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Research Report

Color stability of visible light cured composite resin after soft drink immersion

Alizatul Khairani Hasan, Siti Sunarintyas, and **Dyah Irnawati**
Department of Dental Biomaterials
Faculty of Dentistry, Gadjah Mada University
Yogyakarta - Indonesia

ABSTRACT

Background: *Composite resin is a tooth-colored filling material containing Bis-GMA which exhibits water sorption properties. People tend to consume soft drink with various colors. Water sorption properties can alter the color stability of composite resin purpose.* ***Purpose:*** *This study was to determine the influence of immersion durations of composite resin in soft drink on color stability.* ***Methods:*** *The visible-light cured hybrid composite resin and soft drink were used. Ten disk specimens (2.5 mm thickness and 15 mm diameter) of composite resin were prepared and light cured for 20 seconds, then stored in distilled water for 24 hours at 37° C. The initial color of specimens were measured by Chromameter. After that, each specimen was immersed in 30 ml of soft drink up to 48, 72, and 96 hours at 37° C. The specimens' color were measured again after each immersion. The color changes were calculated by CIE L*a*b* system formula. The data was analyzed by One-Way ANOVA and LSD ($\alpha = 0.05$).* ***Result:*** *The ANOVA showed that the immersion durations of composite resin in soft drinks had significant influence on the color stability ($p < 0.05$). The $LSD_{0.05}$ tests showed significant differences among all groups. The least color change was detected from the group of 48 hours immersion, while the greatest color change was from the group of 96 hours immersion.* ***Conclusions:*** *The immersion of composite resin in soft drinks influenced the color stability (began after 48 hours immersion).*

Key words: *composite resin, soft drink, immersion durations, color stability*

Correspondence: Siti Sunarintyas, c/o: Bagian Biomaterial Kedokteran Gigi, Fakultas Kedokteran Gigi Universitas Gadjah Mada. Jl. Denta, Sekip Utara, Yogyakarta 55281, Indonesia. E-mail: sunarintyassiti@yahoo.com, Phone/fax No. 062-274-515307.

INTRODUCTION

Dental caries is a disease of the calcified tissues of the teeth caused by the action of microorganisms on fermentable carbohydrates. It is characterized by disintegration of organic materials of the teeth. Dental caries occur in the presence of four factors; dental plaque, carbohydrate, susceptible tooth surface, and time.[1] Tooth decay is generally repaired by removing the carious tissue and replacing it with an appropriate restoration.[2]

A study revealed that there appears to be a fairly enthusiastic adoption of tooth-colored restorative materials, influenced by clinical indications and patient's demands.[3] It showed that tooth-colored restorative materials such as composite resins are much more preferred compared to amalgams. In the era of esthetic composite restorations, the demand for overall good color stability is increasing. Most anterior restorations are replaced because of unacceptable color match.[4] The color stability of dental composites is due to exogenous and endogenous reasons. Exogenous influences are staining food or even mouthrinses. The examples of staining food are coffee and red wine.[5] Tea and soft drinks are also classified as strong staining agents. Endogenous or instrinsic color change of a visible-light activated composite may caused by the decomposition of the camphorquinone.[6]

A high water sorption value for a composite resin may indicate that the material has a high soluble fraction.[7] It has been shown that materials exhibiting high water sorption values are more easily stained by hydrophilic colorings in aqueous solutions. The water presumably acts as a penetration vehicle.[8]

Modern lifestyles have changed the behavior of people all around the world to be more practical. People with time constraints would be more inclined to choose food requiring little manipulation before consumption. For example, most

North Americans under 25 years of age readily accept convenience food and beverages. This is because they became familiar with the food early in their lives and are knowledgeable about the time-saving qualities.[9]

One of the most popular convenience food and beverages available for consumption is soft drink. Soft drink is a flavored, nonalcoholic beverage prepared with carbonated water.[10] Although soft drink is water based, much of the taste and appeal comes from the addition of significant amounts of sugar, sugar substitutes and other chemicals that are harmful to health.[11] The flavor of soft drink sometimes comes from a mixture of vanilla, cinnamon and citrus flavorings. Soft drink may be sweetened with sugar, corn syrup or an artificial sweetener.[12] Most soft drinks also contain coloring.[10]

People learn to associate certain colors with certain flavors, and this causes the color of food to influence the perceived flavor. For this reason, food manufacturers add dyes or colorings to their products.[13] Wide selections of soft drinks with different colors such as orange, blue, red, yellow, and dark brown to black are available in the market. Cola, an example of soft drink, contains Caramel Color IV. Caramel Color IV is also known as sulfite-ammonia, soft drinks caramel or acid proof caramel. Caramel colors are dark brown to black liquids or solids having an odor of burnt sugar and pleasant, somewhat bitter taste. Caramel colors are prepared by controlled heat treatment of carbohydrates.[14]

In clinical studies, a change in color was observed in anterior composite restorations over a 3-year period.[15] Most of water sorption takes place during the first week. Specimen discolorations tend to follow the evolution of water sorption.[8] The hydrophilic characteristic of composite resin may affect the color stability of the restoration after the consumption of soft drinks which contain food colorings in certain times. This condition can be very displeasing especially when the anterior restoration is involved. The present study was aimed to determine the influence of immersion durations of composite resins in soft drink on the color stability.

MATERIALS AND METHODS

Ten disk specimens were prepared using two glass slides and a fiberglass mold with an internal thickness of 2.5 mm and a diameter of 15 mm (to fit diameter of chromameter tip). One glass slide was placed on a glass plate and the fiberglass mold was placed on the top of the glass slide. Visible-light-cured hybrid composite resin (Solare A2, GC Corporation, Japan) was put into the mold by a plastic spatula. The mold was then covered by glass slide and glass plate. The glass plate was removed and the specimen was cured by visible-light-curing unit (Litex 600 Dentamerica, USA) for 20 seconds on the top surface of the specimen. After that, the specimen was removed from the mold. All specimens were stored in distilled water for 24 hours at 37° C.

The initial colors of specimens in Commision Internationale del'Eclairage system (CIE L*a*b*) were measured by chromameter (CR-200 b Minolta Co. Ltd., Japan). The chromameter was calibrated to a standard white plate. After that, the specimens were put on a table that was covered by a piece of paper and the measuring tip was placed flat against the surface of the specimens. After the ready lamp had lit, the measuring button on the meter body was pressed and the measured value appeared in the display.

Ten plastic jars were filled with 30 mL of Coca-cola soft drink (PT Coca-Cola Bottling, Indonesia). The specimens were immersed in the coca cola soft drink up to 48 hours (group A), 72 hours (group B), and 96 hours (group C). Immersion duration of 48, 72, and 96 hours are equivalent to soft drink consumption in 2, 3, and 4 years. The soft drink used for immersions were replaced every 24 hours. The jars were put into the incubator (MIR 162 Sanyo, Japan) at the 37° C temperature. After each immersion, the specimens' colors were measured again.

The effect of the immersion durations on the color stability of composite resins were detected by calculating the color changes (the differences between initial and after immersion measurements) using the formula:[16]

$$\delta E^* (L^*a^*b^*) = [(\delta L^*)^2 + (\delta a^*)^2 + (\delta b^*)^2]^{1/2}$$

Notes:
E* = color change
L* = Brightness
a* = amount of red (positive values) and green (negative value)
b* = amount of yellow positive value) and blue (negative value)

The data was analyzed by one-way Anova and Least Significant Difference Tests ($\alpha = 0.05$).

RESULT

The means and standard deviations of color changes (δE*) of the composite resins after immersion in soft drink are presented in Table 1. The results showed trend of color changes increasing by the immersion duration. Test of Normality (Kolmogorov-Smirnov Test) showed that the probability is greater than 0.05. Test of Homogeneity of Variances showed that the probability is also greater than 0.05. The result of One-Way ANOVA showed that the immersion durations of composite resin in soft drinks significantly influenced the color stability ($p < 0.05$). The LSD tests showed significant differences between the means of all groups (Table 2).

Composite resin consists of organic polymer matrix, inorganic filler particles, coupling agent, and the initiator-accelerator system.[16] Most filled resin systems use bis-GMA as the organic polymer matrix. Bis-GMA showed high water sorption value because of the diluents added to reduce the viscosity of the paste.[17] The study to compare

Table 1. Means and standard deviations of color changes of the composite resins after immersion in soft drinks (ðE*)

Immersion durations (hours)	Means ± standard deviations
48	1.0607 ± 0.3098
72	1.8433 ± 0.3784
96	4.9793 ± 0.7526

Table 2. Statistical results of LSD tests from the color changes (ðE*) of composite resins after immersion in soft drink

Group	Mean Difference		
	A (48 hours)	B (72 hours)	C (96 hours)
A (48 hours)	-	-	-
B (72 hours)	0.7827*	-	-
C (96 hours)	3.9187*	3.1360*	-

* The mean difference is significant at the 0.05 level discussions

water sorption and solubility of hybrid and microfilled composite resin proved that microfilled composite resin exhibits higher water sorption than hybrid composite resin, because the microfilled composite has greater matrix content than hybrid composite.[18] However, the hybrid composites are the ones widely used for anterior restorations because of its smooth surface and good strength.[17] This is why the hybrid composite resin was used in the present study instead of microfilled composite resin.

Results of this study showed that the color of composite specimens tend to become darker after each immersion in soft drink. Soft drink used in this experiment contains dark brown caramel coloring. The results were consistent with previous study where Food Red 3 Solution was used as one of the staining agent. In the study, the colors of composite specimens become darker after each immersion in staining agent for 10, 20, and 30 days.[19] Water soluble food coloring agent can be absorbed by hydrophilic basic resin. The water will act as a penetration vehicle.[8] The interfaces between the filler particles and the matrix of composite will accommodate the water.[18] If the composite can absorb water, then it can also absorb other fluids.[7] This means, the composite resin is able to absorb caramel coloring from the soft drink and leads to the color change of the material.

Composite resin will become darker over time. One of the explanations of this phenomenon is because the surface staining caused by food coloring.[20] In clinical studies, a change in color was observed in anterior composite restorations over a 3-year period.[15] In the previous study, the immersion durations of 48 hours, 72 hours, and 96 hours represented soft drink consumption for 2 years, 3 years, and 4 years respectively. The results of this study showed that the ðE* of the composite specimens were higher as the immersion duration were increased.

Color differences of esthetic restorations presenting a higher color change than 1 are considered as acceptable up to color change of 3.3.[8] In the research of this study, color change of hybrid composite resin for both 48 hours and 72 hours immersion were clinically acceptable. Meanwhile, the color change after 96 hours immersion was clinically unacceptable. This means, soft drink consumptions for 4 years will results in clinically unacceptable color change of hybrid composite resin. However, the color change was already statistically detected from the 48 hours immersion. This means, the color stability of the hybrid composite resin will already be influenced after 2 years consumption of soft drink. According to the results of the research, it can be concluded that the immersion duration of composite resin in soft drink influenced the color stability (began after 48 hours immersion).

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