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RESEARCH ARTICLE

The Effect of Pineapple Peel Extract As a Denture Cleanser on Flexural Strength of Nylon Thermoplastic Denture Base Materials

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ABSTRACT

Background: *Nylon thermoplastic has been widely used as denture base material because of its esthetic property, high flexibility, and flexural strength. It is very important to maintain the removable dentures' cleanliness, which is frequently done with the chemical technique by immersing the denture in a solution. The composition of malic acid and citric acid from pineapple peel extract has antibacterial and antifungal properties, so it can be used not only as a denture cleanser but also affect the flexural strength of denture base material.* ***Objective:*** *To determine the effect of pineapple peel extract as a denture cleanser on the flexural strength of nylon thermoplastic denture base material.* ***Method:*** *This is experimental laboratory research with a post-test-only group design using 36 samples, namely 18 Valplast samples and 18 Lucitone FRS measuring 64mm X 10mm X 2.5mm divided into 4 groups (Valplast control, Valplast experiment, Lucitone FRS control, and Lucitone FRS experiment). The samples were treated by immersing them in sterile distilled water as control, and in 3.5% pineapple peel extract for 15 minutes 3 times a day for 10 days as treatment. Flexural strength measurement using Universal Testing Machine. The data obtained were analyzed by the One Way ANOVA test.* ***Result:*** *There was a decrease in flexural strength in the Valplast and Lucitone FRS groups immersed in 3.5% pineapple peel extract. Lucitone FRS groups had higher flexural strength than Valplast's.* ***Conclusion:*** *There is a decrease in flexural strength of nylon thermoplastic denture base after being immersed in 3.5% pineapple peel extract.*

Keywords: *Pineapple Peel Extract, Denture Cleanser, Flexural Strength, Nylon Thermoplastic*

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INTRODUCTION

The material that is now widely used as denture base is nylon thermoplastic, because it has high flexibility and high mechanical strength so that it doesn't easily broke.[1] Nylon thermoplastic is a substance generated from a condensation reaction between diamine monomer and dibasic acid. Nylon contains a linear chain (single polymer bond) that has hexamethyldiamine and carboxylic acid which can form a long polyamide chain.[2]

Valplast dan Lucitone FRS are the two most produced brands of nylon thermoplastic denture base material in dentistry. Valplast is a polyamide resin which contains 99% polylaurylactam. This material has an elastic characteristic so that it does not easily broke, and it is also non allergic. The weakness of this material is its difficulty in finishing and polishing, which can be plaque retention sites.[3,4] Denture cleansing with chemical technique, which can be done by immersing denture into a denture cleanser, can help reducing the plaque retention risk.[5]

Lucitone FRS is also a resin which made from polyamide microcrystalline. Lucitone FRS has harder physical property than Valplast and the other polyamide resin so that it has a better wear durability. The disadvantage of this material is that it absorbs much more water than Valplast material.[3]

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Flexural strength is one of the most important properties as consideration in comparing which one the better denture base material is, since the force on denture base is obtained from masticatory process. The flexural strength test can be done by placing a weight on the middle of the tested material with a crutch at its each corner. This test is called three-point bending, and the maximum stress counted in this experiment is called flexural strength.[6]

Pineapple peels contain malic acid and citric acid, which have very good antibacterial characteristic.[7] The bromelain enzyme contained in the pineapple peel has also been proved capable to reduce and break the glutanine-alanine and arginine-alanine chain, so that it can reduce Candida albicans colony.[8]

The purpose of this research is to determine the flexural strength's difference between Valplast and Lucitone FRS after being immersed into 3,5% pineapple peels extract as denture cleanser, and focusing for the usage of pineapple peel extract, one of natural resources, to be an economic and environmental-friendly nylon thermoplastic's denture cleanser.

MATERIAL AND METHODS

This research is a true experimental laboratory with post-test only group design. The samples were divided into 4 groups, namely

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Valplast control group, Lucitone control group, Valplast experiment group and Lucitone experiment group. There were 9 samples in each group, so the total was 36 samples.

The samples were formed as plate with 64 mm long, 10 mm wide, and 2,5 mm thickness, with the criterias: the surface must be smooth and flat, does not have any porous, and all samples have same size.[9] The sampling technique in this research is total sampling.

A thousand grams of pineapple peels were prepared and dried, then extracted. The extraction method of the pineapple peels used in this research was maceration method, which goal is to dissolve all substances contained in the peels by using a solvent, which is 96% ethanol.[10] After then, it was obtained 166 grams of viscous extract.

Each Valplast control group and Lucitone FRS control group samples were immersed into a sterile aquadest for 15 minutes, 3 times a day for 10 days. Each Valplast experiment group and Lucitone FRS experiment group samples were immersed into a 3,5% pineapple peel extract solution for 15 minutes 3 times a day for 10 days. Immersion process of each sample were carried out in a same size container.[11]

Flexural strength testing of each sample was done with three-point bending method using a Universal Testing Machine. Each sample were placed on two corner with 44 mm distance, and set the cross head velocity to 5 mm/min. The power button was pressed to activate the machine, then pressed the Down button so that the flexural test machine can be done until the maximum weight the sample could resist. After the sample was broken, pressed the stop button and the maximum force obtained would be shown on the screen.[12]

Figure 1. Universal Testing Machine

Figure 2. Pineapple Peel

RESULTS

The research data obtained were analyzed using Shapiro Wilk normality test and Levene statistic homogeneity test. The normality test showed that the data has normal distribution (p>0,05), so that it fulfills the requirement for parametric test. The homogeneity test of this research data showed p<0,05, which showed that the data does not have a homogeny variance.

The comparative test carried out in this research data is Oneway Anova because there are more than 2 unpaired groups with a normal data distribution but an inhomogeneous data variance. The data is said having a significant difference between the groups if the p value showed less than 0,05 (p<0,05). The comparative test of this research data showed p<0,05 so that can be interpreted that there is a significant difference between the flexural strength test groups data (MPa) (table 1).

Table 1. One Way ANOVA Test Result

	Result		
	Mean Square	F	Sig.
Between Groups	25.929	110.463	.000
Within Groups	.235		
Total			

The ANOVA test showed there were a significant difference (p<0,05) between the flexural strength test groups.[13] Based on the LSD test result (p<0,05), it can be stated that there was a significant difference between:

a. Valplast Control Group and Lucitone FRS Control Group.

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b. Lucitone FRS Control Group and Valplast Experiment Group.
c. Valplast Experiment Group and Lucitone FRS Experiment Group.
d. Lucitone FRS Experiment Group and Valplast Control Group.

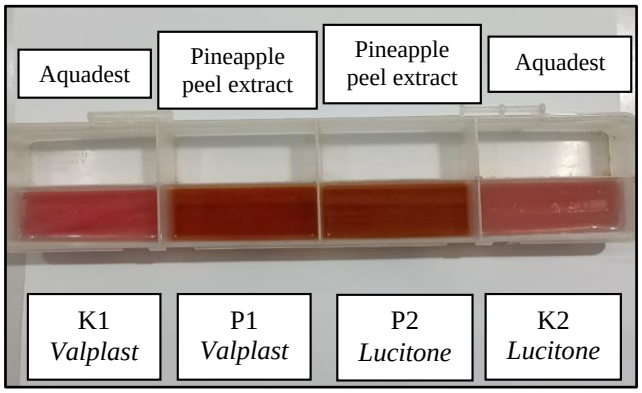

Figure 3. Nylon thermoplastic *Valplast* and *Lucitone FRS* were immersed in aquadest as a control and in 3,5% pineapple peel extract as a treatment.

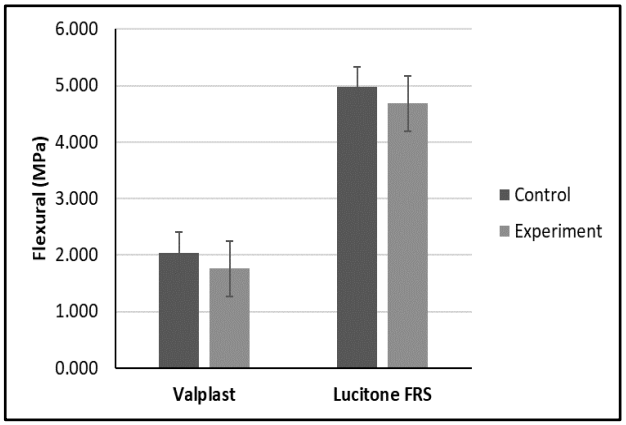

Figure 4. The bar chart shows result of Flexural Strength Test (MPa) between each group.

The laboratory test of this research showed that there was a slight decrease in flexural strength of each samples after being treated by immersing them into the 3,5% pineapple peel extract. The flexural strength mean value of Valplast group before given treated was 2.040 Mpa, after given treated became 1.763 Mpa, and the flexural strength mean value of Lucitone group before given treated was 4.972 Mpa, after given treated became 4.684 Mpa (figure 4).

DISCUSSION

Flexural strength is an ability of a restoration material to resist the force in masticatory process, which is a combination of compressive strength and tensile strength.[14] Flexural strength is considered as an indicator of material's mechanical properties. Flexural strength testing is carried out with three-point bending method using a Universal Testing Machine.[6]

The purpose of this research is to find out the difference of Valplast and Lucitone FRS nylon thermoplastic's flexural strength after being immersed into 3,5% pineapple peel extract as a denture cleanser.

Nylon thermoplastic is now an alternative as denture base material which was made from a polyamide resin.[15] Polyamide is generated from a condensation reaction between diamine (2-NH2 group) and dibasic acid or carboxylate acid (2-COOH group). This material has a good flexibility characteristic, it is light weight and is not easily broken, it can be retentive on its position while resisting the masticatory load so that the material provides comfort as a denture.[16]

Nylon thermoplastic is a crystalline polymer. This crystalline property makes the nylon thermoplastic has a long chain which causes this material is not easily dissolved in a solvent, so that it is able to resist from abrasion, chemical solution, and highly stable.[17]

Lucitone nylon thermoplastic has a higher flexural strength mean value than the Valplast one, either in the control group or the experiment group. This result shows that the Lucitone nylon thermoplastic has lower flexibility than Valplast. This result is in accordance with the study done by Vojdani & Giti (2015) which suggested to use valplast for a tooth abutment that has bigger undercut because valplast material has higher flexibility so that it can pass through the undercut area.[17]

There is also a higher decrease of the flexural strength value on the Lucitone experiment group than the Valplast experiment group. This result is again in accordance with the

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study by Kenji *et al* (2014) which stated that Lucitone has higher water-absorbing ability, it can absorb 28-30 µg/mm^3 water, compared to Valplast which can absorb water for 17 µg/mm^3.[3] Lucitone also has higher hydrophilic properties so that the water molecule will be more easily absorbed by this material. This water-absorbing ability is obtained from the molecule chain of amide group. The higher the concentration of amide group, the more water can be absorbed.[18]

Pineapple peel was chosen for this research's sample to reduce the waste pollution, since the peel contains malic acid, citric acid, and bromelain enzyme.[7] These two organic acids have a very good antibacterial property, which have a very low pH (about 3,71), and the bromelain enzyme have antifungal property, so that the pineapple peel extract has a good potency to be used as a denture cleanser.[19,20] Research by Dayasoeharso (2016) and Posuma (2016) concluded that pineapple peel extract within 3,5% concentration was very effective as a denture cleanser in detaining the growth of *Candida albicans*.[21,22]

The experiment group on both Valplast and Lucitone, which was given treated by immersing into the 3,5% pineapple peels extract (figure 3), show decrease in their flexural strength than the control groups'. The flexural strength's decrease can be caused by the citric acid composition which can cause oxidation process and absorbs water into the polyamide resin so that the malic acid and citric acid release hydrogen (H^+) ions and bond the polyamide chain. The polymer chain in the thermoplastic nylon can be dissolved by the solvent molecule which will weaken the chemical structure followed by the decrease of the polymer's strength properties.[1,23]

The One Way ANOVA result showed the significance value was lower than 0,05 ($p < 0,05$) which can be stated that there is a significant difference between the group's data. The difference in flexural strength average in each group then is described in the LSD result, which showed that there is a significant difference between the control group and the experiment group, both in valplast and lucitone, which showed flexural strength decrease in the experiment group. This research result is in accordance with the result of research done by Sundari *et al* (2016) which stated that the flexural strength decrease of the nylon thermoplastic was caused by the water absorption.[1] Water plays a role in hydrolytic degradation and erosion by stretching the matrix's fillers.[24] The water absorption by a diffusion process into the polymer will cause the solvent molecules penetrate and took place between the chain, so that the chain will be stretched then degradated. This degradation and water molecules between the chain then cause two impacts, the first is expansion of the polymer mass, or the second is the strength decrease of the polymer, especially the flexural strength. The longer is the immersion time, the more solvent molecule penetrates the intermolecular space so that the polar interaction will decrease and affects the flexural strength.[1,12]

CONCLUSION

Based on the research result, it can be concluded that there is a decrease of the flexural strength of Valplast denture base and Lucitone denture base after being immersed into 3,5% pineapple peel extract.

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