Global Scientific and Academic Research Journal of Dentistry and Oral Medicine
ISSN: 2584-2382 (Online)
Frequency: Monthly
Published By GSAR Publishers
Journal Homepage Link- https://gsarpublishers.com/journal-gsarjdom-home/

The Effect of Black, Green, and Red Tea Brewing *Oolong* (*Camellia sinensis)* on Transverse Force of Denture Base Acrylic Resin *Heat Cured*

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Article History

Received: 05/12/2024
Accepted: 16/12/2024
Published: 18/12/2024

Vol – 1 Issue – 12

PP: -01-05

Abstract

Background:*. One of the important components in the manufacture of dentures is the denture base. 95% of the replica material is made of resin derived from the heat cured type. The denture base will always be in contact with the food and drink consumed by the denture user. This study used black, green, and oolong tea (Camellia Sinensis). Tea leaves have different polyphenols depending on the fermentation process, the higher the polyphenols in the tea, the more heat-cured the resin will be. Polyphenols in leaves are in the form of catechins, when the phenolic compounds in contact with the above resin can penetrate into the material and damage the polymer chain, resulting in a decrease in the mechanical properties of the resin, one of which is a decrease in transverse strength.* ***Purpose:*** *The purpose of this study was to determine the effect of transverse strength of heat-cured denture base from immersion in black tea, green tea, and oolong tea for 10 days and to examine the comparative effect of immersing heat-cured acrylic resin on black tea , green tea, and oolong tea for 10 days.* ***Methods:*** *This type of research is an experimental laboratory with the post test only control group design. The acrylic resin sample is in the form of a square measuring 65 x 10 x 2.5 mm. The sample was divided into 4 groups. Group A was soaked in distilled water for 10 days, group B was soaked in black tea for 10 days, group C was soaked in green tea for 10 days, group D was soaked in oolong tea for 10 days. Soaking 10 days is equivalent to 8 minutes of soaking per day for 5 years. Transverse strength test was carried out using tarno grocki/UPH-100kN.* ***Results:*** *The group that was treated with green tea steeping for 10 days had the lowest transverse strength value compared to the group that was soaked in distilled water, black tea and oolong tea. The group that was treated with black tea steeping for 10 days had the highest transverse strength value compared to other groups but was still below the transverse strength standard.* ***Conclusion:*** *The steeping of black tea, green tea, and oolong tea has an effect on decreasing the transverse strength of heat-cured acrylic resin with an immersion time of 10 days.*

Keywords: *steeping tea, arcylic resin, transverse strength*

INTRODUCTION

Acrylic resin *heat cured* most frequently used in society because it has advantages such as biocompatible material properties, more affordable prices, easy to manipulate, no*toxic*, color matches the surrounding tissue, aesthetic, has good adhesion to the denture elements. [1]Acrylic resin *heat cured* also has weaknesses including relatively low strength and hardness compared to other materials, making it prone to cracking or fracture, poor thermal conductor, and easy to abrade. [2]Porosity is also one of the properties of acrylic resin denture base. The presence of porosity can cause the absorption of fluids that enter the oral cavity so that the porosity that occurs in the denture base is one of the causes of the decrease in the transverse strength of the denture base.[3]

Tea comes from a part of the plant *Camellia sinensis*and

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based on the processing process it is divided into unfermented tea (white tea and green tea), fermented tea (black tea), and semi-fermented tea (tea *oolong*). Fermented tea (black tea) and semi- fermented tea (oolong tea) during processing release the polyphenol oxidase enzyme found in the tea plant itself with the aim of *self fermented*. Tea is a natural source of caffeine, theophylline, and antioxidants with fat, carbohydrate, or protein content. Tea itself contains antioxidants in the form of polyphenols (catechins). In green tea, catechins do not change, while in black tea, there is a fermentation reaction or enzymatic oxidation in the tea leaves which causes catechins to change into their oxidation compounds, namely *theaflavins* And *thearubigin*.[4,5] *Theaflavins* will give a yellow color and *thearubigin* will give a reddish brown color.[6] With the presence of polyphenol compounds, someone who uses acrylic resin-based resin-based removable dentures *heat cured* and often consuming tea can cause a decrease in the strength of the dentures themselves.

Acrylic resin has the property of absorbing water slowly over a certain period of time, with an absorption mechanism through the diffusion of water molecules according to the law of diffusion. The absorption of compounds in acrylic resin is one of the factors causing a decrease in transverse strength in acrylic resin. [7]Phenolic compounds when in contact with acrylic resin can penetrate into the material and damage the polymer chain bonds, resulting in a decrease in physical and mechanical properties, one of which is a change in color. [8]The color changes that occur can be an indicator of material damage. The purpose of this study was to determine how much influence the transverse strength of heat-cured denture bases from immersion in black tea, green tea, and oolong tea infusions for 10 days and to examine the comparative effect of immersion in heat-cured acrylic resin in black tea, green tea, and oolong tea infusions for 10 days on transverse strength.

RESEARCH METHODS

This type of research is *experimental laboratory* with design *the post test only control group design*. Acrylic resin sample making *heat cured* starting with the creation of a master model/*mold space.* The mold is made using red wax measuring 65 x 10 x 2.5mm. The cuvette is smeared with Vaseline and then a plaster mixture is made with a ratio of powder and water of 100 gr : 45 ml (according to the manufacturer's instructions) in a rubber bowl, then stir for about 60 seconds. Next, put the mixture into the bottom cuvette which has been smeared with Vaseline, then vibrate it. The red wax plate is placed on the dough in a horizontal position. After the plaster mixture has hardened, smear the top of the mixture and the red wax plate using Vaseline, then install the top cuvette and add plaster mixture until it is even and full (while vibrating). Then the cuvette is closed and pressed using *press beagle.* After the dough is set, it is done *wax removal* by boiling water in a pan to a temperature of 100ºC and inserting a cuvette into it. When the boiling is complete, immediately open the cuvette to take *mold space*.[3]

Coating the surface mold space by using separator material cold mold seal (CMS). Then stir the acrylic resin material heat cured with a powder liquid ratio of 3:1 according to the manufacturer's instructions. After polymerization reaches dough stage, put the dough in the mold (mold space) whose surface has been reviewed by CMS. Then the surface of the dough is coated with cellophane plastic and pressed (1500 psi) slowly using hydraulic bench press. Then the cellophane paper is removed and the final pressing can be done. Next, heating is carried out (curing) by inserting the cuvette into an aluminum pan containing boiling water (100ºC) until the entire the surface of the cuvette is submerged. Heating/curingon the fire for ± 20 minutes according to the factory rules. After that the cuvette is lifted and left to cool for approximately 10 minutes. Then the cuvette is opened and the specimen is taken. Then continued finishing And polishing.[3]

Make the tea infusion by weighing 30 grams of each tea leaf, then adding 200 ml of mineral water into each bottle autoclave. Then insert each bottle autoclave into the water bath until temperature of 70±1°C and wait for 4 minutes. After that, insert each leaf tea in a bottlea utoclave which has been heated from water bath. Then the brewed tea is dissolved and put into 1 bottle each autoclave the new one with the method is filtered and the temperature is maintained at 37°C using shaking incubator for soaking for 10 days and each tea infusion is changed every day.[6,9,10]

Group A was soaked in distilled water for 10 days, group B was soaked in black tea for 10 days, group C was soaked in green tea for 10 days, group D was soaked in tea *oolong* for 10 days. The 10-day immersion is equivalent to a daily immersion of 8 minutes for 5 years. The transverse strength test was conducted using a tarno grocki/ UPH-100kN.

The first way to use the Tarno Grocki/UPH-100kN tool is to turn it on by pressing the button. Power to the on position, then the sample is placed on the measuring device on a flat and level surface with a distance between the two supports of 20 mm. After that, the test rod is marked in the middle and placed in the middle of the press tool so that the pressure is directed at one line of the test rod, then the tool will drop at the marked midpoint at a speed of 1/10/mm/second until the sample breaks and the tool will display a number, then entered into the established formula test.[11]

The transverse strength test is calculated using the formula:

$$S = \frac{3LP}{2bd^2}$$

Information :

S	: transverse strength (MPa)
L	: distance between supporting loas (mm)
P	: load (KgF)
b	: sample width (mm)
d	: sample thickness

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The data obtained were then analyzed using the normality test Shapiro-Wilk and homogeneity test Levene-test. Next, parametric tests were carried out One Way ANOVA and continued with LSD test on the type of immersion infusion group.

RESULT

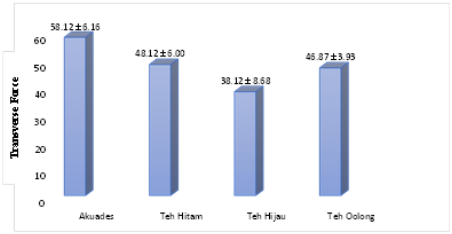
Transverse strength data on samples after immersion in each sample group can be seen in Table 1 and Figure 1 :

Table 1. Results of the reduction in transverse strength of acrylic resin samples after immersion. (MPa)

No.	Transverse Strenght (KT) (MPa)							
	Group A (Aquades)		Group B (Black Tea)		Group C (Green Tea)		Group D (Tea *Oolong*)	
	Load (Kg)	KT	Load (Kg)	KT	Load (Kg)	KT	Load (Kg)	KT
1	17	63.75	13	48.75	8	30	13	48.75
2	14	52.5	14	52.5	10	37.5	11	41.25
3	15	56.25	13	48.75	11	41.25	12	45
4	18	67.5	15	56.25	12	45	13	48.75
5	14	52.5	11	41.25	7	26.25	14	52.5
6	15	56.25	11	41.25	13	48.75	12	45

Infromation :

Group A : Group soaked in distilled water for 10 days
Group B : Group soaked in black tea for 10 days
Group C : Group soaked in green tea for 10 days
Group D : Group soaked in oolong tea for 10 days



Based on the data obtained from Table 1, the highest average value of transverse strength on the heat-cured acrylic resin samples was found in group A (control) which was soaked in distilled water while the lowest average value of transverse strength on the surface of the heat-cured acrylic resin samples was found in group 3 which was soaked in green tea infusion. The results of the average value of the transverse strength measurement can also beseen in the form of a graph in Figure 1 below:

Figure 1. Histogram of the average value of transverse strength of acrylic resin samples after immersion.

Normality test results Shapiro-Wilk Each group shows a significance value of more than 0.05, so it can be interpreted that the data is normally distributed. The results of the homogeneity test Levene shows a significance value of 0.276 ($p > 0.05$) which means the data is homogeneous. The results of the normality and homogeneity tests show that the data is normally distributed and homogeneous so that a parametric statistical test is carried out One Way ANOVA. Test results One Way ANOVA shows a significance value of 0.00 ($p < 0.05$) which means that there is a significant difference in the value of the reduction in transverse strength of acrylic resin heat cured which is influenced by the type of immersion brew. Furthermore, LSD tests were conducted on groups of immersion brew types (Table 2).

Table 2. LSD test results for immersion type groups

Groups	Aquades	Black Tea	Green Tea	Tea *Oolong*
Aquades	-	0,014	0,000	0,007
Black Tea	0,014	-	0,014	0,740
Green Tea	0,000	0,014	-	0,029
Tea *Oolong*	0,007	0,740	0,029	-

Based ontestLSDfromacrylic resin immersion type groupheat cured(Table 2) shows that there is a statistically significant difference ($p < 0.05$) in all groups, namely :

a. Between the aquades groups for black tea, green tea, and teaoolong
b. Between green tea groups and black tea, and teaoolong

DISCUSSION

The average value of the transverse strength of the acrylic resin denture base heat cured immersed in distilled water in this study was 58.12 ± 6.16 MPa, the average value of the transverse strength of the acrylic resin denture base heat cured soaked in black tea infusion was 48.12 ± 6.00 MPa, the average value of the transverse strength of the acrylic resin denture base heat cured soaked in green tea infusion was 38.12 ± 8.68 MPa, the average value of the transverse strength of the acrylic resin denture base heat cured soaked in brewed tea oolong is 46.87 ± 3.93 MPa.

The average value of the transverse strength of the acrylic resin denture base heat cured which is soaked in black tea, green tea, and tea infusions oolong lower compared to the

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control group (aquades). This is due to the presence of polyphenol compounds contained in black tea, green tea, and tea infusions oolong thus causing a decrease in transverse strength. The results of this study also found that the average transverse strength was the lowest in samples soaked in green tea infusion compared to samples soaked in black tea and tea infusions oolong. This is because the polyphenol content in green tea is higher, namely 19.18%, where as in black tea it is only 16.5% and in tea oolong only 17.6%.[5]

Acrylic resin has one weakness, namely that it is hygroscopic (can absorb water). Acrylic resin soaked in infusion can cause absorption by diffusion. Diffusion is the movement of a substance through cavities or gaps in acrylic resin. Diffusion occurs between macromolecules, causing one macromolecule to separate from another, thus decreasing its strength. The longer the soaking period, the more infusion can penetrate into the microporosity space of a material. Water absorption by diffusion into the resin matrix will reduce the mechanical strength of the material because the increase in water will increase the distance between the molecular chains that will act as plasticizer.[7]

The factor causing the decrease in transverse strength in acrylic resin is the nature of acrylic resin which tends to absorb water or liquids, chemicals and food ingredients can disrupt the polymer bond in acrylic resin. Acrylic resin can absorb water with the diffusion process is the movement of a substance through a cavity. In acrylic resin, water molecules will penetrate the acrylic resin mass and occupy positions between the polymer chains. The diffusion coefficient of water in acrylic resin heat curedis 1.08 × 10-12m2/second at 37°C.4When acrylic resin is soaked in a liquid, it will cause the compounds from the liquid to easily bond by damaging the structure of the acrylic resin polymer. The physical chemical reaction that occurs is a hydrolysis reaction or the breaking of the double bond between C = O in the acrylic resin polymer. Furthermore, the hydrolyzed O atom will bond with the H atom from water (H2O) and forms intermolecular bonds in acrylic resin.[3]

Other factors that can result in a decrease in transverse strength Acrylic resin is one of the consumption of food and beverages. Tea is one of the drinks that is not only popular with Indonesian people, the world community positions tea as the second most consumed drink after mineral water.[37] In Indonesia, the average tea consumption per person reaches 0.61 kg/capita/year.[12]

The decrease in transverse strength that occurs when acrylic resin is soaked in black, green and black tea infusions oolong caused by the presence of physical chemical bonds, namely the absorption and penetration of substances contained in the tea infusion (phenol) into the microporosity of the acrylic resin surface which causes the transverse strength of the substance to bond mechanically with the acrylic resin polymer.[13] Acrylic resin is formed through a free radical addition polymerization reaction that forms polymethyl methacrylate (C 5O2H8)n with low polarity. Phenol has the chemical formula C6H5OH and its structure has a hydroxyl group (-OH). Phenol has properties that tend to be acidic, acidic compounds can release H ions+ from its hydroxyl group in water. The release of H ions+ causing the formation of phenoxide anions (C6H5O-). When the ester group of acrylic resin reacts with phenol, H ions are produced + in phenol it will release and bind to CH3O-which is released from the ester group, while the phenoxide anion (C6H5O-) in phenol will bind to the acyl functional group (RCO+) of ester. This ion exchange reaction causes degradation of polymer bonds so that some bonds will break away and the solvent molecules that enter will occupy positions between the polymer chains so that the polymer chains separate which causes the chemical bonds of the acrylic resin to become unstable and chemical damage occurs on the surface of the acrylic resin denture base material.[14] The length of contact time between acrylic resin materials heat cured and phenol compounds can affect the transverse strength, this is because the longer the acrylic resin heat cured immersed the greater the reduction in transverse strength that occurs.

CONCLUSION

Brewing black tea, green tea, and tea oolong have varying influences on the reduction of transverse strength of acrylic resin heat cured with a steeping time of 10 days and green tea infusion had the greatest effect on reducing transverse strength compared to black tea and green tea oolong because green tea has the highest amount of phenols.

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