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THE IMMERSION EFFECT OF MIXTURE OF SMALL WHITE GINGER AND GARLIC EXTRACT ON COLOR CHANGES OF ACRYLIC PLATE

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ABSTRACT

Background: Heat cured acrylic resin is often used as a component of denture. One of the heat cured acrylic resin properties is water absorption that affects the change in acrylic color. An alternative using natural compound to minimize the effect is arising when compared to synthetic materials. A mixture of small white ginger and garlic extract can be used as natural denture cleaner. **Objective:** This study aimed to know the color changes of heat cured resin plate that immersed in a mixture of 70% small white ginger and 10% garlic extract. **Method:** This was a true experimental study with pretest and posttest with control group design, using simple random sampling. The sample was cylindrical acrylic with 15 mm diameter and 2 mm thickness. The research was done using 18 samples heat cured acrylic resins which were divided into 3 groups, the mixture of 70% small white ginger and 10% garlic extract, alkaline peroxide, and distilled water. The color change of the sample was tested using digital analysis tools set. **Results:** The mean value of color changes in heat cured acrylic resin plate after immersion in a group of mixed extracts, alkaline peroxide, and distilled water were 6.23, 3.65 and 2.48. Data were analyzed using One Way ANOVA parametric test and Dunnett's T3 Post Hoc test. **Conclusion:** There is a difference in color changes of heat cured resin plate after the immersion in a mixture of extract and alkaline peroxide. Acrylic resin that immersed in mixed extract demonstrates a higher value of color change.

Keywords: Color changes, heat cured type acrylic resin, small white ginger and garlic extract.

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INTRODUCTION

Prolong untreated tooth loss can result in decreased alveolar bone, impaired speech, decreased masticatory function to the disruption of temporomandibular joint. Based on the results of Riset Kesehatan Dasar (RISKESDAS) RISKESDAS 2013 in South Kalimantan region, some of people age 65 and over had tooth loss prevalence of 23.48% and only 2.1% had replaced their teeth with dentures. Denture is a prosthesis used to replace one or more teeth by support of teeth, mucosa, or its combination to restore masticatory, aesthetic, and speech functions. The commonly used denture plate material is polymethyl methacrylate acrylic resin of heat cured type because it is non-toxic, has good physical and aesthetic properties, does not irritate

the surrounding tissue, and is relatively inexpensive.^{1,2,3,4}

Acrylic resin has the property of absorbing water so that when it contacts with saliva, it can increase the attachment of microorganisms to dentures, which can result in denture stomatitis. Prevention of denture stomatitis can be done in two ways, which are by mechanical and chemical methods. Mechanical cleaning is done with a toothbrush, while chemical cleaning by soaking the denture into a disinfecting solution which is alkaline peroxide. Immersion of dentures in an alkaline peroxide solution can cause absorption by acrylic resin through a diffusion process. The solution molecule that penetrates the mass of polymethyl methacrylate causes the polymer chain to be disrupted and separated so that it affects the

nature of the acrylic resin, one of which is color change.^{5,6,7}

Currently, the use of plants as traditional medicine has been widely used in Indonesia. The advantage of using medicinal plants as a denture cleanser is to minimize the side effects of synthetic and cheaper ingredients. Some medicinal plants can be used as natural denture cleansers such as small white ginger (*Zingiber officinale var amarum*) and garlic (*Allium sativum* L). Small white ginger extract is known to inhibit the growth of *Candida albicans* fungi on the surface of heat cured acrylic plates. The antifungal effect possessed by small white ginger extract is due to the content of essential oils included in the phenol compound.^{5,6,8,9}

Volatile oils in garlic also have antifungal activity, while they also contain allicin as an antimicrobial and flavonoids as antibacterial. The difference between small white ginger extract and garlic extract is that each has weaknesses in taste, smell, and content, so it is expected that when there is mixing with a volume ratio of 1:1, it can cover each other's shortcomings. The content of phenol contained in ginger and garlic when in contact with acrylic resin can cause damage to one of them to changes the color stability. It occurs because the H⁺ ion in phenol binds to CH₃O⁻ which is released from the acrylic resin ester group, while the benzene group in phenol binds to the RCO group of esters. This ion exchange reaction causes the bond of acrylic resin to weaken and cause discoloration. The purpose of this study was to determine the effect of a mixture of 70% small white ginger extract and 10% garlic extract on the change of color of heat cured acrylic resin denture plate.^{7,9,10,11}

MATERIALS AND METHODS

This research began with an ethical feasibility test published by the Faculty of Dentistry, Universitas Lambung Mangkurat Number 172/KEPKG-FKGULM/EC/I/2019. The method used in this study was true experimental with pretest and post-test with control group design. The sample used in this study was following the specifications of the ADA (American Dental Association) number 17 which was cylindrical acrylic with 15 mm diameter and 2 mm thickness. The sampling was obtained by simple random technique with a sample of 18 pieces and divided into three treatment groups. Group 1 comprised of a mixture of 70% small white ginger extract and 10% garlic extract. Group 2 comprised of alkaline peroxide solution as a treatment and positive control. Group 3 comprised of sterile distilled water as a negative control. The

length of soaking carried out in this study was for 1 day 6 hours and 25 minutes.

Samples were made in the wet laboratory of the Faculty of Dentistry, Universitas Lambung Mangkurat, Banjarmasin. The making of acrylic resin plate samples employed cylindrical acrylic moulds with a diameter of 15 mm and 2 mm thickness according to ADA specifications number 17. First, mould space was made by mixing cast powder and water and was then inserted into the bottom cuvette. The acrylic mould was placed and waited until setting. The surface of the cast on the bottom cuvette that had been hardened was smeared with vaseline, then attach the top cuvette, then put the cast mixture and vibrate it. The cuvette was then pressed with a press tool, then wait until the setting, and opens. The acrylic plate model was then removed until the mould space was obtained from the mould. The mould space was coated with Cold Mould Seal (CMS) to the entire surface of the cast, which was expected to come into contact and be exposed to excess acrylic resin.^{9,12}

The making of heat cured type acrylic resin was by mixing polymer and monomer with a ratio of 3: 1, then stirring until it reaches the dough phase. The dough was put into mould space until it is full, cover it with a plastic sheet, then attach the top cuvette and press it with a hidrolic press with a pressure of 1000 psi (70 kg/cm). The cuvette was then opened, cut the excess acrylic, then closed again, and pressed with a pressure of 2200 psi (154 kg/cm). The cuvette was put into a pot filled with water at 70°C for 20 minutes to boil. The cuvette in the boiling water was left for 20 minutes; then the fire is turned off and wait until the cuvette reaches room temperature, then the sample was removed from the cuvette.^{7,13,14}

The sample was trimmed using a fraser bur. Then, the surface of the sample was smoothed using a bur stone and continued with abrasive paper (sandpaper) number 800, 1000, 1200, up to 2000 under water flow. When the surface was smooth, polishing was done by using a wool wheel and pumice to produce a surface that was smooth, not porous, and shiny.¹²

The production of 70% small white ginger extract and 10% garlic extract were carried out at the Faculty of Mathematics and Natural Sciences Laboratory of the Faculty of Mathematics and Natural Sciences, Universitas Lambung Mangkurat, Banjarbaru. The small white ginger (*Zingiber officinale var amarum*) that has been harvested was cleaned with clean water and dried in a drying cupboard with a temperature of 45° C to dry, then smoothed using a blender to form a powder and weigh.⁹

The powder was mixed with 70% ethanol stirred with simplicia which proportionate with ethanol which is 1: 5, then filtering and replacing

new solvents every 1 x 24 hours, the process was repeated up to three times filtering. The collected powder was put into the rotary evaporator, then evaporated with a full water bath, then diluted. 9 Garlic (*Allium sativum l*) 100 gr which has been peeled and washed with water to clean. The washed garlic was then crushed using a blender with 50 ml distilled water until homogeneous, after being mixed centrifugation at 3000 rpm for 30 minutes and filtered using Wittman paper, and diluted. After dilution on each extract, the concentration of 70% small white ginger extract and 10% garlic extract were obtained. Both extracts were then mixed with volume 1: 1.¹¹

The measurements in the samples were carried out in the laboratory of the Faculty of Biochemistry, Faculty of Medicine, Universitas Lambung Mangkurat, Banjarbaru. Measurement of discoloration in the sample before and after immersion in a mixture of 70% small white ginger extract and 10% garlic extract, alkaline peroxide, also distilled water was carried out with a series of digital analysis tools. The acrylic sample were inserted into a box to take pictures with a high-resolution digital camera (webcam). The location of the acrylic sample was adjusted with the webcam. When taking the picture, lightning was used as a light source for standardizing light conditions. The results of the images were seen using the MATLAB software, then detected using a color system standard, namely the Commission Internationale de L'Eclairage (CIELAB) recommended by the American Dental Association (ADA). Each sample calculated the color change value with the following equation:

$$\Delta E = \sqrt{(\Delta L)^2 + (\Delta a)^2 + (\Delta b)^2}$$

$$\Delta L = L_o - L_t$$

$$\Delta a = a_o - a_t$$

$$\Delta b = b_o - b_t$$

Information:

- ΔE : Color changes.
- L : Brightness coordinate.
- a : Red-green chromatic coordinates.
- b : Yellow-blue chromatic coordinate.
- L_t, a_t, b_t : Before immersion.
- L_o, a_o, b_o : After immersion.

RESULTS

Based on the measurements that have been made, the results of the average color change values are obtained in each group. The results of the mean values in the three groups are presented in the table as follows.

Table 1. Mean value and standard deviation of color change in heat cured type acrylic resin plate

Group	Mean ± Standard Deviation
Mixture Extract	6,229 ± 0,72
Alkaline peroxide	3,650 ± 0,27
Aquades	2,484 ± 0,26

Based on the results above, it was found that the lowest value was in immersion in the aquadest group, while the highest color change was a mixture of 70% small white ginger extract and 10% garlic extract. The highest color change in the group mixture of small white ginger extract 70% and 10% garlic extract can also be seen clinically because it has a value of $\Delta e \geq 3.3$, so this immersion group has the lowest aesthetic value compared to the others.

The results obtained from the color change test were then followed by statistical tests using SPSS V.22 software. The results of the research data are then tested for normality and homogeneity tests. Data normality test was carried out by the Shapiro-Wilk Test because the number of samples used was <50. The results obtained from the normality test in the soaking group of small white ginger extract and garlic extract had a significance value of $p=0.055$, alkaline peroxide had a significance value of $p=0.92$, and aquades had a significance value of $p=0.393$. These results indicate that all immersion groups get a value of $p>0.05$, which means that data is normally distributed. Data analysis was then continued by testing group homogeneity using Levene's Test. The homogeneity test results show the value of $p=0.000$ ($p>0.05$) which means the data is not homogeneous.

The results of statistical data analysis show that all groups of data are normally distributed, although not homogeneous so that it can be continued with the one way ANOVA parametric hypothesis test. The results of the parametric one way ANOVA test showed a value of $p = 0,000$ ($p < 0,05$) which means there was an effect of soaking a mixture of 70% small white ginger extract and 10% garlic extract, alkaline peroxide, and distilled water on the disc color change.

Further tests were carried out using Post Hoc Dunnett T3 because the data were normally distributed and not homogeneous. The Post Hoc Dunnett T3 test was used to determine the data group that had a significant difference in the mean color change in each group. Based on the Post Hoc test Dunnett T3, it shows that all groups that have

been compared have a significant difference in color change values because of the value of $p < 0.05$. The results of the above research data show that H_0 is rejected and H_a is accepted because there are significant differences in color changes from each group, so the research hypothesis is following the results of hypothesis testing.

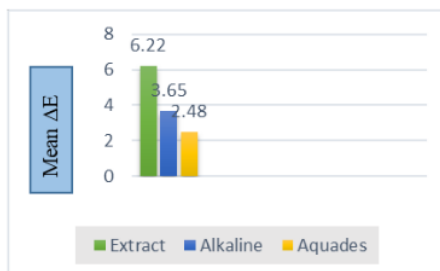


Figure 1. The diagram of mean value in color change of heat cured type acrylic resin plate after immersion.

DISCUSSION

The acrylic resin which ² was soaked for 1 day, 6 hours 25 minutes in a mixture ¹ of small white ginger extract and garlic extract, alkaline peroxide, and distilled water in this study experienced a change in color. The alkaline peroxide group and colored aquades are faded and somewhat reddish. L value on the acrylic plate in all three groups is positive, which means that there is ¹ an increase in brightness. In the mixed group of small white ginger extract and garlic extract the value of a decreased causing the color to become more green, while the alkaline peroxide group and aquades increased so that the color ¹ was redder. The value of b in the mixed group of small white ginger and garlic extract and alkaline peroxide increased causing the color to become more yellow, while aquades decreased so that the intensity of the color was bluer.¹⁵

The small white ginger extract contains dark brown oleoresin oil, while garlic extract has yellow tannins and both extracts have essential oils, most of which are green. The color produced from the extracted content affects the increase and decrease in the value of L (brightness), a (green-red), and the value of b (blue-yellow ²) on the acrylic plate. Acrylic plate soaked in a mixture of small white ginger extract and garlic extract changes color to become more faded, greenish and yellowish.^{9,16}

The content of phenol ⁴ contained in small white ginger and garlic when in contact with acrylic resin can cause damage, one of which changes in color stability. Phenol in contact ¹ with acrylic resin causes H^+ ions in phenol to bind to CH_3O^- which is released from the ester resin acrylic group, while the benzene group in phenol

binds to the RCO group of esters. This ion exchange reaction causes the bond of acrylic resin to weaken and cause a physical change in the polymer, one of which is color ¹⁹

The color changes in the heat cured type acrylic plate soaked in a solution of 70% small white ginger extract and 10% garlic extract had a higher average value compared to other groups because the two extracts contained phenol and tended to be acidic and color absorption. The color produced by mixing small white ginger extract and garlic extract is visually brown.¹⁷

The change in the color of acrylic plates also occurs because of the content of phenol, which can degrade polymers due to water absorption. Absorption of acrylic resin on the water by diffusion has a significant effect on the characteristics and dimensions of acrylic resin polymers. Water absorbed by acrylic resin penetrates the polymethyl methacrylate mass, then occupies a position between the polymer chains and causes the chain to be disrupted. The interrupted polymer chain becomes easier to move so that the chain bond is weakened and causes the release of pigments from the acrylic resin. Weak bonds affect the strength of the polymer chain and change the physical characteristics of the polymer so that the color of the resin fades and reduces its aesthetics.⁹

Denture cleanser that is commonly used is alkaline peroxide because it has bactericidal, fungicidal and effective properties to remove stains on the surface of dentures, but the material has a weakness that can cause physical changes in the denture base. Acrylic plates soaked with alkaline peroxide will fade the surface color. This color fades because of the strong oxidation of the solution. The sodium perborate content causes the discoloration of acrylic in an alkaline peroxide solution.^{18,19,20}

Sodium perborate dissolved in water will decompose and form alkaline peroxide compounds and will release oxygen so that the chemical cleaning action occurs by oxygen bubbles. Alkaline ⁵ peroxide, when formed in water, will produce H_2O_2 (hydrogen peroxide) + alkali, $2 H_2O_2 \rightarrow 2H_2O + 2O$ (nascent oxygen). This nascent oxygen has a chemical cleaning effect. The cause of the discoloration in acrylic resin ⁴ is related to the strong oxidizing property of the solution so that the oxygen released causes oxidation of tertiary amine accelerators or unreacted double bonds in the resin matrix.¹³

Immersion of acrylic plates in aquades has the lowest average value among the other groups. The cause of this low value is that aquades only contain H_2O and do not have other ions. Immersion of acrylic in distilled water causes an increase in the value of L (brightness) and a (green-red) and a decrease in the value of b (blue-

yellow), this is presumably due to the absorption of colors from aquades which are visually bluish white.^{9,14}

Changes in the color of acrylic plates can be caused by intrinsic factors and extrinsic factors. The intrinsic factor is chemical changes in the material itself, such as an imperfect polymerization process. Extrinsic factors are derived from outside, namely color changes such as drinking habits, for example, tea, coffee, wine, or other beverages that contain substances.²¹

Color change (ΔE) > 1 can be seen visually by 50% of observers, whereas if it is less than this number, a small difference in color will not be seen. The results of the color change can be seen visually if the value (ΔE) ≥ 3.3 .²² Based on the research that has been done, it can be concluded that the mixture of small white ginger extract and garlic extract group has the highest value (ΔE) of 6.22 so that changes color can be seen visually as color change value is greater than ≥ 3.3 .

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