DENTINO
JURNAL KEDOKTERAN GIGI
Vol VIII. No 1. March 2023

THE IMMERSION EFFECT OF 50% KASTURI (*Mangifera casturi*) LEAF EXTRACT ON COLOR CHANGES OF THERMOPLASTIC NYLON DENTURE BASE

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ABSTRACT
Background: *The most commonly used denture cleanser is alkaline peroxide. Long-term use of alkaline peroxide caused color change on denture base. One of which can be used as an alternative ingredient is kasturi leaf (Mangifera casturi). 50% kasturi leaf extract has antifungal properties against candida albicans. 50% kasturi leaf extract can be used as an alternative natural denture cleanser.* ***Purpose:*** *To know the immersion effect in 50% kasturi leaf extract on color changes of thermoplastic nylon.* ***Methods:*** *This study was true experimental with pretest dan posttest with control group design. 24 samples used simple random sampling with 8 samples in each groups. The sample is round sized 20mm in diameter and 3mm thickness. The treatment divided into 3 group, 50% leaf extract as treatment group, alkaline peroxide as positive control group, dan aquadest as negative control group. The color change was measured before and after immersion for five days using digital analysis tools with CIELab system.* ***Results:*** *One Way ANOVA dan Post Hoc Bonferroni statistical test showed significant differences (p<0,05) between the immersion groups in 50% kasturi leaf extract (6,25 ± 1,90), alkaline peroxide (4,00 ± 0,99), and aquadest (2,19 ± 0,71).* ***Conclusion:*** *The 50% kasturi leaf extract has effect on color changes of thermoplastic nylon denture base. The color changes in 50% kasturi leaf extract is higher than alkaline peroxide and aquadest.*

Keywords : *Color changes, Kasturi leaf, Thermoplastic nylon*
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INTRODUCTION

Tooth loss is a dental and oral health problem that frequently occurs in society. Based on the RISKESDAS 2018, tooth loss is in the second place of dental problems in Indonesia by 19%. Tooth loss results in impaired masticatory, speech, and aesthetics. This problem can be solved by making artificial teeth.[1,2]

Thermoplastic denture base material is new innovation because it has several advantages, such as it does not have metal grip, is flexible, aesthetics, and hypoallergenic so that it becomes an alternative to conventional and metal denture replacement materials. The disadvantage of thermoplastic nylon is its high water absorption, resulting in the color change of the base.[3,4,5]

Color stability is the physical properties of materials to maintain color in a certain time and environment. This property is an important factor for denture materials. Color change due to time or damage will affect the aesthetic results of the denture caused by intrinsic and extrinsic factors. Intrinsic factors are the changes due to material properties themselves, such as water absorption, surface roughness, and etc. Extrinsic factors occur due to the absorption of the pigmented solution.[4,6]

Denture requires specific hygiene treatment to prevent the accumulation of plaque and debris, the growth of microorganisms, and color change. Unclean debris will increase the risk of oral diseases such as denture stomatitis.[7,8] Denture cleaning is performed mechanically, chemically, and in combination. Mechanic cleaning is performed by brushing and ultrasonic cleaning tools. The chemical method is performed by immersion using cleaning solvent, oxygen exposure with air-drying, and microwave radiation. Another technic is the combined mechanical and chemical cleaning methods. This method is more effective than using only one of the methods.[5,7,9]

The denture cleaner that is often used is alkaline peroxide (sodium perborate). Alkaline

peroxide removes bacteria by forming oxygen bubbles and removing dirt on the denture surface. Denture immersion using alkaline peroxide for 20 minutes causes the penetration of cleanser into the dental pores, which can kill bacteria. Denture cleaning materials on the market are relatively expensive. The use of alkaline peroxide for a long period can cause a color change in the prosthesis. Thus, alternative materials as denture cleaning are required.[3,10,11]

Kasturi (*Mangifera casturi*) is a typical plant of South Kalimantan, in which its fruit is used by the community for consumption because of its distinctive taste and aroma. Other parts, such as leaves, roots, and fruit seeds, have not been used maximally. The previous study stated that kasturi leaf extract have the highest phenolics and flavonoids than the bark and rind of kasturi.[12,13] Kasturi leaves are one of the plants that can be a denture cleaning material according to requirements of denture cleaning, antibacterial and antifungal. Kasturi leaves contain alkaloids, terpenoids, flavonoids, phenols, and saponins as antibacterial and antifungal.[14,15,16,17]

Based on the background above, a study regarding the immersion effect of 50% kasturi (*Mangifera casturi*) leaf extract on color changes of thermoplastic nylon denture base is required.

MATERIAL AND METHODS

This study has obtained ethical clearances issued by the Ethics Commission Faculty of Dentistry Universitas Lambung Mangkurat no. 016/KEPKG-FKGULM/EC/II/2021. The method used was true experimental with pretest-posttest with control group design. Samples used cylindrical thermoplastic nylon with a diameter of 20 mm and thickness of 3 mm according to ADA No.12 with a flat, smooth, and non-porous surface. Furthermore, samples were collected by simple random sampling technique with 8 samples in each treatment group. Treatment groups consisted of 3 groups, 50% kasturi leaf extract , alkaline peroxide, and aquadest. The soaking time of thermoplastic nylon was 5 days, which was assumed soaking 20 minutes a day for a year.

Samples of thermoplastic nylon were made in Asrynonsne Dental Laboratory Surabaya. The first was making mold space using acrylic glass. The next step was making mold by applying vaseline on the top and bottom of the cuvette. The bottom cuvette was filled with dental stones. A Mould of acrylic glass was embedded in the cuvette and connected by sprue. The top cuvette was placed, and dental stone was poured and wait until it hardened. The cuvette was soaked in boiling water for dewaxing. The cuvette was opened, and acrylic glass was removed, and the remaining sprue was cleaned. Gypsum surface was smeared by CMS (Could Mould Seal).

Nylon was prepared in cartridge form, and then the cartridge was put into an oven heated at 287.7°C (550°F) for 11 minutes. The cuvette was placed in the injection unit. The material in the cartridge was pushed into the mold. The injection pressure was maintained at 5 bar for 3 minutes. The cuvette was bench-cooled for 20 minutes before deflasking. The cuvette was opened, and samples were taken out, and the sprue was cut.

The surface of the samples was polished. Sharp parts of the samples were polished using the fraser bur. The samples were polished with sandpaper with a size of 400, 800, 1200 on a rotary grinder with a speed of 500 rpm while flowing water for 5 minutes. Samples were polished with pumice for 2 minutes.

Kasturi leaf extract were made by the maceration method. Kasturi leaves were picked by hand and weighed 1 kg. Kasturi leaves were washed then dried with an oven for 4 hours at 40°C. After drying, Kasturi leaves were crushed with a blender until obtaining simplicia powder of Kasturi leaves. Simplicia powder was immersed in ethanol solvent 96% with a ratio between powder and solvent of 1:5. Maceration was carried out 3 x 24 hours, and the solvent was replaced every day. The results of immersion were then filtered using filter paper 3 times until the filtrate was clear. Extracts were heated in waterbath at 40°C. Extracts were evaporated with a rotary evaporator until obtaining the thick extract. Thick extract of Kasturi leaves was then diluted using aquadest until obtaining a concentration of 50%.

Thermoplastic nylon samples were immersed in saline solution and incubated at 37°C for 24 hours to adapt to the conditions of the oral cavity before the assessment. The assessment of color change on samples was measured before and after immersion of 50% kasturi leaf extract solution, alkaline peroxide, and aquadest using a digital analysis tool. Color change value was analyzed using MATLAB with color system of Commission Internationale de L'Eclairge (CIELab) with formula $\Delta E = (\sqrt{(\Delta L^*)^2 + (\Delta a^*)^2 + (\Delta b^*)^2}$.

RESULT

Color change value of thermoplastic nylon immersed in a solution of 50% kasturi leaf extract, alkaline peroxide solution, and aquadest was obtained in table 1.

Table 1. Mean values and Standard Deviations of Color Changes of Thermoplastic Nylon Samples

Groups	Color Changes Value (ΔE) Mean ± Standard Deviation
50% Kasturi Leaf Extract	6,25 ± 1,90
Alkaline Peroxide	4,00 ± 0,99
Aquadest	2,19 ± 0,71

Based on the table above, it can be seen that the highest average color change value was found in 50% kasturi leaf extract immersion group, while the lowest average color change value was found in aquadest immersion group.

Based on the measurement conducted, L, a, and b values were obtained in each group. ΔL, Δa, and Δb values were presented in the following diagram.

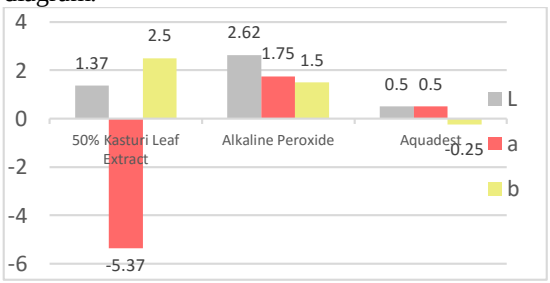

Figure 1. Mean Value ΔL, Δa, and Δb in each group

Information:
ΔL : brightness coordinates (L – L)
Δa : red – green chromatic coordinates (a - a)
Δb : yellow – blue chromatic coordinates (b - b)
L_t, a_t, b_t : before immersion
L_0, a_0, b_0 : after immersion

Based on Figure 1, the results of the data were obtained ΔL (+) value in all treatment groups, which means that the intensity of sample brightness becomes brighter. Δa value in 50% kasturi leaf extract immersion group showed (-) value, which means that the intensity of sample color becomes greener, while in alkaline peroxide and aquadest immersion groups showed (+) value, which means that the increase of color intensity to be redder occurs. Δb value in 50% kasturi leaf extract and alkaline peroxide immersion groups showed (+) value, which means that the intensity of sample color become yellower, while aquadest immersion group showed (-) value, which means that intensity of sample color becomes bluer.

The data obtained from the results of testing the effect of color change in thermoplastic nylon samples were then conducted a statistical analysis using SPSS 25.0. The results of the data were performed normality and homogeneity tests. The normality test used was Shapiro-Wilk Test and obtained p-value=0.553 in 50% kasturi Leaf Extract immersion group, p=0.117 in alkaline peroxide immersion group, and p=0.820 in aquadest immersion group. This showed p>0.05 in all immersion groups, which means that the data were normally distributed. After that, the homogeneity test was conducted using Levene's Test and obtained p-value = 0.102 (p>0.05), which means the data variance was homogenous. The data of test results were normal and homogenous so that One Way ANOVA parametric analysis can be continued.

The results of One Way ANOVA parametric statistical analysis showed p-value = 0.000 (p<0.05), which means that there was a significant difference. Then, it was continued with the Post Hoc Bonferroni test to find out which groups had significant differences. The results of the significant test can be seen in Table 2.

Table 2. Post Hoc Bonferroni Significance Value of Color Changes Thermoplastic Nylon Sample

	p value		
	50% Kasturi Leaf Extract	Alkaline Peroxide	Aquadest
50% Kasturi Leaf Extract	–	0,007*	0,000*
Alkaline Peroxide	–	–	0,034*
Aquadest	–	–	——

Information: * = there was a significant difference (p<0,05) with Post Hoc Bonferroni test

The results of the Post Hoc Bonferroni test showed that there was a significant difference (p<0.05) between all groups, 50% kasturi leaf extract group compared to alkaline peroxide group, 50% kasturi leaf extract group compared to aquadest group, and alkaline peroxide group compared to aquadest group.

DISCUSSION

The results of the study showed that color change occurred in the color measurement of thermoplastic nylon immersed in the treatment group of 50% kasturi leaf extract, positive control group of alkaline peroxide, and negative control group of aquadest. Color change of each group occurred because thermoplastic nylon is hydrophilic. This is because polyamides have linear chain so that it is weaker and tend to absorb water that can cause a color change.[18]

The immersion of thermoplastic nylon sample group in 50% kasturi leaf extract solution had an increase of L value (+1.37), a decrease of a value (-5/37), and an increase of b value (+2.5).

Color change becomes brighter, greener, and yellower. This color change is caused by one of the contents in kasturi leaf extract, namely flavonoids. Based on the study by Wibawaningtyas et al., flavonoids are phenol groups with acidic properties. This compound has a chemical formula of C_6H_5OH, and its structure has a hydroxyl group (-OH) bound on the phenyl ring. In the chemical formula of phenol, C binds O stronger than H, so H ions are easily oxidized and become acids. Oxidation of H ion causes phenol compound to dissolve into phenoxide anion $C_6H_5O^-$ and cation H^+. Cation H^+ easily breaks the OH bond in the polyamide chain so that the polyamide chain becomes shorter and causes a decrease in the physical properties of thermoplastic nylon, including color change.[19] The phenol solution in contact with resin will cause damage to the properties and resin surface. This causes the pigment to stick on the surface of thermoplastic nylon resin.[20]

The immersion of the thermoplastic nylon group in alkaline peroxide solution had an increase in L value (+2.62), a value (+1.75), and b value (+1.5). Color change that occurs was dominated by the increase of L value towards lighter (faded). This was caused by the sodium perborate content in the alkaline peroxide cleaner. When dissolved in water, sodium perborate will decompose and form alkaline peroxide. If alkaline peroxide dissolves in water, then it will result in H_2O_2 (hydrogen peroxide) + alkali, $2H_2O_2$. Hydrogen peroxide will decompose into $2H_2O + 2O$ (nascent oxygen). Free radicals of hydrogen peroxide can cause the disruption of the polyamide bond, resulting in the entry of oxygen that does not have an electron pair into the polymer chain, then oxidation reaction occurs.[3,21] In the study by Awing and Koyama stated that sodium peroxide dissolved in the water would release hydrogen peroxide, which is a bleaching agent. The active component of bleaching in hydrogen peroxide is the perhydroxy anion formed through H_2O_2, which reacts with materials through oxidation that can cause a color change.[22]

The immersion of thermoplastic nylon sample groups in aquadest experiences low color change compared to other groups, which is the increase of L (+0.5), a (+0.5), and decrease of b (-0.25). This is because aquadest is pure water containing H_2O molecules and stable ions. Aquadest is a colorless, odorless, tasteless compound and a weak electrolyte. Polyamide has the ability to absorb liquid in contact so that absorbed substances react with elements in the resin[7,22] Color change that occurs is assumed due to the absorption of bluish-white aquadest color, which can be seen visually.[23] A study by Awing and Koyama showed no significant color change in thermoplastic nylon resin immersed in aquadest for the first 8 hours to the seventh hour.[22]

The color change was caused by intrinsic and extrinsic factors. The intrinsic factor was a change due to the physical properties of materials, such as water absorption and surface roughness. The extrinsic factor was caused by the absorption of coloring pigments from food and beverages as well as denture cleaner.[4,24] Color change was also caused by other factors, such as sample size, sample microporosity, and duration of contact between the denture base and pigmented solution.[6] The larger the sample surface, the higher the color change that occurs. Color change also can be caused during the sample-making process. Procedures that do not meet the requirements cause the trapped air in the sample. Microporosity formed makes the adhesion of the dye to the porous area.[4,20] Duration of contact between materials and pigmented substances affects the color change because the longer the immersion time, the greater the color change that occurs.[25]

Based on the result of the study, it can be concluded that there is an effect of the immersion of 50% kasturi leaf extract on color changes value of thermoplastic nylon denture base. The color changes in 50% kasturi leaf extract is higher than alkaline peroxide and aquadest.

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