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EFFECT OF HIBISCUS AND CINNAMON HERBS ON THE COLOR STABILITY OF ESTHETIC RESTORATIVE MATERIALS

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ABSTRACT

This study aimed to evaluate the effect of hibiscus and cinnamon herbs on the color stability of three esthetic restorative materials. Sixty-six standardized cylindrical specimens were fabricated from three different restorative materials (n=23); resin-modified glass ionomer RMGI (Fuji LC, GC Corporation), microhybrid (Amaris, Voco), and nanohybrid resin-based composites RBC (IPS Empress Direct, Ivoclar Vivadent). The colors of specimens were measured using the CIE L*a*b* system by a reflection spectrophotometer. After baseline measurements, 11 specimens of each material were stored in one of the two beverages for 30 days; afterward, new color measurements were carried out. A few random specimens were evaluated for surface topography using a scanning electron microscope (SEM). The data were analyzed using the two-way analysis of variance (ANOVA) followed by the Tukey test. There were significant differences in the (ΔE) between the two beverages ($P < 0.05$). The (Δ E) was significantly higher for hibiscus than for cinnamon. In addition, the ΔE for RMGI was significantly higher than that for all other materials. The color stability of RMGI and RBCs depends mainly on material composition and beverage type. The composition of hibiscus has a greater deteriorating effect on restorative materials than cinnamon in terms of color change.

KEY WORDS: Color, Dental restorations, Herbs, Surface properties.

INTRODUCTION

Tooth-colored restorative materials such as RMGIs and RBCs are among the materials that frequently applied in dental practice for esthetic restorations, so a great innovation had occurred to improve not only their mechanical and physical properties but also their esthetic properties. Esthetic failure is one of the main resons for the replacement of restorations. The oral cavity is as a dynamic environment that is characterized by the presence of microflora, saliva, and continuous intake of colored food (chromagens), all of which affect the restoration of color stability and its

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surface properties. However, the esthetic quality of restorations has been enhanced with the evolution of material science in recent years, with color changes and surface deterioration of restorative materials remaining the most common clinical problems in the long term.[1]

Herbs are staging a rebound, and a herbal renaissance is occurring everywhere on the globe. Herbal medicines are widely used as they are considered as safe natural ingredients, unlike the synthetics that have many side effects that are deleterious to the environment and humans. In dentistry, herbal extracts are used successfully as toothpaste, anti-cariogenic agents, and anti-microbial plaque agents.[2] Hibiscus (Hibiscus sabdariffa) has a long history of utilization in Africa and neighboring tropical nations for a lot of reasons, including cancer, hypertension, fever, liver diseases, and constipation. Dried or fresh calyces of Hibiscus sabdariffa are utilized in the production of herbal drinks, cold and hot beverages, wine, fermented drinks, jam, ice cream, jellied confectionaries, chocolates, cakes, puddings, and flavoring agents. Recent studies have reported that Hibiscus sabdariffa contains a wide range of bioactive constituents and possesses a wide range of pharmacological effects.[2]

Cinnamon has been utilized and consumed for millennia. Nowadays, cinnamon is one of the most common spices, that is widely utilized in dessert, cereal, and pastries, and is progressively used as a seasoning segment in primary courses and side dishes. Moreover, it has been used for medical purposes thanks to its many health benefits. Previous studies suggest a potential role of cinnamon as an antioxidant, anti-diabetic, anti-inflammatory, and anti-microbial effect. It has even been associated with a reduced risk of heart diseases, Alzheimer's disease and cancer. Besides, it has demonstrated a significant role in dental health (as a result of calcium content) and has analgesic, anti-microbial, and anti-inflammatory effects.[3]

Currently, hibiscus and cinnamon can be suggested and should be considered as a piece of our daily diet as their liberal use is safe, and several health advantages can be obtained from these natural herbs. Many studies have already been conducted on esthetic restorations and discoloration in color-induced environments (tea, coffee, soda, juices, and wine),[4] however, there is a little information in the literature about the effect of herbs on the color stability of esthetic restorative materials. Therefore, this in vitro study aimed to evaluate and compare the color stability of different esthetic restorations (RMGI, a micro-hybrid RBC, and a nano-hybrid RBC) after exposure to two herbal drinks (Hibiscus and Cinnamon).

MATERIALS AND METHODS

The tested materials in the current study are RMGI (Fuji II LC), microhybrid RBC (Amaris), and nano-hybrid RBC (IPS Empress Direct). The full descriptions of these materials are presented in Table 1.

Standardized sixty-six disc shaped specimens were constructed from the three illustrated restorative materials (n = 23). Group 1: RMGIC (Fuji II LC, GC Corporation, Japan), Group 2: micro-hybrid resin composite (Amaris, Voco, Germany) group 3: nano-hybrid resin composite IPS Empress Direct (ED; Ivoclar Vivadent, Zurich, Swizerland). A cylindrical plastic mold (diameter: 10 mm; depth: 2 mm) was used to construct the standard disc shape specimens. The mold was placed over a glass slab with a thickness of 2 mm, covered with 0.05 mm of transparent polyethylene film.[6] The mold space was filled with each test material in a bulk-pack technique, avoiding gross excess and entrapping of air. After inserting the restorative material, another transparent polyethylene film and glass slab were pressed against the material to remove the excess material. The applied materials of the three tested

TABLE 1

Restorative Material	Manufacturer	Classification	Composition	Batch No.
Fuji II LC	GC corporation, Tokyo, Japan	RMGIC	Powder: 100% alumino-silicate glass. -Liquid: 20%-30% distilled water, 20%-30% polyacrylic acid, 35% HEMA,10% UDMA, ,1% camphorquinone. Particle size: <5.9 μm	1603071
Amaris	Voco Cuxhaven, Germany	Micro-hybrid resin composite	Resin: (Bis-GMA, UDMA, TEGDMA) Filler (80% by weight) Inorganic fillers in a methacrylate matrix Particle size: 0.7μm	1109084
IPS Empress Direct	Ivoclar Vivadent Schaan, Liechtenstein	Nano-hybrid resin composite	Resin: (Bis-GMA, UDMA) Filler(81.2 wt%) Barium, alumina, fluorosilicate glass, barium glass filler, mixed oxide and ytterbium trifluoride Particle size: 0.55 μm	R67351

groups were light-cured from each side with a light-emitting diode (LED, Bluephase, Ivoclar Vivadent) according to the manufacturer's instructions. A radiometer (Bluephase Meter, Ivoclar Vivadent) was used to measure and monitor the intensity of the light-curing at 800 mW/cm^2.

After polymerization, the specimens were removed from the mold and hand-polished using wet silicon carbide (Sic) abrasive paper 600-grit for 10 seconds to decrease granulation. Then, they were stored in dark containers with deionized water at 37ºC± 1ºC for 24 hours. After that, the excess deionized water was removed from the surface of each specimen using absorbent paper.

Color Measurement Procedure

The specimens were tested for baseline color (zero value) using the UV-3101PC spectrophotometer. Prior to the estimations, the spectrophotometer was calibrated following the manufacturer's instructions. Thereafter, three readings at each specimen center were detected on a white background, and the mean value of the three readings was measured. The alterations of color were revealed with the color system known as Commission Internationale d'Eclairge L*a*b* (CIE L*a*b*), which is a color system with three-dimensional color measurements, where L* refers to the coordinate of lightness, and a* and b* are the chromaticity coordinates, with a: being the red-green axis, and b: being the yellow-blue axis.[4]

Each group was then divided into two subgroups of 11 specimens; one subgroup was immersed in hibiscus tea and the other in cinnamon. For preparation of hibiscus tea, one tea bag of hibiscus (Lipton Hibiscus Herbal Infusion, Egypt) was added to 150 ml of distilled water and boiled for one minute. For cinnamon, 4.5 gm of the cinnamon extract were dissolved in 150 mL of distilled water and boiled for one minute. To mimic a person's daily consumption, each of specimens was individually immersed for 15 min respectively on the same day. A digital pH-meter (CONSORT nv, Parklaan 36, B2300 Turnhout, Belgium) was used to measure the pH of the fresh immersion liquids. After storage in each herb, specimens were rinsed gently using distilled water. Thereafter in an incubator at 37°C (BTC, Model: BT1020, Egypt), specimens were stored in artificial saliva to mimick the oral conditions till the following day's immersion point in the subsequent herbs. This step was repeated for 30 days, with the daily renewal of each beverage. Through the storage period, the flasks were wrapped to restrain solutions from evaporation.[5]

Scanning Electron Microscope Evaluation

A few random specimens for each group were dehydrated, fixed on aluminum stubs. After that, they were coated with a gold sputter. SEM (LEO VP 435 [Carl-Zeiss NTS Gmbh, Oberochen, Germany]) was then utilized to determine the differences in surface texture in each group at 1000 x magnification. [6]

RESULTS

Statistical analysis was carried out by multifactorial ANOVA followed by the Tukey Post-hoc test (*P≤0.05*) to estimate the differences in ΔE, ΔL, Δa, and Δb immediately and after storage in staining solutions. The data analysis was done using SPSS for Windows (version 11.0.0, SPSS Inc., Chicago, IL, USA).

There was a statistically significant difference in ΔE between the tested materials (P<0.001); however, RMGI has yielded a significantly higher ΔE than the micro-hybrid and nano-hybrid RBC (P<0.001). The nanohybrid RBC showed the least color change. The mean values of ΔE of the two beverages for each tested material are shown in Table 2. For each tested material, two beverages resulted in significant color changes (P<0.05). The hibiscus solution for each material showed the higher color change (Figure 1).

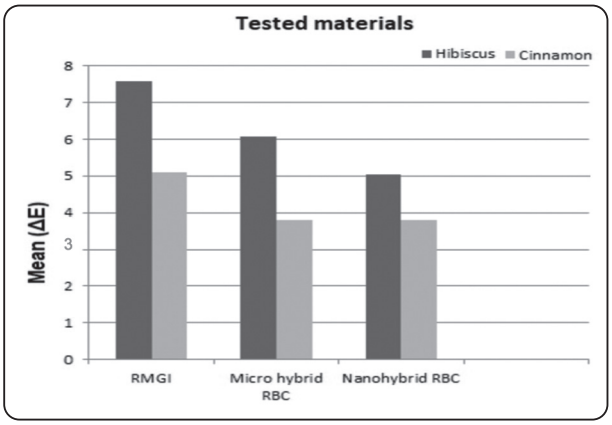

Fig. (1) Mean color change in the three restorative materials

The SEM images of the three restorative materials showed smooth surfaces after finishing and polishing procedures and before storage in different media. However, after storage in the different media, changes had occurred between the three restorations depending on the structural

TABLE (2): Comparison between the mean (ΔE) color change values among different restorations and drinks.

	RMGI	Microhybrid RBC	Nanohybrid RBC	P2	P3	P4	P5
	Mean±SD	Mean±SD	Mean±SD				
Hibiscus	7.56±0.29	6.07±0.23	5.05±0.19	<0.001*	<0.001*	<0.001*	<0.001*
Cinnamon	5.11±0.16	3.81±0.18	3.81±0.08	<0.001*	<0.001*	<0.001*	<0.001*
P1	<0.001*	<0.001*	<0.001*				

SD: Standard deviation P: Probability *: High significance <0.001

P1: For comparison between Hibiscus and Cinnamon (Test used: unpaired Student's t-test)

P2: Comparison between groups (test used: one way ANOVA followed by post-hoc tukey)

P3: Significance between Nano-hybrid RBC and Micro-hybrid RBC groups

P4: Significance between Micro-hybrid RBC & RMGI groups

P5: Significance between Nano-hybrid RBC & RMGI groups

differences between them as shown in Figure 2. RMGI showed the roughest surface, unlike nano-filled RBC that showed the least changes in surface roughness. Hibiscus had a significant effect on surface roughness, especially with RMGI. This appeared as a large pitted area and cracks along the surface, which is less significant within the micro-hybrid and nano-filled RBC. In contrast, cinnamon had a lower effect on the surface topography of the three restorative materials used. It appeared as small pittings and minute cracks in RMGI. However, in micro-filled and nano-filled RBCs, the pittings are smaller and further away from each other compared to hibiscus.

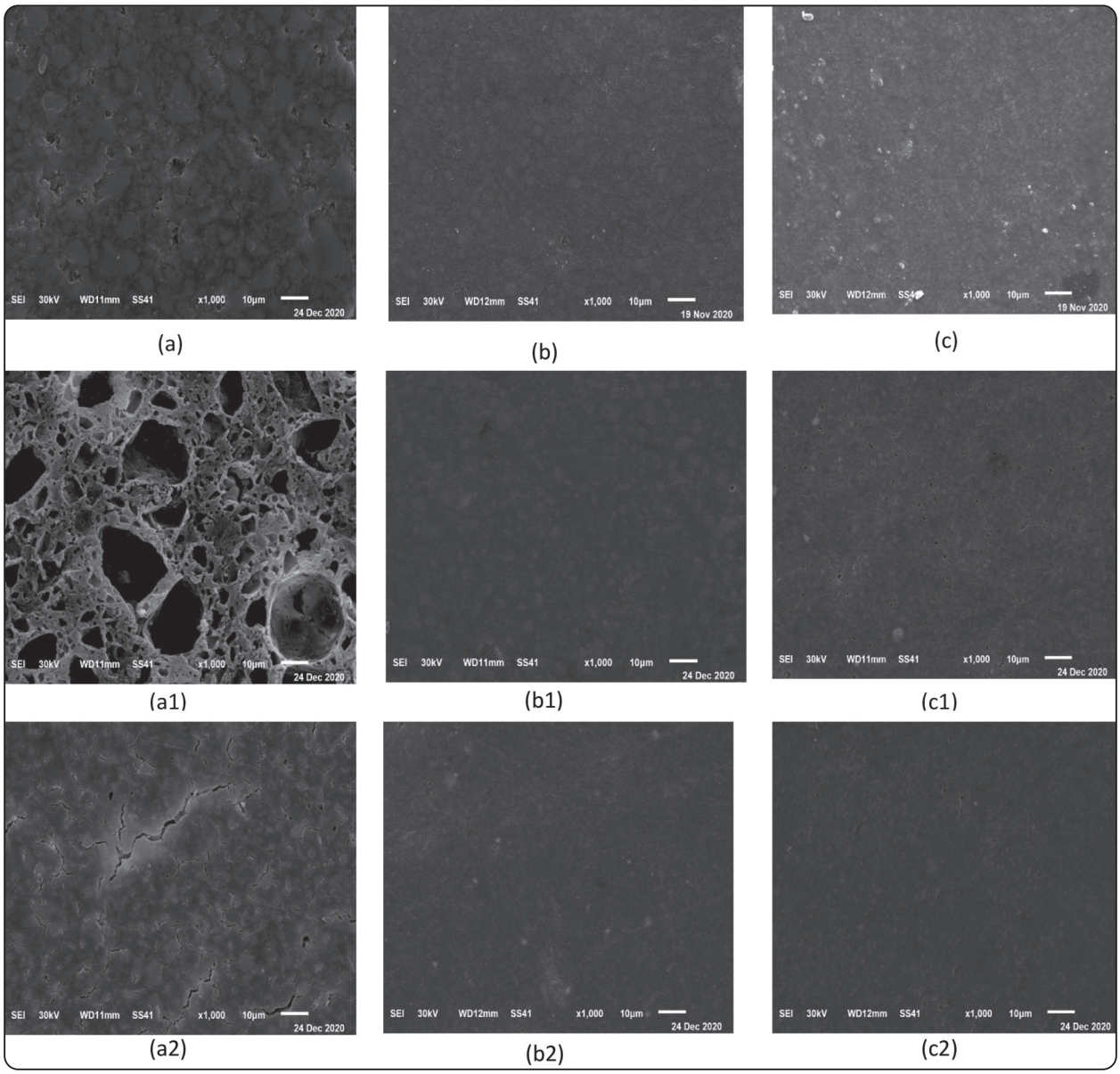

Fig. (2) SEM at magnification 1000x that show surface topography before and after staining. (a) RMGI, (b) micro-hybrid RBC, (c) Nano-hybrid RBC. (a1) RMGI after storage in hibiscus, (b1) micro-hybrid RBC after storage in hibiscus, (c1) micro-hybrid RBC after storage in hibiscus, (a2) RMGI after storage in cinnamon, (b2) micro-hybrid RBC after storage in cinnamon, (c2) Nano-hybrid RBC after storage in cinnamon.

DISCUSSION

Restorations for anterior teeth are particularly challenging as they have to fulfill esthetic, functional, form, and phonetic requirements. They also need to mimic the remaining tooth structure not only immediately but also over a long period. RMGIs are one of the modifications of Glass Ionomer restoratives (GIs) to combine the advantages of chemical bonding, caries inhibiting, and fluoride release GI potentials with the esthetic properties of RBC to be used as anterior restoration.[7] Moreover, technological progress in the development of RBCs has shown improvements in the esthetic, mechanical, and physical properties of these materials. Changes in RBC, especially in the size, type, and distribution of filler particles, happen to be able to face the oral environment as the shapes and sizes of fillers influence the surface morphology of resin composites and the stain susceptibility. Filler particle technology is considered as an influencing factor in the optical properties and wear resistance of RBC restorations. By decreasing the sizes of filler particles, improvements in surface smoothness and gloss are expected.[8]

Herbal medicine has been considered by all cultures throughout history. Several popular conventional drugs on the market are derived from herbs. The two beverages used in the study were selected because they are widely used in daily life thanks to their excellent taste and medical value. Although herbs may be useful treatment alternatives for oral health problems, it is clear that we need more research about their discoloring effect on tooth structure and restorations.[9]

RMGI demonstrated the highest color alternation ($\Delta E>3.3$). This may be because of the sorption of water by the resinous components in RMGI, as the presence of hydrophilic monomers, physical adsorption or physiochemical reactions in RMGI, incomplete polymerization, chemical degradation, or wear can raise the material susceptibility to extrinsic staining.[10] Moreover, the surface roughness of RMGI is high due to the large particle size when compared to the surface roughness of the other two types of RBC. The surface texture of a tooth-colored restoration affects the color stability of the restoration.[11]

In addition, micro-hybrid RBC has a significant discoloration that exceeds that of nano-hybrid RBC. These findings may be due to the organic matrix composition (Bis GMA, UDMA, TEGDMA), as the addition of TEGDMA in a small amount to a Bis-GMA-based resin matrix may enhance the water absorption of the composite material.[12] Likewise, TEGDMA has a repeating central ethoxy group that has high cognation with water molecules via the hydrogen bond with oxygen, resulting in increased composite material surface hydrophilicity and water sorption that produces a weaker bond between the filler particles and resin matrix and the consequent interfacial gaps or micro-cracks induced between the filler and matrix, which enables the penetration of stains and discoloration of RBC restorations.[13]

Furthermore, the least alteration in color was revealed in nanohybrid RBC. This is probably because its resin matrix structure is more hydrophobic (Bis GMA, UDMA) than that of other materials. Moreover, it has a smaller filler particle size (0.55 μm) and a higher filler weight (81,2%) as it is based on nanotechnology to support more incredible surface smoothness, color stability,y and long-term polishing durability.[14]

Our findings are in line with the results of the studies by Sulaiman TA et al.[15] and Rao YM et al.,[16] who reported that after artificial accelerated aging, the greatest change in color occurred in the RMGI followed by micro-filled resin composites and the lowest color change occurred for nano-hybrid resin composites. Also, Hashemikamangar SS et al.[17] explained that RMGI cement color can be affected by aging procedures as a result of water sorption.

The two beverages resulted in significant color changes, and the hibiscus solution showed a higher color change than that of cinnamon. The anthocyanin natural pigment and cyandin diglucoside in hibiscus may yield to the dark-purplish dye,[18] while the cinnamon color resulted from tannis, cinnamon contains a large amount of tannins (around 10%), which can cause a darker discoloration.[19] In addition, cinnamon extract solutions with a pH 5.38 can affect the restoration surface, leading to increased deposits of tannins from the cinnamon extract solution. There is no evidence of the difference between the effect of hibiscus and cinnamon on the color stability of restorative materials in the literature. These results may be due to the lower pH (2.75) of the hibiscus solution compared to that of the cinnamon solution (5.38), which may deteriorate the surfaces of the restorations, leading to more discoloration. Consequently, this layer becomes more porous, liable to water sorption, and, therefore, more susceptible to surface staining. [20] Therefore, further studies are needed to explore the relationship between color changes of dental restorations exposed to various herbs and the impact of other agents of daily diet and oral hygiene that can also affect the action of these herbs.

CONCLUSION

Within the limitations of this study, it can be concluded that:

1. All the three tested restorative materials displayed color change but in variable degrees after immersion in two different beverages.
2. The resin-modified glass ionomer showed the highest color change, followed by the micro-hybrid, and the least color change was demonstrated by the nano-filled composite.
3. Hibiscus displayed more color changes on restorative materials than cinnamon.

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