, while decreasing surface hardness, increasing surface roughness and discoloration of the lowest heat cured type acrylic resin are found in the immersion group in distilled water.

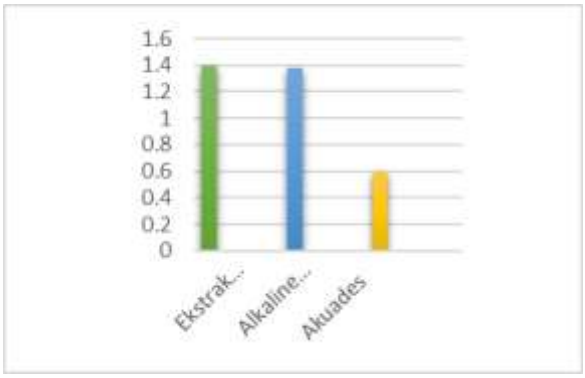

Figure 1: Average Diagram of the Decrease in Hardness of Heat Cured Acrylic Resins

Based on figure 1, the measurement results obtained a mean value of the decrease in surface hardness of the heat cured acrylic resin type after soaking for 5 days. In immersion basil leaf extract 12.5% and 25% of the banana stems mauli obtained a mean value of 1.40 VHN hardness reduction, alkaline peroxide 1.38 VHN and in distilled water for 0.60 VHN.The change in surface hardness value is obtained from the difference between the surface hardness value of the heat cured acrylic resin type before and after immersion. The results obtained are then performed a Shapiro-Wilk analysis test to find out whether the data is normal or not.

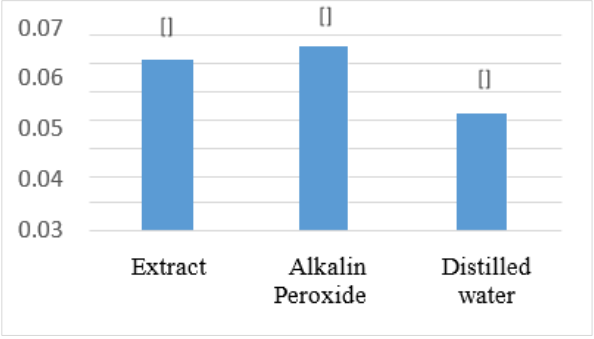

Figure 2: Mean Increased Surface Roughness Value Type Heat Cured Acrylic Resin.

Based on figure 2, the average value of surface cured acrylic resin increased surface roughness. Soaking in the banana stem extract mauli 25% and basil leaves obtained 12.5% average increase in surface roughness of 0.0613 µm, alkaline peroxide at 0.0633µm, and distilled water at 0.0425 µm. Values of surface roughness on alkaline peroxide immersion group is higher than the immersion group using banana bark extract mauli 25% and 12.5% and the basil leaves the immersion group using distilled water.

Table 2: Average Table (mean) Value of Discoloration of Acrylic Resin Heat Cured Type Based on ΔL, Δa, and Δb

	ΔL	Δb
Extract	1,11	3,46
Alkaline Peroxide	1,64	1,06
Distilled water	1,31	-0,62

Information:
- ΔL: brightness coordinates ($L_o - L_t$)
- Δa: red-green chromatic coordinates ($a_o - a_t$)
- Δb: yellow-blue chromatic coordinates ($b_o - b_t$)
- L_t, a_t, b_t: before immersion
- L_o, a_o, b_o: after immersion

Based on table 2, the results of the data show that all treatment groups get the value ΔL (+) so that the brightness intensity of the sample becomes brighter. The immersion group in the alkaline peroxide solution and the distilled water solution obtained Δa (+) values which showed the intensity of the sample color becoming redder, while the immersion group in the mixture of basil leaf extract 12.5% and 25% banana Mauli stems obtained (-) results which show the intensity of the sample's color becoming greener. The immersion group in the mixture of basil leaf extract 12.5% and 25% mauli banana stems and alkaline peroxide solution get a value of Δb (+) so that the color intensity of the sample becomes more yellow, while in the immersion group in the

distilled water solution get a value of Δb (-) which shows the intensity of the sample's color becoming bluer.

Data obtained from the test results are then performed statistical analysis using SPSS v.23 to determine the distribution of normal and homogeneous data. The first step is to test the normality of the data using the Shapiro-Wilk test and then test the homogenity of the data with the Levene's Test. Data results for all groups were normally distributed (p> 0.05) and homogeneous data variants (p <0.05). The test results obtained normal and homogeneous data distribution so that it was continued with parametric analysis One way ANOVA. The significance of the test for increasing surface roughness, surface hardness and discoloration of heat-cured acrylic resin can be seen in Table 3-5.

Table 3: Table of Significance Values of the Decreased Surface Hardness Test of the Acrylic Resin of Heat Cured Type

	Alkaline Peroxide	Distilled Water	Extract
Alkaline Peroxide	-	0,000*	1,000
Distilled Water	-	-	0,000*
Extract	-	-	-

*= There are significant differences (p<0,05)

Based on table 3, above, the significance values tested using the Post Hoc Bonferroni test showed that the immersion in a mixture of basil leaf extract 12.5% and banana stems Mauli 25% compared with immersion in alkaline peroxide there was no significant difference. Immersion group on the mixture of basil leaf extract 12.5% and 25% mauli banana stems compared with immersion in distilled water there were significant differences. The immersion group in alkaline peroxide compared with immersion in distilled water was significantly different (p<0,05).

Table 4: Table of Significance Values of the Increased Surface Roughness Test of the Acrylic Resin of Heat Cured Type

	Alkaline Peroxide	Distilled Water	Extract
Alkaline Peroxide	-	0,001*	0,715
Distilled water	-	-	0,000*
Extract	-	-	-

*= There are significant differences (p<0,05)

Based on table 4, the significance values tested using the Post Hoc Bonferroni test showed that immersion in the mixture of basil leaf extract 12.5% and banana Mauli stem 25% compared with immersion in alkaline peroxide there was no significant difference. Immersion group on the mixture of basil leaf extract 12.5% and 25% mauli banana stems compared with immersion in distilled water there were significant differences. The immersion group in alkaline peroxide compared with immersion in distilled water was significantly different.

Table 5: Table of Significance Values of the Discoloration Test of the Acrylic Resin of Heat Cured Type

	Alkaline Peroxide	Distilled Water	Extract
Alkaline Peroxide	-	0,020*	0,000*
Distilled water	-	-	0,000*
Extract	-	-	-

*= There are significant differences (p<0,05)

Based on table 5, the above results of the Post Hoc Bonferroni test showed that there was a significant difference (p <0.05) between the blended 12.5% basil extract and 25% mauli banana stems compared with the alkaline peroxide group and distilled water group and there were differences significant among the alkaline peroxide groups compared to the distilled water group.

DISCUSSION

The results of this study, each group of immersion type acrylic resin heat-cured namely a mixture of basil leaf extract 12.5% and 25% mauli banana stems, alkaline peroxide and distilled water experienced a decrease in the value of hardness, increased surface roughness, and discoloration after immersion. for 5 days.

Decreased hardness, increased roughness and discoloration due to heat cured acrylic resin has the property of absorbing water through diffusion, namely the transfer of a substance through a cavity. Absorption of water causes the solvent molecules to occupy the space between the polymer chains, resulting in the chain being disrupted and separated. [3,15]

Color changes that occur in heat cured acrylic resin soaked in a mixture of basil leaves extract 12.5% and banana stems mauli 25% have increased values of L (1.11), decreased value of a (-0.07) and increased value of b (3.46). The results show that the color changes become brighter, greenish and yellowish.

The value of b indicates the color becomes more yellowish, it is suspected because there is a tannin content in a mixture of basil leaf extract 12.5% and 25% banana Mauli stem. According to Gupta (2016) in his research stated that tannin was found as a yellowish or light brown pigment. Values indicate the color becomes greener. This is presumably because in addition to the tannin content in the mixture of basil leaf extract 12.5% and 25% mauli banana stems are essential oils. According to Moghaddam and Mehdizadeh (2017), most of the essential oils have pale yellow pigments and some are green. [22,23]

Other color changes that occur in the immersion of the mixture of basil leaf extract 12.5% and banana stems Mauli 25% showed an increase in the value of L = 1.11 (towards the brighter). This can be caused because in making a mixture of 12.5% basil leaf extract and 25% mauli banana stems using distilled water as a dilution material. Hydrophilic acrylic resins can absorb water-soluble substances by the diffusion mechanism of water molecules so that the solution of distilled water penetrates acrylic resin and affects the physical properties of acrylic resins, one of which changes color to be brighter.[2]

Changes in the nature of the heat-cured acrylic resin soaked in a blend of 12.5% basil leaf extract and 25% mauli banana stems are affected by the active ingredients of both extracts. Basil leaves have active compounds such as alkaloids, saponins, flavonoids, steroids, tannins, eugenols, triterpenoids, phenols, and the largest namely essential oils. Mauli banana stems have active compounds saponins, flavonoids, beta carotene, lycopene, alkaloids, ascorbic acid and the largest form of tannins is 67.6%. These compounds are derived from phenols. [16,18]

This was also proven by Sari et al (2016) who explained that when phenol came into contact with acrylic resin, phenol would release H + ions and bind to CH3O- which was released from the ester group while the benzene group on phenol would bind to the RCO group from the ester, so that expansion on acrylic resin chain ties. [4,12]

Heat cured acrylic resins soaked in alkaline peroxide experience a decrease in hardness, surface roughness, and discoloration. This relates to the strong oxidizing ability of the solution when the tablets are dissolved, sodium perforate will decompose [H_2O_2 (*hydrogen peroxide*) + alkali → 2 H_2O_2 + 2O (*nascent oxygen*)]. These oxidizing properties can have a detrimental effect on the physical properties of acrylic resins because the oxygen released will form an unreacted double bond in the resin matrix.3 Regarding the sodium borate contained in alkaline peroxide, Chandu et al (2015) research state that the use of denture alkaline peroxide cleanser is continuously able to change the color of dentures because of its whitening action. [3,24,25,26]

Head curred acrylic resins soaked in distilled water did not show any significant changes when compared to other groups. This is by the research of Suakrsono et al (2008) who said that distilled water is pure water that only contains H_2O molecules without the presence of other compounds that can affect the nature of acrylic resins. Distilled water does not have minerals so that they have less effect on dissolving particles and cannot accelerate the breaking of polymer chains from acrylic resins. [3,27,28,29,30]

CONCLUSION

Based on the research that has been done, it can be concluded that there is an effect of soaking the mixture of basil leaf extract 12.5% and 25% mauli banana stems on the value of hardness, surface roughness, and color change of heat-cured acrylic resin type. There is a decrease in the value of hardness in the heat-cured type acrylic resin, an increase in the surface roughness value in the heat-cured type acrylic resin and a color change that is clinically unacceptable in the heat-cured type acrylic resin.

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