



Transverse strength of Robusta-soaked (*Coffea canephora L.*) acrylic resin denture

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Abstract

Acrylic resin is an artificial base material that is often used in dentistry because it has a resistance to the load that is received at the time of mastication known as transverse strength. The high consumption of Robusta coffee in Indonesia gives denture users easy access for the beverage. Robusta coffee (*Coffea canephora L.*) contains high chlorogenic acid which can affect the transverse strength of heat cured acrylic denture. This study aims to determine the transversal strength of acrylic resin denture which were soaked and not soaked with Robusta coffee liquid (*Coffea canephora L.*). This type of research is an experimental laboratory research study with Post Test Only Control Design Group. The size of the acrylic plate was 65 mm x 10 mm x 2.5 mm acrylic, immersed in Robusta coffee liquid; light roasted, medium roasted, dark roasted for 7 days. Transversal strength was tested using "Tensile tester". One way Anova Test was applied for the data analysis. The results showed that there was a significant difference in the transverse strength of the heat cured acrylic denture after being immersed with Robusta coffee ($p = 0.322$). There was no reduction in the transverse strength of the heat cured acrylic resin denture after being soaked with Robusta coffee liquid.

Keywords: acrylic resin, transverse strength, Robusta coffee

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INTRODUCTION

It is estimated that 1.6% of the Indonesian population experience total teeth loss. In general, the prevalence of Indonesian who have used dentures, both temporary and fixed, is 4.5% of the total population. The prevalence of dental-mouth problems and loss of natural teeth depends on a person's age. The older the age, dental-mouth problems will be more prevalence. However, starting from 55 years old the prevalence of dental-mouth problems decreases again. It was found that 1.8% of the samples in the 45-54 age group have lost all natural teeth, and in the age group of 65 years, 17.6% have experienced loss of natural teeth (Riset Kesehatan Dasar. 2007). Since the mid-1940s, denture bases have been made using polymethyl methacrylate acrylic resin (Ali, 2016). Acrylic resin has the property to absorb water slowly over a period of time by the mechanism of absorption through the diffusion of water molecules according to the laws of diffusion (Pambudi, Sulistyorini, & Mayasari, 2017). Absorption of ingredients contained in acidic beverages will react chemically with acrylic resins and settle in its pores. According to Craig and Payton's research, acrylic resins can be affected by acetic acid by the increasing concentrations or high pH that weakens the bonding of acrylic resin polymers (Daulay, Ningsih, Diansari, 2012).

Transverse strength is the durability of the object against the load received, the transverse strength test can give an idea of the resistance of the object in receiving the load during mastication (Pantow, Siagian, & Pangemanan, 2015). One of the factors that can affect the strength of denture base material is acidic foods or drinks consumed by denture users. Acidic drinks are beverages that have a pH level below 7, just like coffee which after fermentation has an optimum pH of 4.5-4.8 (Meng, & Latta, 2005).

Robusta coffee is coffee that is very much produced in Indonesia to reach 87.1% of total coffee production, Robusta coffee is also the most consumed coffee in Indonesia (Andari, Wulandari, & Robin, 2015; Girma, et al, 2017). Coffee can be useful as an antioxidant, stimulating brain performance and anticancer substances. The antioxidant content in coffee is higher compared to tea and chocolate. Besides having advantages, coffee also has disadvantages which because it is high in caffeine content and organic acids (Rejo, Rahayu, & Panggabean, 2010). Coffee is a beverage that contains several chemicals which are commonly grouped into acids, this has become a

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character of several types of Robusta coffee. The results of the study showed that coffee that had been dissolved in water still left acidic content, namely chlorogenic acid and trigonelin which were originally 7.60% and 1.70% to 0.80% and 0.29%.⁷ In the pH test it was found that coffee has a pH of 3.0 and the acidic nature of the coffee can cause erosion on the surface layer of polished acrylic resin, thereby increasing stain formation. Coffee also has many phenol groups in its molecule (Daulay, Ningsih, Diansari, 2012). Chlorogenic acid is a compound that is included in the phenolic component, has water-soluble properties and is formed from the esterification of quinic acid and certain transcinamic acids such as caffeoylquinic acid, feruloylquinic acid, and p-coumaroylquinic acid. The main subgroups of isomeric chlorogenic acid in coffee are caffeoylquinic acid (CQA), feruloylquinic acid (FQA), dicaffeoylquinic acid (diCQA) and p-coumaroylquinic acid (p-CQA) in smaller amounts (Farah, et al. 2006).

Philips stated that acrylic resins have porous properties and are easy to absorb liquid. Hence, it is suspected that there can be absorption of coffee and its contents into acrylic resin on Robusta coffee consumption, among which the consumers may include denture users. With the high content of chlorogenic acid in Robusta coffee, it is possible to be absorbed into the acrylic resin and will affect the strength of the denture base made from acrylic resin.

The results of other studies indicate that the flexural strength of heat cured acrylic denture have decreased after being soaked for 7 days in Robusta coffee, this allows a decrease in transverse strength on the heat cured acrylic denture. Therefore, the authors would like to examine the transverse strength of acrylic resin denture bases that are soaked and not soaked in Robusta coffee (*Coffea canephora* L.) (Meng, & Latta, 2005). This study aims to determine the transverse strength of acrylic resin denture which were soaked and not soaked in Robusta coffee liquid (*Coffea canephora* L.).

MATERIAL AND METHODS

This type of research was an experimental laboratory research study with Post Test Only Control Design Group. The sample used was a heat cured acrylic resin plate with a size of 65 mm x 10 mm x 2.5 mm. Samples were divided into 4 treatment groups with a control group immersed in sterile aquadest, immersed in Robusta coffee liquid; light roasted, roasted medium, and dark roasted.

The Robusta coffee beans that have been roasted produced three types of roasting result; light roasted, medium roasted, and dark roasted. By doing the roasting process of different coffee beans, the concentration of the chlorogenic acid content can be obtained. Within 100 grams of light roasted Robusta

coffee, there is 14.05% chlorogenic acid, in 100 grams of medium roasted Robusta coffee there is 19.11% chlorogenic acid, and in 100 grams of dark roasted Robusta coffee there is 11.31% chlorogenic acid. Tests of chlorogenic acid concentration in Robusta coffee beans have previously been conducted by Farah³ by testing the concentration of chlorogenic acid in 100 grams of Robusta coffee beans. After that, Robusta coffee beans were ground using the medium to coarse method to get Robusta coffee in order to carry on to the brewing process. The brewing was done using pour over method with the Hario V60 tool. Brewing was done with a ratio of 1 gr: 16 ml, so the ratio in one cup of coffee that is needed is 15 gr: 240 ml which can be interpreted as 15 grams of coffee and 240 ml of water in one glass (Said, 2007). Heat the water until it reaches a temperature of 90°C followed by water pouring with 135 ml, 300 ml, and 765 ml respectively for 5 cups, each cup containing 240 ml of coffee liquid. In this study, in each glass in the treatment group there were 15 grams of Robusta coffee and 240 ml of water. Contained in each glass were concentrations of different chlorogenic acids with 2.1% light roasted, 2.8% in roasted medium, and 1.6% in dark roasted.

The immersion of the heat cured acrylic resin plate was done for 7 days. Immersion for 7 days can be used for 22 months. 1 day or 24 hours is 1440 minutes, in which 1440 minutes/15 minutes x 7 days = 672 days = 22 months (Meng, & Latta, 2005). After soaking the heat cured acrylic resin plate for 7 days, the transverse strength test is carried out by using "tensile tester". After obtaining the results of the transverse strength, the data analysis is performed to find out the significance of the heat cured acrylic resin transverse strength test result data.

Analysis of research data was done using SPSS statistical test version 16.00 (2007). Data analysis was done using parametric statistical test with One way Anova Test to find out the difference in the transverse strength of acrylic resin dentures that are soaked and not soaked with Robusta coffee liquid.

RESULTS

After the transverse strength test was carried out on a heat cured acrylic resin plate that was soaked and not soaked with Robusta coffee liquid the results in **Table 1** were obtained.

Transversal strength of heat cured acrylic resin plates that were soaked and not soaked with Robusta coffee liquid for 7 days were analyzed using One Way Anova Test and showed p value greater than 0.05. The significance test was done One Way Anova Test the value is said to have significant differences if the p value is less than 0.05 ($p < 0.05$), if the p value is greater than 0.05 ($p > 0.05$) then the data does not have a significant difference. In this study the p value obtained was 0.322,

Table 1. The results of the analysis on the transversal strength test on a heat cured acrylic resin plate that was soaked and not soaked with Robusta coffee liquid

Category	N	Mean \pm SD	Sig.
The control group was immersed in a sterile aquadest	5	8.4 \pm 1.854724	0.322
Group 1 was soaked with light roasted coffee liquid	5	6.7 \pm 2.749545	
Group 2 was soaked with roasted medium coffee liquid	5	6.5 \pm 1.183216	
Group 3 was soaked with dark roasted coffee liquid	5	8.5 \pm 1.354006	

which means the p value was greater than 0.05. This shows that there is no significant difference in the decrease in the transverse strength of the heat cured acrylic resin plate soaked with sterile aquadest, light roasted, medium roasted, and dark roasted Robusta coffee.

DISCUSSION

The strength of denture base material is influenced by the forces in the mouth, including the transverse, impact and flexural forces (Meng, & Latta, 2005). Aside from those, the acidic food or beverage consumed by denture users can also affect the strength of the denture materials. Robusta coffee is useful as an antioxidant, while the acidic liquid in coffee can affect the roughness, hardness, and strength of acrylic resin denture (Daulay, Ningsih, Diansari, 2012).

This study used the old method of immersion (Sundari, Sofya, & Hanifa, 2016). Being soaked for 7 days represented coffee consumption for 22 months. In Sundari's study which compares the flexural strength of thermoplastic nylon and heat cured acrylic resin, it was found that there was a decrease in the flexural strength of heat cured acrylic resin denture base compared to thermoplastic nylon which is soaked with Uleekareng Robusta coffee liquid. It can be said that denture users who have the habit of consuming Robusta coffee, within a period of 22 months can change the physical properties of the denture base, one of which is the flexural strength. This can be caused by the ability of water absorption from each material used in the absorption of water that occurs will cause solution particles to penetrate and affect chemical bonds, the longer soaking the more solution that can penetrate into the microporosity space (Sundari, Sofya, & Hanifa, 2016).

The incoming solvent molecule will penetrate and occupy a position between the polymer chains, causing the polymer chains to separate. This polymer chain separation can weaken the chemical structure so that it can result in decreased polymer strength. Based on the matrix degradation theory, resin immersed in water will absorb water molecules and will penetrate into the intermolecular space of the polymer chain so that the polar interaction decreases, this causes the distance between the polymers to increase, then the matrix expansion will occur, then the matrix will soften so that there will be a decrease in the strength of the resin. Ion H⁺ the chlorogenic acid contained in coffee will cause polymer bond degradation so that some bonds will break away. The release of this bond will cause the empty spaces between the polymer matrix to increase so that it facilitates the diffusion of liquid from the outside into the resin. Results in other studies also found significant differences in flexural strength of heat cured acrylic resin and thermoplastic nylon after being immersed in denture cleaning solutions.

Robusta coffee contains chlorogenic acid which is one of the phenolic components, the Robusta coffee content of chlorogenic acid is classified as very high compared to Arabica coffee. Different coffee roasting produce different concentrations of chlorogenic acid. There are 2.1% in light roasted Robusta, 2.8% in roasted medium, and 1.6% in dark roasted Robusta coffee in each glass of each treatment group respectively. Based on the results of this study, there is no decrease in the transverse strength of denture bases after the acrylic plate is soaked with Robusta coffee liquid for 7 days. Many studies state that by doing the roasting process, chlorogenic acid can be broken down into phenol derivatives and can cause the value of the content to be reduced in the coffee beans (Salman, & Saleem, 2011). But in this study, it can be stated that the content of chlorogenic acid in each glass of each treatment cannot affect the transverse strength of the acrylic resin plate.

CONCLUSION

It can be concluded that there is no decrease in the transverse strength of heat cured acrylic resin denture base after being soaked with light roasted, roasted medium, and dark roasted Robusta (*Coffea canephora* L.) coffee liquid.

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