Effect of immersion time in sour turmeric drinks on color changing of heat cured acrylic resin plates

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ABSTRACT

Introduction: Heat cured acrylic resin is a material that is often used as a denture base. The most common problem faced by heat cured acrylic resins is discoloration. Heat cured acrylic resin has the property of absorbing water slowly. One of the health drinks with the potential for discoloration in heat cured acrylic resin is sour turmeric drinks, because turmeric (*Curcuma domestica Val.*) in this drink contains yellow curcuminoid. The aim of this research was to analyse the effect of immersion time in packaged sour turmeric drink on the colour change of heat cured acrylic resin plate for 7 days and then re-immersed for another 7 days statistically.**Methods:** Experimental study with control group pre-test and post-test design. The samples were heat cured acrylic resin plates with N number was 32, and divided into two groups, the control group and the treatment group. The control group (16 samples) was immersed in distilled water and the treatment group (16 samples) was immersed in sour turmeric drinks. First, all samples were immersed for 7 days (group 1), dried and performed color changed measurement, then immersed for additional 7 days (group 2), dried, and performed color changes measurement. Data analysis was performed by the Friedman test and Mann Whitney test. **Results:**The results of the Friedman test showed significant color changes in acrylic resin plates in the treatment group, especially on the value of chrome and hue. The results of the Mann Whitney test showed that there were significant differences in the heat cured acrylic resin plate after immersion in distilled water solution and packaged sour turmeric drinks for 7 days (group 1) and 7 days + 7 days (group 2), especially in the chroma and hue values. **Conclusion:**Immersing heat cured acrylic resin plates in sour turmeric drinks has color changes effect, the longer the immersion time, the greater the potential of the color changes.

Keywords: Sour turmeric drink packaging, heat cured acrylic resin, color change.

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INTRODUCTION

The material that is often used as a base for dentures in the Indonesian dentistry today is heat cured acrylic resin. The heat cured acrylic resin has several properties which make it the primary choice of denture base material. However, heat cured acrylic resins also have some disadvantages,

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which are easily formed porosity, abrasion, easy fracture, or broken when falling to the floor, loss of elasticity, and discoloration due to several factors.[1,2] Heat cured acrylic resin is a resin that requires heat energy for polymerization of these materials using water immersion in a water bath and other types of hot acrylic resin using a polymerization process with microwave oven,[3 4] The composition of the heat cured resin is as follows:[3,4,5] (1) Powder: pre-polymerized polymethyl methacrylate (PMMA), benzoyl peroxide (0.2-0.5%) as an initiator, zinc dioxide, or titanium dioxide to prevent the color of denture bases from resembling the color of the surrounding tissue. Mercury sulfide or cadmium sulfide or dyes as pigments. (2).

Liquids or liquids: methyl methacrylate, hydroquinone (0.006%) as inhibitors (prevent fluid polymerization during storage), and glycol dimethacrylate (1-2%) as cross-linking agents.At present, there is a tendency for people to seek alternative treatments that are sourced from natural ingredients (back to nature).

Turmeric is an Indian rhizomatous herbal plant (Curcuma longa) of the ginger family (Zingiberaceae) of well-known medical benefits. The medicinal benefits of turmeric could be attributed to the presence of active principles called curcuminoids. Curcumin, demethoxycurcumin (DMC), and bisdemethoxycurcumin (BDMC) are collectively known as curcuminoids. These yellow colored curcuminoids are isolated from Curcuma longa L. (turmeric) rhizomes [6,]

Turmeric tamarind traditional drinks are one of the traditional medicines that are more favorable by people today. According to Head of National Agency of Drug and Food Control (BPOM) said that traditional medicine is ingredients of herbs, animal, minerals, galenic or mixing of these ingredients that is heredity has been used as medicine and practical conformity with the norm in the community.[7,8]

This statement categorizes turmeric tamarind traditional drink as internal medicine. Back to nature is precise if proclaimed by the government. Basic ingredients of turmeric tamarind traditional drink are turmeric, tamarind, sugar, and salt. There are some add more with young tamarind's leaves, temulawak, kedawung's seed, and lime juice. Types of sugar that are used as sweetener that commons are palm sugar but some use white sugar, even cyclamate (artificial sweetener). The benefits of turmeric tamarind, a traditional drink have proved naturally by our ancestors. Curcumin is active content that found in turmeric. As active substance, curcumin is strong anti-oxidant which protect cells from degradation that caused by free radicals [8]

The aim of this research was to analyse the effect of immersion time in packaged sour turmeric drink on the colour change of heat cured acrylic resin plate for 7 days and then re-immersed for another 7 days statistically, where the color change also increased proportionally with time.

METHODS

Materials

The content of Kunyit Asam® Sidomuncul (Semarang, Indonesia) turmeric acid per sachet corresponds to the dose needed by the body, which is equivalent to 30 grams of fresh turmeric and 10 grams of tamarind acid with the addition of citric acid, sucrose, and salt.[9] Color matching in dentistry usually still uses a shade guide.

Quantitatively, the colors and appearance must be depicted in 3 dimensions, namely: value, chroma, hue. [11]Value or lightness is a color quality that distinguishes between light colors and dark colors. This can be influenced by the distance between the object and the light source. If the light value will be high and if dark the value will be low. Chroma is the color quality that can distinguish as saturation of a color.

The thicker the material, the more intense the color effect will be. The higher the chroma, the color will be sharper. Hue is a color quality that can distinguish between one color with another color such as red, green, yellow, blue and others. Hue variations usually occur due to intrinsic and extrinsic factors and other influences.[10]

Inthis study we used a vita easy shade where the position of the tool tip would show the value of the overall color and then the value of value, chroma and hue. In previous study using 3D shade guide that showed the overall color value. Vita Easy Shade shows more detailed colors than 3D shade guide.

Figure 1. (Vita Easyshade, Easyshade Advance 5, Brand Vita North America, Germany.

The design used was experimental laboratory research with a pretest-posttest with a control group design approach.The study was conducted at the Laboratory Room Faculty of Dentistry Prof. DR. Moestopo University in October 2018. The 32 samples consisted of heat-cured acrylic resin plates with a sample length of 20 mm, a width of 10 mm, and sample thickness of 1 mm (block). Porosity was minimized by the ratio of polymer to monomer as recommended by the manufacturer, and stirring using a vibrator.Sampling by simple random sampling.

The research's work procedure was carried out as follows: 1) Preparing the tools and materials to be used in the study (2) Each sample was cleaned with water and dried with a dry tissue. (3) Perform measurements with the VITA Easyshade test on each sample (pre-test).(4)

The turmeric acid solution is prepared according to the manufacturer's instructions (Sido Muncul). The powder was dissolved into 300 mL of boiling water (temperature of 100ºC was measured with a thermometer), and filtered using a filter. (5) Put 10 ml of Kunyit Asam® Sido Muncul (Semarang, Indonesia) brand turmeric acid drink in a plastic container. (6) Prepare distilled water in a measuring cup as much as 200 ml, then put it in a plastic container. (7)

The samples were divided into two groups, which were the control and treatment group, with 16 samples in each group. The control group was immersed in a plastic container filled with distilled water, while the treatment group was immersed in a plastic container that contained acid turmeric drinks which was already in a 10 ml dose. (8) Both control and treatment group samples were measured using a digital spectrophotometer (Vita Easyshade, Easyshade Advance 5, Brand Vita North America, Germany. (9) Both samples in control and treatment groups were then immersed within 24 hours for 7 days (assumed for 6 year consumption in group 1) and then the samples were rinsed with water, dried with tissue paper and the color changes were recorded using a digital spectrophotometer and named as "after 7 day immersion".

To determine the base shade of a natural tooth, touch the symbol for base shade determination in the main menu. Trigger the measurement by pressing the measurement button and place the measuring tip flush in the central area. To obtain detail information on the measured Vita easy shade, touch the shade specification on the display like L for value, C for chrome, and H for hue. (9)

The second immersion was then performed for additional 7 days (assumed for 12 year consumption in grop 2) and then the samples were rinsed, dried with tissue paper and the color changes were recorded using a digital spectrophotometer and named as "after additional 7 day immersion". (10) Compared color changes in control group and treatment group and performed data processing, presentation and analysis.

Figure 2. From left to right, the acrylic resin plate in treatment group : treatment, group 1 and group 2

RESULTS

Table 1. The mean shows the plate color values on the described acrylic resin, namely heat cured in the control group (control, group 1, group 2)

Table 1. Average color values of heat cured acrylic resin plates in control group (control, group 1, group 2)

Immersion	Sample number	Before immersion			Group 1 immersion			Group 2 immersion		
Control Group	16	Value	Chroma	Hue	Value	Chroma	Hue	Value	Chroma	Hue
		-19.18	7.78	-39.98	-18.98	7.49	-41.04	-18.81	6.96	-39.42

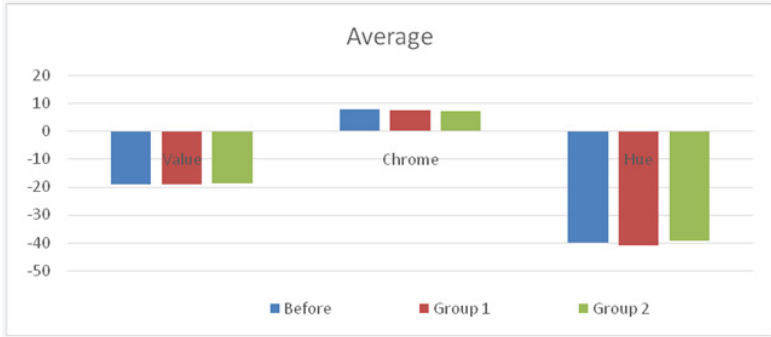

Figure 3. Graph of change in color average value of heat cured acrylic resin plate immersed in control group, group 1 and group 2

Table 2. Test for normality control of control group using Shapiro Wilk

Variables of all groups	p-value of shapiro wilk
Value control group	0.005
Chroma control group	0.016
Hue control group	0.0.15
Value group 1	0.013
Chroma group 1	0.022
Hue group 1	0.011
Value group 2	0.038
Chroma group 2	0.024
Hue group 2	0.008

Table 3. Friedman test comparison of controls group, group 1 and group 2

	Asymp.Sig.
Value control group, group 1 and group 2	0.717
Chroma control group, group 1 and group 2	0.114
Hue control group, group 1 and group 2	0.065

Friedman test results on the value control group, group 1 and group 2 showed a value of P = 0.717 (P> 0.05). This shows that "There was no significant color change in the value of the heat cured acrylic resin plate that was immersed in control group before, group 1 and group 2". Friedman test results on the value of Chroma control group, group 1 and group 2 showed a value of P = 0.114 (P> 0.05). This shows that "There was no significant color change in the value of the chrome plate of heat cured acrylic resin which was immersed in control group, group 1 and group 2".

Friedman test results on hue values control group, group 1 and group 2 showed a value of P = 0.065 (P> 0.05). This shows that "There was no significant color change in the hue value of the heat cured acrylic resin plate soaked in control group, group 1 and group 2". Table 4 and Figure 5 show that there was a change in color treatment group, group 1 and group 2 on a heat cured acrylic resin plate. In the mean value, value increases, the chrome value increases, and hue value increases.

Table 4. Average color values of heat cured acrylic resin plates before, group 1 and group 2 immersion of treatment group

Solution	Sample N number	Before immersion			Group 1			Group 2		
		Value	Chroma	Hue	Value	Chroma	Hue	Value	Chroma	Hue
Treatment group	16	-18.60	-7.82	-39.73	-18.85	10.00	-33.40	-18.25	11.10	-32.05

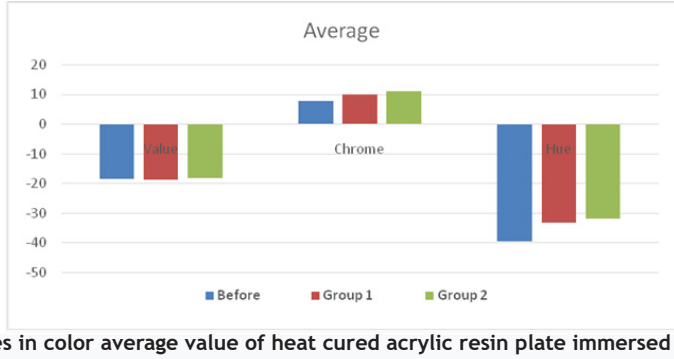

Figure 5. Graph of changes in color average value of heat cured acrylic resin plate immersed in turmeric tamarind drinks before, Group 1 and Group 2

Table 5. Normality test for the treatment of turmeric tamarind packaging using Shapiro-Wilk

	Shapiro-Wilk
	P-Value
Value before immersion	0.010
Chroma before immerssion	0.009
Hue before immersion	0.030
Value group 1	0.007
Chromagroup 1	0.017
Hue group 1	0.037
Value group 2	0.011
Chroma group 2	0.016
Hue group 2	0.003

Table 5 shows that the results of normality test data using Saphiro Wilk value values, chrome, hue treatment group, group 1 and group 2 are not normally distributed (p <0.05). Therefore Friedman test will be used to compare treatment group, group 1 and group 2.

Table 6. Friedman test comparison of soaking turmeric tamarind beverage packaging before, group 1 and group 2 immersion

	Asymp.Sig.
Value before, group 1 and group 2 immersion	0.368
Chromabefore, group 1 and group 2 immersion	0.000
Hue before, group 1 and group 2 immersion	0.000

Table 7. Mann-Whitney test differences in soaking control with soaking turmeric tamarind beverage packaging in the previous time

	Sig.(2-tailed)
Value before immersed	0.308
Chromabefore immersed	0.439
Hue before immersed	0.558

The results of the Friedman test showed a significant color change in acrylic resin plate immersed in treatment group, especially on the value of chrome and hue. Friedman test results on the value treatment group, group 1 and group 2 showed a value of P = 0.368 (P> 0.05). This shows that "There was no significant color change in the value of the heat cured acrylic resin plate after soaked in treatment group, group 1 and group 2".

Friedman test results on the value of chrome treatment group, group 1 and group 2 showed a value of P = 0,000 (P <0.05). This shows that "There was a significant color change in the value of the chrome plate of heat cured acrylic resin which was immersed in treatment group, group 1 and group 2".Friedman test results on hue values treatment group, group 1 and group 2 showed a value of P = 0,000 (P <0.05).

This shows that "There was a significant color change in the hue value of the heat cured acrylic resin plate after soaked in treatment group, group 1 and group 2". After that, the Mann Whitney test was carried out to compare the results between the control and the treatment group, group 1 and group 2.The results of the Mann Whitney test showed that there were significant differences in the heat cured acrylic resin plate after immersion in control group and treatment group, especially in the chrome and hue values. Mann Whitney Test Results on the value of value groeup 2 showed P = 0.345 (P> 0.05).

This shows that "There is no significant difference in the value of the heat cured acrylic resin plate after being soaked with control group and treatment group for groeu 2.Mann Whitney Test Results on chromes group 2 showed a value of P = 0,000 (P <0.05). This shows that "There is a significant difference in the chrome plate of acrylic cured heat acrylic resin after being soaked with control group and treatment group for group 2". Mann Whitney Test Results on hue value group 2 showed a value of P = 0,000 (P <0.05). This shows that "There is a significant difference in the hue plate of heat cured acrylic resin after being soaked with control group and treatment group for group 2".

Table 8. Mann-Whitney test differences in soaking control with soaking turmeric tamarind beverage packaging after 7 days (group 1)

	Sig.(2-tailed)
Value group 1	0.880
Chroma group 1	0.000
Hue group 1	0.000

Table 9. Mann Whitney test differences in soaking control with soaking turmeric tamarind beverage packaging after additional 7 day immersion (group 2)

	Sig.(2-tailed)
Value group 2	0.345
Chroma group 2	0.000
Hue group 2	0.000

Mann Whitney Test Results on the value showing the value of P = 0.880 (P> 0.05). This shows that "There is no significant difference in the value of the heat cured acrylic resin plate after being soaked with control group and treatment group for group 1". Mann Whitney Test Results on the chrome value showing the value of P = 0,000 (P <0.05). This shows that "There was a significant difference in the chrome plate of heat cured acrylic resin after being soaked with control group and treatment group for group 1".Mann Whitney Test Results on hue values showing a value of P = 0,000 (P <0.05). This shows that "There was a significant difference in hue plate heat cured acrylic resin after being soaked with control group and treatment group for group 1".

The results of the Mann Whitney test showed that there were significant differences in the heat cured acrylic resin plate after immersion in control group and treatment group, especially in the chrome and hue values. Mann Whitney Test Results on the value of value groeup 2 showed P = 0.345 (P> 0.05). This shows that "There is no significant difference in the value of the heat cured acrylic resin plate after being soaked with control group and treatment group for groeu 2.

Mann Whitney Test Results on chromes group 2 showed a value of P = 0,000 (P <0.05). This shows that "There is a significant difference in the chrome plate of acrylic cured heat acrylic resin after being soaked with control group and treatment group for group 2".

Mann Whitney Test Results on hue value group 2 showed a value of P = 0,000 (P <0.05). This shows that "There is a significant difference in the hue plate of heat cured acrylic resin after being soaked with control group and treatment group for group 2".

DISCUSSION

This research was conducted to determine the effect of immersion packaged turmeric tamarind drinks on the change in color of the heat cured acrylic resin plates for 7 days and additional 7 day immersion. The study was conducted on 32 samples divided into 2 groups: the control group and the treatment group. The results of this study obtained that average value of value, chroma and hue of control group was no difference but after soaking were significant differences.

The results of this study obtained the average value of value, chrome, hue in the control group each is -19.18, 7.78, -39.98, group 1 each is -18.98, 7.49, -41.04, and group 2 each is -18.81, 6.96, -39.42. The average value of value, chrome, hue in the treatment group were -18.60, -7.82, -39.73, group 1 respectively -18.85, 10.00, -33.40, and group 2 respectively- each is -18.25, 11.10, -32.05.

The results of this study indicate that there were no significant differences in the control group, whereas, in the treatment group, there were significant differences, especially in the value of chrome and hue. Friedman test results showed that immersion in treatment group for group 2 more effect on the heat cured acrylic resin plate's discoloration than group 1. This means that the hypothesis is accepted. The more significant the change in the color of the acrylic resin heat cured polymerization heat, the greater the color change of the acrylic resin.

The color change that occurs in this study is caused by several factors, among others: The first factor is an intrinsic factor, which is a chemical change in the material itself, namely the polymerization process is not perfect resulting in porosity[1,3,16] Acrylic resin material has the property of absorbing water slowly land within a certain period of time by diffusion absorption of water. Excessive water absorption can cause discoloration.[1,11,14,15,16]

The second factor is the extrinsic factor, namely stain due to the absorption of dyes from exogenous sources, which can cause color changes including thermal changes, accumulation of stains, drinking habits (bottled acid turmeric), the concentration and length of exposure to stain ingredients in drinks can affect resin pigmentation.[1] Color changes can occur due to several factors such as dirt, imperfect polymerization and processing during manufacturing or manipulation. Most materials used for resin restoration depend on the process of absorption and adsorption of liquid. Polymethyl methacrylate absorbs water slowly over time.

The change in color of the polymer denture base can be caused by the penetration of a colored solution. There is evidence that beverages such as tea, coffee, herbal medicine and wine significantly increase stain levels in enamels and acrylic resins.[1,5,11] Research conducted by Anjani M et al.[12] states that there is an effect on the duration of immersion of heat cured acrylic resin in denture cleanser on dimensional changes for 7 days.

This means that 7 days of immersion which were chosen to reflect a real world immersion time of 5 minutes daily for 6 years. Roslan H et all[13], were concluded that acrylic denture teeth showed less color changes when immersed in the black coffee solution compared to turmeric solution and that the amount of color change also increased proportionally with time.

This research is supported based on Singh SV. And Aggarwal P et al[14], there were color changes in all brands of heat polymerization acrylic resins in turmeric solution. Gaurav Gupta and Tina Gupta had conducted research on color changes in provisional materials and found turmeric solution to have maximum staining potential, followed by coffee, tea and pepsi. Turmeric solutions will cause discoloration of heat polymerized acrylic resins. This is because turmeric coloring is more polar.[15]

Color changes in the heat cured acrylic resin plate due to turmeric acid beverage packaging can be caused by several factors. The first factor is the intrinsic factor is the chemical change in the material itself, which is the imperfect polymerization process resulting in porosity. [1,6,16] Acrylic resin has the property of absorbing water slowly over a period of time with the mechanism of diffusion water absorption. Excessive water absorption can cause discoloration.[1,11,12]

The second factor is extrinsic factor is stain due to absorption of coloring agents from exogenous sources, which can cause color changes including thermal changes, accumulation of stain,

habit of consuming drinks (turmeric tamarind packaging) concentration and duration of exposure to stain in drinks can affect resin pigmentation. [1] Turmeric acid drink has curcumin content which is an important component giving a distinctive yellow or orange color. Curcumin is a polyphenol group that has potential as an antioxidant in counteracting free radicals. Curcumin in the acidic atmosphere will be yellow, while in an alkaline atmosphere will be red.[16]

The qualitative research data shows that there is a varying color change on each heat cured acrylic resin plate that is immersed with turmeric acid packaging. The variation in color changes that occur in heat cured acrylic resin plates that are soaked with turmeric acid packaging is thought to be related to the porosity properties of each heat cured acrylic resin plate. Porosity in the presence of bubbles on the surface and below the surface can affect physical properties, aesthetics, and cleanliness of denture bases.

The porosity is due to the evaporation of unreacted monomers and low molecular polymers when the resin's temperature reaches or exceeds the boiling point of the material. Porosity also can come from improper stirring between the powder component and the liquid. When this happens, some parts of the mass will contain more monomers than others. During polymerization, this part shrinks more than nearby areas, and localized shrinkage tends to produce bubbles.[17] In this research there were bubbles on the surface. Practical use for health drinks makes it easy for people to get health drinks everywhere.

Patients with heat cured acrylic resin prosthesis who often consume health drinks for long periods, turmeric can be absorbed and left behind in porosity cavities on denture bases which can cause discoloration on the base of the denture used. Clinical results show that excessive water absorption can cause discoloration. Turmeric tamarind drinks contain curcumin which gives a distinctive yellow or orange yellow color.[7]

From the results of this study, it is hoped that the public will be able to find out about the longstanding effects of packaged turmeric acid drinks on the change in color of the heat cured acrylic resin plate, so that denture users will pay more attention to the cleanliness of their dentures and pay more attention to the amount of consumption of packaged turmeric acid drinks. Suggestions for denture users who like to drink tamarind turmeric was not to drink and get used to gargling with tamarind turmeric for a long time.

CONCLUSION

There were changes in the color of the heat cured acrylic resin plates after immersing in turmeric acid drinks for 7 days and additional 7 days. The color change after an additional 7 day immersion is more significant than 7 day immersion. The longer the immersion time, the greater the potential of color change.Things that can be done to progress this research are conducting research with a larger amount of samples and doing a longer immersion time trial to get a more accurate final result.

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