

The Effectiveness Of The Long-Term Acrylic Resin Plate Immersion In Various Concentrations Of Black Tea On Color Change Difference

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ABSTRACT

Background: Dentures are generally made of a heat-cured type polymethyl methacrylate acrylic resins. Acrylic resin has the property to absorb water slowly over a period of time by absorbing it through the diffusion of water molecules and experiencing water saturation within 17 days. Polyphenols that come in contact with acrylic resin plates will react with esters of polymethyl metacrylate in acrylic resins to form brown colored coatings that are attached to the surface of the acrylic resin plates. **Purpose:** Candida albicans colonies of the acrylic resin plate in long-term black tea immersion. **Materials and Methods:** Black tea, which contains antibacterial and fungicidal properties, can reduce Candida albicans attached to the surface of acrylic resin plates. In this study, acrylic resin plates immersed in a black tea with a concentration of 10 grams, 20 grams and 40 grams in 300 ml of water for 1 hour, 4 hours and 8 hours turned out to be a decrease in transverse strength and there was a thickening of the brown colored layer that attaches to the resin plate acrylic with strong curls. **Result:** Statistical tests show that there are significant differences between each group of transverse strengths and thickness of the layers. **Conclusions:** The more concentrated the concentration of black tea brewing and the longer the acrylic plate is immersed in the brewing of black tea
Keyword: acrylic resin, black tea, color changes, immersion

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INTRODUCTION

Dentures are generally made of a heat-cured type polymethyl methacrylate acrylic resins. This acrylic resin material has the following properties: non-toxic, easily manipulative, non-irritating, insoluble in oral fluid although absorbing water, aesthetically fulfilled, color can be made similar to gingival, stable, easily repaired, has dimensional changes small, inexpensive and widely used alternative prices[1]. The mechanical properties of resins are one of the factors determining the use of acrylic resins[1]. Acrylic resin has the property of absorbing water slowly over a period of time by the mechanism of absorption through the diffusion of water molecules according to the laws of diffusion and experiencing water saturation within 17 days[2–4].

Tea can be used as an acrylic resin plate soak, this is due to the fact that tea has an antibacterial properties. One type of tea that known in Indonesia is *Camelia sinensis* or black tea. Black tea is often used as a drink because it is cheap, easy to obtain and contains disinfectants properties. The nature of disinfection is produced by the content of fluoride, polyphenols, katchin and oxidized derivatives, so it is antibiotic[5].

Polyphenols are soluble in water[6], so polyphenols can dissolve in tea brewing, the amount of polyphenols in tea brewing is influenced by the concentration of the solution. The more concentrated the more the amount of polyphenols used in brewing the tea. The more polyphenols that used in tea brewing, the more likely that the polymer chains are broken, thereby weakening the mechanical strength of the acrylic resin plate[7–9].

With the use of dentures, the mucosa covered with removable dentures for a long time will be closed, thereby blocking the cleaning of the mucosal surface and denture by the tongue and saliva, which will cause the formation of denture plaque[10]. Microbial plaque on the surface of dentures facing the mucosa is a contributing factor and pathogenesis of denture stomatitis[11,12], which has been reported that 65% of denture wearers suffer from denture stomatitis[13]. Plaque buildup and food debris will cause the frequency and density of *Candida albicans* to increase. Denture stomatitis is associated with proliferation of *Candida albicans* found in plaque attached to the denture. *Candida albicans* infection was significantly reported as a cause of denture stomatitis[10]. The aim of this study was to show how much influence the black tea had on the change in color, the transverse strength, and the growth of *Candida albicans* colonies of the acrylic resin plate in long-term black tea immersion.

METHOD

This research was conducted by Experimental Laboratories with Factorial Design. Sample Criteria namely Shape and Size The shape and size of the sample is rectangular in shape with a size of 65 x 10 x 2.5 mm (A.D.A., 1975), the sample material is made of heat cured type acrylic resin. The Classification of Research Samples:

- The study sample was classified into 3 groups of concentrated solution and 1 control group, namely:

A1: Immersed in a brewed black tea with 10 gram of black tea in 300 ml of water.

A2: Immersed in a brewed black tea with 20 gram of black tea in 300 ml of water.

A3: Immersed in a brewed black tea with 40 gram of black tea in 300 ml of water.

A4: Immersed in aquades (Control Group)

- The research sample was classified into 3 immersion groups. B1 = Soaking time is 1 hour
B2 = Soaking time is 4 hours B3 = Soaking time is 8 hours.

The location of the study was carried out at the Joint Basic Laboratonum, Airlangga University Surabaya, Laboratory of Food and Beverage Products and Beverages Industry Center Surabaya, Laboratory of Materials Science and Dentistry Technology, Faculty of Dental Medicine, Universitas Airlangga, Surabaya.

Way of work:

Sample creation

Master sample made from Brass Alloy (brass) with a size of 65 x 10 x 2.5 mm (Figure 4.1). First the master sample was planted in a cuvette. Planting is done with Moldano hard casts, while the ratio of powder to water is 100 grams of hard cast with 30 ml of water. Stirring is done by using a vacuum mixer for 30 seconds then in a cuvette above the vibrator. After the cuvette is full then the master is planted in the cuvette. The masters were planted in cuvettes in 3 pieces and waited for \pm 20 minutes



Fig. 1 Master Sample made from brass with the size of 65x10x2,5 mm

Tea Brewing

First the black tea is weighed in advance as much as 10 grams, 20 grams and 40 grams. Tap water is put into a pan and cooked until it boils. 300 ml of boiling water is taken. Next 10 grams of black tea weighed in 300 ml boiled water and stirred (10 times). After settling for 5 minutes, then filtered to obtain a 10 gram black tea steeping concentration in 300 ml of water. The same way was used for the 20 grams and 40 grams black tea. The acrylic resin plate is then soaked in the brewed black tea.

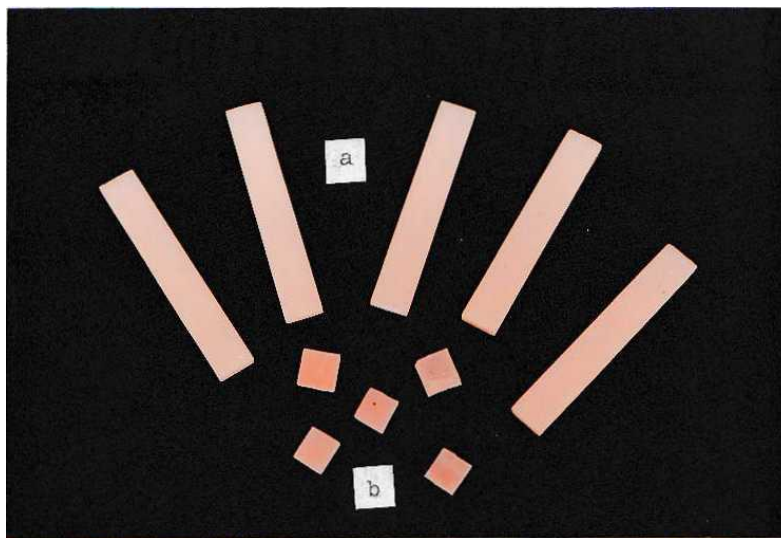


Fig. 2 Sample Test Rod (a) 65 x 10 x 2.5 mm; (b) 10 x 10 x 1 mm

Sample Immersion

The sample is soaked in a bowl containing 300 ml of brewed black tea, each cup contains 6 samples. Then the bowl is closed with a lid made of glass. In the same way the samples were immersed in distilled water, used as a control group. Duration of the immersion is 1 hour, 4 hours and 8 hours.

Transverse Strength Measurement

After the sample has become acrylic then the sample is taken according to the criteria in a random manner. In this study the treatment of the sample was immersion in a solution of black tea or water in a closed bowl made of glass. The method of measuring transverse strength is to place the sample on a transverse strength device then load it, so the sample is broken. Samples were placed on two supports, the distance between the supports are 35 mm. Only then will the sample be loaded until the sample is broken.

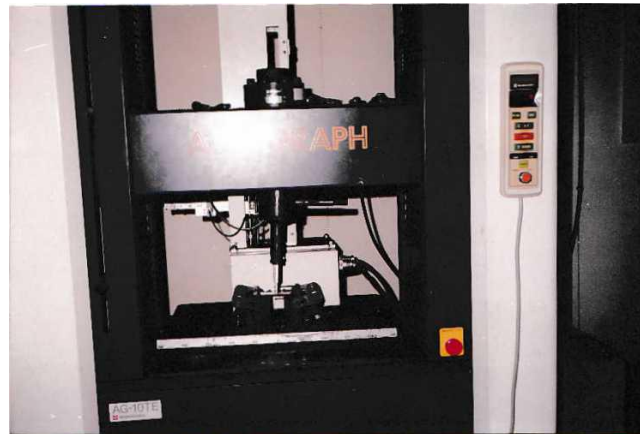


Fig. 3 Acrylic Resin Sample that about to be tested

Preparations for measuring the thickness of the Black Tea Polyphenol Layer

The cross section of acrylic resin is leveled with a sharpener. With the help of blister paper in successive sizes, which is 240; 400; 600; 1000; 1500 grits. Furthermore, the surface of the acrylic resin plate is daubed with velvet cloth and aluminium powder (0.1 μ m grit), so that the surface looks smooth, without any scratches. Then the acrylic resin plate is washed with water, then dried. Acrylic resin plates are immersed in the brewed black tea with a concentration of 10 grams of black tea, 20 grams and 40 grams. At each concentration of black tea, the acrylic resin is immersed for 1 hour, 4 hours and 8 hours.



Fig. 4 Shimadzu Japan *Microhardness Tester* used to view the thickness of polyphenol layer

that attached into the sample

Sample Measurement

The sample is placed on the Shimadzu Japan microhardness tester table with a leveled / smoothed surface facing on the objective lens. Then the objective lens is focused with magnification 400 times.

Acrylic resin plates immersed in a brewed black tea. After the immersion, the acrylic resin plate is dried and should not be contaminated. Then the surface of the acrylic resin that contains a layer of black tea was scraped with a scapel of 1 mg. 1 mg of acrylic resin mixed with 99 mg K Br (Potassium Bromide), then crushed to a fine powder. Then put into a mold so that it becomes round and slightly transparent.



Fig. 5 Spectofotometer *Infra Red* Yasco F.T.I.R – 5300

When printing using a Shimadzu Japan printing tool The mold making uses a pressure of 500 kg f / cn-T with a vacuum for 5 minutes. After that the printout is inserted into the infrared spectrophotometer

Analysis of this study by means of statistical tests: Student's t test, Anova Test run tun v / akXu! trend analysis with 5% significance level, Tuckey's multiple comparison test, Kruskal Wallis One Way Anova Test, Multiple Regression

RESULT

Table 1 Analysis of variance of two-way test of black tea polyphenol layers obtained between acrylic resin plates immersed in brewed black tea with concentrations of 10 grams, 20 grams and 40 grams for 1 hour, 4 hours and 8 hours

Source of variation	JK	Db	RJK	F	P	S/NS
Main effect	52.230	4	13.058	88.063	.0000	S
Concentration	11.596	2	5.798	39.102	.0000	S
Immersion time	40.635	2	20.317	137.024	.0000	S
2 way interaction	8.975	4	2.244	15.132	.0000	S
Concentration << Immersion	8.975	4	2.244	15.132	.0000	S
Explained	61.206	8	7.651	51.598	.0000	S
Residual	6.672	45	.148			
Total	67.878	53	1.281			

Overall there are significant differences in the layers of black tea polyphenols on acrylic resin plates. There are significant differences in the layers of black tea polyphenols on acrylic resin plates due to the long immersion time in brewed black tea for 1 hour, 4 hours and 8 hours

Table 2 Tukey's-HSD analysis results between acrylic resins immersed in brewed black tea with concentrations of 10 grams, 20 grams and 40 grams

Concentration	10 gram	20 gram	40 gram
1 hour immersion			
10 gram	-	NS	NS
20 gram	NS	-	NS
40 gram	S	S	-
4 hour immersion			
10 gram	-	NS	NS
20 gram	NS	-	NS
40 gram	S	S	-
8 hour immersion			
10 gram	-	NS	NS
20 gram	NS	-	-
40 gram	S	S	-

Table 3 Analysis of variance of one-way test for different polyphenol layers in acrylic resins obtained from acrylic resins immersed in brewed black tea with concentrations of 10 grams, 20 grams and 40 grams

Source of variation	Degree of freedom	Sum of squares	Mean squares	F	P
4 hour immersion	2	10.4478	5.2239	29.3660	0000
Error group	15	2.6693	.1779		
8 hour immersion	2	35.1475	17.5738	83.8866	0000
Error group	15	3.1424	.2095		

During the 4 hour immersion showed $P < 0.05$, meaning that there was a significant difference between the acrylic resin soaked in brewed black tea against each concentration of 10 grams, 20 grams and 40 grams for 4 hours. During the 8 hour immersion showed $P < 0.05$, means there is a significant difference between the acrylic resin soaked in brewed black tea for each of the 10 gram, 20 gram and 40 gram concentrations for 8 hours.

Table 4 Correlation analysis between transverse strength and black tea polyphenol layers on acrylic resin plates immersed in black tea brewing with concentrations of 10 grams, 20 grams and 40 grams

	Transverse strength	Black tea layer
Transverse strength	$r = 1.0000$ $P = .0000$ B	$r = -.6884$ $P = .0000$ B
Black tea layer	$r = -.6884$ $P = .0000$ B	$r = 1.0000$ $P = .0000$ B

The table shows that there is a significant relationship between the transverse strength and the polyphenol layer of black tea on acrylic resin immersed in black tea brewing with concentrations of 10 grams, 20 grams and 40 grams of tea.

Table 5 Results of multiple regression tests between transverse strength and polyphenol layers on acrylic resin plates immersed in black tea brewing for 1 hour, 4 hours and 8 hours

.Analysis of Variance	DF	Sum of Squares	Mean Squares	F	P
Regression	1	7.57971	7.57971	46.30073	.0000
.\coiuuui	52	8.51271	.16371		

Multiple regression obtained a value of $P < 0.05$, meaning there is a significant difference between the transverse strength and polyphenol layers attached to the acrylic resin plate immersed in brewed black tea for 1 hour, 4 hours and 8 hours.

Table 6 Correlation analysis between transverse strength and black tea polyphenol layers on acrylic resin plates immersed in black tea brewing for 1 hour, 4 hours and 8 hours

	Black tea layer	Transverse strength
Black tea layer	$r = 1.0000$ $P = .0000$ B	$r = -.6863$ $P = .0000$ B
Transverse strength	$r = -.6863$ $P = .0000$ B	$r = 1.0000$ $P = .0000$ B

The table shows that there is a significant relationship between the transverse strength and black tea polyphenol layers on the acrylic resin plate which is immersed in brewed black tea for 1 hour, 4 hours and 8 hours.

DISCUSSION

Color Changes

In this study, to see the change in color of acrylic resin that has been immersed in brewed black tea is done by looking at the black tea attached to the surface of the acrylic resin measured by a microhardness tester.

There is a significant difference in the layer of black tea attached to the acrylic resin that has been immersed in brewed black tea in all groups. In addition, the results of research and data analysis using the Tuckey-HSD statistical test with a significance level of 0.05 showed that there were significant differences in the immersion of acrylic resin in black tea brewing. This is because the black tea polyphenols are attached to the acrylic resin so that the surface of the acrylic resin is coated in color from black tea.

There is a significant difference in the layer of black tea attached to the acrylic resin that has been immersed in brewed black tea with a concentration of 10 grams, 20 grams, 40 grams. In addition, the results of research and data analysis using the Tuckey-HSD statistical

test with a significance level of 0.05 showed that there were significant differences in the immersion of acrylic resin in black tea brewing with concentrations of 10 grams, 20 grams and 40 grams. This is because the more concentrated the concentration of black tea, the greater the black tea polyphenols in brewed black tea so that more ester groups of acrylic resin react with black tea polyphenols. This color change is due to the more and more thick polyphenols that adhere to the surface of the acrylic plate, making the acrylic resin darker in color.

There is a significant difference in the layer of black tea attached to the acrylic resin that has been immersed in brewed black tea for 1 hour, 4 hours and 8 hours. In addition, the results of research and data analysis using the Tuckey-HSD statistical test with a significance level of 0.05 showed that there were significant differences in the immersion of acrylic resin in brewed black tea for 1 hour, 4 hours and 8 hours, possibly due to tea polyphenols black attaches to acrylic resin and is followed by strong bonds. This is consistent with what was stated[14] that tea has the potential to cause changes in color, because the tea polyphenol content has a polar structure that causes stronger physical chemical bonds to occur, in addition polyphenols easily oxidize oxygen both in free air and in the water environment, so it will easily lead to darker color changes in the physical chemical bonds that occur, namely absorption (absorption), adhesion of polyphenol particles to the surface and absorption of attachment of polyphenol particles that enter in part through the micro bang, the more micro bang the more absorption so the bond gets stronger[15]. Although the Tuckey HSD test on label 3.3; 3.5; 3.7; 3.9; 3.11 between each black tea brewing concentration and soaking time showed a significant difference (S) and no significant difference (NS), but after re-testing with the Kruskal Wallis One Way Anova test showed a significant difference. This is because the test value generated by the microhardness tester is less homogeneous.

In this study to see the relationship between transversal strength and polyphenol layers by using multiple regression analysis. multiple regression obtained a value of $P < 0.05$ means there is a significant difference between the transverse strength and black tea polyphenol layers attached to the acrylic resin plate. This is probably due to the more concentrated concentration and the longer immersion the more polyphenols in black tea brewing so that the higher the acidic properties in black tea brewing, the thicker the black tea polyphenol layer is inherent and the transverse strength decreases.

Reaction of Black Tea Polyphenols with Acrylic Resin Plates

The acrylic resin plate is a polymer which is an ester compound. This ester

compound is easy to experience hydrolysis. This will be accelerated by the presence of acid and water. Tea contains polyphenolic compounds that are acidic. If the acrylic resin plate is immersed in brewed black tea, it will take a chemical reaction but it is so small as if it does not appear so that the acrylic resin plate (polymethyl-methacrylate) will become methacrylate. The chemical reaction that occurs is very small, this may be due to the polyphenol content in steeping black tea is very small in number and soaking time is very short.

CONCLUSION

The more concentrated the concentration of black tea brewing and the longer the acrylic plate is immersed in the brewing of black tea, the more polyphenols that coat the surface of the acrylic plate so that the color of the acrylic resin plate gets darker.

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Ethical Clearance : Approved

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