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EFFECT OF 25% TOBACCO LEAF EXTRACT (*Nicotiana Tabacum L.*) AS A DENTURE CLEANING PASTE ON SURFACE ROUGHNESS AND COLOR CHANGE THERMOPLASTIC NYLON

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Abstract

Thermoplastic nylon as a denture base requires mechanical cleaning with denture paste. Previous research showed that tobacco leaf extract paste (TLEP) 25% was fungistatic on thermoplastic nylon denture bases. The aim is to evaluate the roughness and colour changes of thermoplastic nylon against tobacco leaf extract paste 25% during one year of simulated use. This research hypothesizes that thermoplastic nylon's roughness and colour value will decrease further after brushing using 25% TLEP. Sample groups include brushing without paste, paste without TLEP 25% and TLEP 25%. The sample size for each group was 15 samples; measurements use a surface roughness tester and a colour reader. Brushing was carried out for 23.5 minutes on a plate measuring 60x10x2.5 mm as a surface roughness test and 3.90 minutes on a plate measuring 10x10x2.5 mm as a colour change test. The sample size for each group was 15 samples; measurements use a surface roughness tester and a colour reader. The research results were tested using Kolmogorov-Smirnov and Levene and One-way ANOVA with a significance level of 0.05. There were no differences in surface roughness and colour changes on thermoplastic nylon plates after brushing with 25% TLEP ($p>0.05$). This study concluded that 25% TLEP did not affect increasing surface roughness and changing the colour of thermoplastic nylon plates with values below the threshold.

Key-words:
Tobacco leaf extract (Nicotiana tabacum L); denture cleaning paste; thermoplastic nylon

1. Introduction

Thermoplastic nylon, as a denture base material, has long chain bonds, so it is more stable and resistant to chemical solutions and has high impact strength. Apart from that, thermoplastic nylon also has pleasing aesthetics and biocompatibility and is hypoallergenic because it does not leave residual monomers. However, this material also has disadvantages such as shrinking, changing dimensions and being hydrophilic, so it readily absorbs water (Naini, 2015). The nature of thermoplastic nylon, which readily absorbs water, can cause polymer chains to break, causing surface roughness (Soesetijo & Hidayati, 2016)

The surface roughness of thermoplastic nylon can facilitate plaque attachment, making it easier for microorganisms such as bacteria and fungi to colonize. The surface roughness can cause various problems in the oral cavity, namely denture stomatitis (Dewi et al., 2020). An increase in the quantity and quality of surface roughness can be a factor that influences the change in the color of thermoplastic nylon because the physical properties of thermoplastic nylon have high water absorption and absorption capacity.

Mechanical cleaning of dentures can be done by brushing with a toothbrush using cleaning paste (Wardojo et al., 2019). In previous research, a 25% concentration of paste tobacco leaf extract as a cleaning denture paste had antifungal properties in inhibiting the growth of *Candida albicans* (Savitri et al., 2022). This ability can reduce the prevalence of denture stomatitis in removable denture wearers.

Tobacco leaves have several positive ingredients, namely active compounds such as alkaloids, flavonoids and terpenoids, which act as antibacterial compounds. Tobacco leaves have several positive elements, namely active compounds such as alkaloids, flavonoids and terpenoids, which act as antibacterial and antifungal compounds (Putri, et al.,

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2014). The presence of this compound may cause changes in the physical properties of thermoplastic nylon, namely surface roughness and colour. Based on the above, the researcher wants to know whether there is a change in the roughness of the colour surface of thermoplastic nylon as a denture base material.

This research hypothesizes that thermoplastic nylon's roughness and colour value will decrease further after brushing using 25% Tobacco Leaf Extract Paste.

2. Method

This type of research is laboratory experimental research with a randomized post-test-only control group design to test changes in surface roughness and a pre-post-test control group design to test colour changes in thermoplastic nylon plates. The study was carried out at the Dental Technology Laboratory, Faculty of Dentistry, University of Jember for making thermoplastic nylon plates, making tobacco leaf extract paste (Nicotiana tabacum L.) located in the Biosciences laboratory at the Dental and Oral Hospital, Jember University and the Pharmacy Laboratory at Universitas Jember, measuring surface roughness at Materials Laboratory, Faculty of Engineering, Universitas Jember, and colour change measurements at the Polytechnic Food Analysis Laboratory.

The research samples were carried out for two groups, namely the surface roughness test and the thermoplastic nylon colour change test. The surface roughness test was divided into groups of 15 samples, each with a brushing time of 23.5 minutes. In sample group 1, thermoplastic nylon plates were subjected to electric brushing but did not use the paste as a control group; in group 2, thermoplastic nylon plates used an electric brush that was treated with placebo paste for 23.5 minutes and in group 3, thermoplastic nylon plates using an electric brush given a paste of 25% tobacco leaf extract. The thermoplastic nylon plate sample shape measures 60x10x2.5 mm for testing the surface roughness of thermoplastic nylon (Fig. 1). Measurements were carried out using a Surface Roughness Tester (TR 220, China).

The colour change test was also divided into three sample groups of 15 samples, each with a brushing time of 3.90 minutes. In sample group 1, thermoplastic nylon plates were subjected to electric brushing but did not use the paste as a control group; in group 2, thermoplastic nylon plates used an electric brush that was treated with placebo paste for 23.5 minutes and in group 3, thermoplastic nylon plates using an electric brush given a paste of 25% tobacco leaf extract. Form a thermoplastic nylon plate sample measuring 10 x 10x2.5 mm for the colour change test (. Measurements were carried out using a colour reader.

Process for Making 25% Tobacco Leaf Extract in the Laboratory

The research material in tobacco leaves has been prepared as much as 6 kg. Tobacco leaves are dried in an oven at 50°C for 24 hours. Next, use a blender so that the dried tobacco leaves become powder. The resulting powder was filtered using a 16-mesh sieve. Then, filtering and macerating the tobacco leaves was carried out with a solvent ratio of 96% ethanol (1:4) m/v for three days until a blackish-brown colour was formed. The soaking results are filtered to obtain a filtrate. The filtrate was concentrated using a rotary evaporator to get a greenish-brown tobacco leaf extract (Fig. 1) (Suprayitno et al., 2020).

Figure 1. Tobacco leaf extract

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Process for Making 25% Tobacco Leaf Extract Paste in the Laboratory

Preparation begins by preparing a placebo paste consisting of calcium carbonate (29%), magnesium carbonate (26%), propylene glycol (8%), glycerin (6%), TEA/ triethanolamine (4%), and distilled water (25%), and oleum menthae piperithae (2%) are mixed in a mortar and pestle; stir all the ingredients until a homogeneous paste is formed (Fig. 2).

Figure 2. Preparation begins by preparing a placebo paste

This placebo paste is a basic paste without mixing tobacco leaf extract, which is obtained weighing 100 grams and placed in a closed container so that it does not dry out. How to make a paste of 25% tobacco leaf extract by mixing 75 grams of placebo paste with 25 grams of tobacco leaf extract and then stirring until it forms a homogeneous paste (Kristiana D., et al., 2023).

Laboratory Process for Making Thermoplastic Nylon Plates

The research samples were made with a size of 60 x 10 x 2.5 mm, as many as 45 pieces, and a length of 10 x 10 x 2.5 mm, as many as 45 pieces, and made into canker sores. The master model and sprue are inserted into the mould chamber, performing a night release process. The mould chamber is isolated with a separator, and then thermoplastic nylon that has been melted at 280oC is injected into the cartridge; apply pressure using a hydraulic bench press of 6-8 bar for 5 minutes, do polishing (Anusavice et al., 2013). Making thermoplastic nylon plates measuring 60 x 10 x 2.5 mm for testing the surface roughness of thermoplastic nylon and measuring 10 x 10 x 2.5 mm for testing acrylic colour changes (ADA Specification no. 12).

Mechanical Cleaning with Tobacco Leaf Extract Cleaning Paste.

Paste 25% tobacco leaf extract weighed 3 mg. The thermoplastic nylon plate was brushed over the stained area with an electric toothbrush and cleaning paste for one minute, then rinsed with running water (Fig 3). Repeat the procedure until reaching a total time of 23.5 minutes and 3.90 minutes for each test group (Kristiana D. et al., 2023).

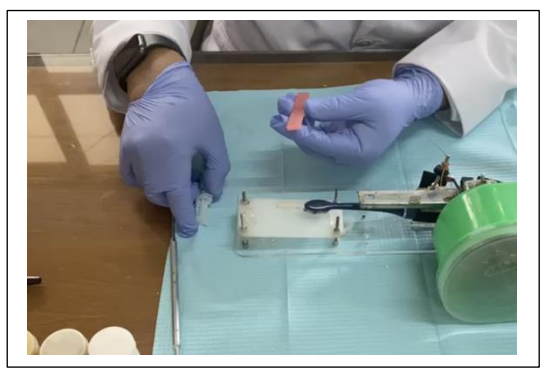

Figure 3. Mechanical Cleaning with Tobacco Leaf Extract Cleaning Paste

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Thermoplastic Nylon Surface Roughness Testing in the Laboratory

Surface roughness measurements were carried out using a Surface Roughness Tester TR 220 surface roughness test tool with an accuracy of 0.01 µm. The test is carried out by placing the sample on a flat surface. The sample is measured three times at different points by placing the stylus starting from the end of the sample where the distance has been marked so that it forms a parallel line; then, by activating the tool, the test equipment monitor will display the surface roughness value of the test object. Surface roughness measurements are carried out by measuring the movement signal of a stylus moving along a straight line on the surface as an indicator tool to measure the surface roughness of the test object. Next, the average roughness is calculated based on the measurement results at three points. The average value is the surface roughness value (Fig. 4) (Sundari et al., 2016).

Figure 4. Thermoplastic Nylon Surface Roughness Testing in the Laboratory

Colour Change Measurement in the Laboratory

In this study, colour changes were carried out using a colour reader "General Colorymeter" by measuring the L, a, and b values on the samples before and after treatment. Next, compare the measurement results before and after treatment (Fig. 5).

Figure 5. Colour Change Measurement in the Laboratory

In this study, colour changes were measured using the formula (Inami et al., 2015):

$$\Delta Eab = \sqrt{(L2 - L1)^2 + (a2 - a1)^2 + (b2 - b1)^2}$$

ΔE : colour change value
L : dark/light colour on a scale of 0 (black) to 100 (white)
A : red/green
B : blue/yellow
L1, a1, b1 : Before brushing your teeth
L2, a2, b2 : After brushing

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3. Result and Discussion

The results of the research showed that the highest average surface roughness value was found in the group of thermoplastic nylon plates that were brushed using 25% tobacco leaf extract paste (K3), namely 0.180 µm, followed by the group that was brushed using placebo paste (K2) amounted to 0.172 µm and the lowest average surface roughness value in the group that brushed without paste (K1) was 0.171 µm. (Table 1).

Table 1. The average surface roughness value in the group of thermoplastic nylon plates (µm)

Group	n	Average surface roughness (µm)	Standard Deviation
K1	15	0.171	0.061
K2	15	0.172	0.029
K3	15	0.180	0.023

The normality test results for the surface roughness of thermoplastic nylon plates in each group were more significant than 0.05 ($p > 0.05$). The significance value of K1 is 0.172; K2 is 0.077, and K3 is 0.200. The homogeneity test results for all treatment groups were 0.072 ($p > 0.05$). The results of the One-Way Analysis of Variance test show a significance value of 0.791 ($p>0.05$). These results indicate no significant difference in surface roughness in each treatment group.

The highest average value of colour change was found in the group of thermoplastic nylon plates that were brushed using 25% tobacco leaf extract paste, namely 2.61, followed by the group that was brushed with placebo paste, namely 2.56, and the lowest average value of colour change was in the group that brushed without paste, namely 2.48 (table 2).

Table 2. Average value of colour changes in the group of thermoplastic nylon plates

Group	n	Average surface roughness (µm)	Standard Deviation
K1	15	2.48	0.472
K2	15	2.56	0.343
K3	15	2.61	0.313

The normality test results of colour changes on the surface of thermoplastic nylon plates in each group were more significant than 0.05 ($p > 0.05$). The significance value of K1 is 0.200, K2 is 0.078, and K3 is 0.121. The homogeneity test results for all treatment groups showed 0.158 ($p > 0.05$). The results of the One-Way Analysis of Variance show a significance value of 0.679 ($p > 0.05$). These results indicate no significant difference in surface roughness in each treatment group.

Discussion

Surface roughness of thermoplastic nylon plate after brushing with 25% tobacco leaf extract paste

This study aims to evaluate the roughness and color changes of thermoplastic nylon against denture cleaning paste made from 25% tobacco leaf extract during one year of simulated use. The time calculation is based on the surface area of the maxillary denture which is simulated in the area of the test plate shown and is based on a brushing cycle of 45 seconds. These results show that the simulation for one year is 23.5 minutes with a surface area of 60x10x2.5 mm with daubing on the side of the surface and the simulation time is 3.90 minutes with a surface area of 10x10x2.5 mm. This will show that the use of denture cleaning paste meets the requirements as a mechanical cleaning agent.

The results showed no significant difference in the surface roughness of the thermoplastic nylon plate. However, based on the average value data, there was an increase in surface roughness on thermoplastic nylon plates after brushing with 25% tobacco leaf extract paste (K3) compared to placebo paste (K2) or without paste (K1).

This can be caused by contact between the thermoplastic nylon plate and chemical compounds in tobacco leaves, namely phenol, during brushing. When phenol comes into

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contact with the surface of the thermoplastic nylon plate, it is able to penetrate into the microporosity space of the thermoplastic nylon and dissolve it. Phenol is a chemical from the aromatic hydrocarbon group which can cause polymer degradation due to H+ ions from acids. Phenolic compounds have acidic properties because they release H+ ions from their hydroxyl groups. The polymer degradation that occurs causes the physical properties of thermoplastic nylon to change, resulting in a decrease in physical properties (Kristiana et al, 2023).

The threshold value for ideal or acceptable denture base surface roughness in the oral cavity is 0.2 µm (Simanjuntak, et al., 2019). This is also supported by the research results of Hamanaka, et al (2016), that the threshold value for the surface roughness of thermoplastic nylon after being pulsed is 1.70 ± 0.40 µm. So, if the surface roughness value of thermoplastic nylon, after coating with 25% tobacco leaf extract, shows 0.186, it shows that it is still below the threshold value for the surface roughness of thermoplastic nylon as a denture base.

The difference in the average surface roughness value in the placebo paste group (K2) was higher than the no-paste group, which the composition of the placebo paste could cause. The placebo paste material in this study contained calcium carbonate, which functions as an abrasive material that can increase surface porosity or roughness. Based on the results of this study, it is known that the use of denture cleaning paste containing 25% tobacco leaf extract does not cause an increase in surface roughness.

Colour changes of thermoplastic nylon plate after brushing with 25% tobacco leaf extract paste

This is results of the One-Way ANOVA test analysis showed a significance value of 0.679 ($p>0.05$), meaning that each group had no significant difference in the colour change of the thermoplastic nylon plate after brushing without paste, placebo paste and 25% tobacco leaf extract paste. However, based on the average value data, there was an increase in colour changes on thermoplastic nylon plates after brushing with 25% tobacco leaf extract paste (K3) compared to without paste (K1) or with placebo paste (K2).

Factors that influence the results of this research are the presence of phenol compounds in the form of flavonoids, alkaloids in the form of nicotine, saponins in the form of steroids and essential oils in the form of terpenoids. Phenolic compounds can penetrate thermoplastic nylon, causing damage to the polymer chain bonds. The ester group can react with phenol, resulting in the release of H+ ions and bonds with OH- ions released from the ester group so that the phenol group will bond with RCO from the ester group (Sari et al., 2016).

Besides that, large amounts of Hydrogen ions (H^+) can reduce surface tension, resulting in a diffusion process into the polymer chain in the ester group. It will cause the polymer chain bonds to become unstable, resulting in a lot of space between the polymer matrix. This situation will make it easier for bonds to occur between tobacco leaf compounds and the polymer matrix so that the polymer chains in the ester groups will be disrupted and separated. Disrupted and isolated polymer chains can increase the discolouration of thermoplastic nylon (Kristiana D, 2022).

The colour change value in vitro research is clinically acceptable if $\Delta E \leq 3.70$, while in vivo analysis, the colour change is acceptable if $\Delta E \leq 6.80$ (Savitri et al., 2022). This research is an in vitro laboratory study with the highest colour change value occurring at 2.61 or $\Delta E \leq 3.70$ in all treatment groups, so the colour change in all groups is still acceptable. The low weight of colour change in thermoplastic nylon is also supported because its surface has less microporosity**.**

4. Conclusion and Suggestion

1. 25% tobacco leaf extract paste (Nicotiana tabacum L.) does not affect increasing the surface roughness of thermoplastic nylon plates.
2. 25% tobacco leaf extract paste (Nicotiana tabacum L.) does not affect changing the colour of thermoplastic nylon plates.
3. The average value of change in surface roughness of thermoplastic nylon plates is still below the threshold value of 0.2 µm, and the average value of change in colour change is also still below the threshold value ($\Delta E \leq 3.70$).

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