

Effect of Coloring Beverages on Esthetic Restoration in Primary Teeth

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Abstract:

Purpose: *In-vitro* study to assess the effect of children's coloring beverages on resin modified glass ionomer and compomer in relation to microleakage, color stability, microhardness.

Materials and Methods: Microleakage was evaluated in eighty extracted primary molars, standard class V cavities were prepared on buccal surfaces of the teeth. They were randomly divided into two equal groups (n=40) according to tested materials. For color and microhardness assessment 160 disks were prepared using teflon mold, each disk was 5mm diameter and 2mm thickness. Disks divided into two groups each (n=80) according to type of restoration used.

Each group was divided into four subgroups regarding beverages used to: Water (subgroup A), Orange (subgroup B), Pepsi (subgroup C), Chocolate milk (subgroup D). Samples were immersed in beverages for 3 hours per day and the rest of the day in distilled water for 7 days. Microleakage test was assessed by dye penetration technique and observed under a stereomicroscope. For color value each specimen was measured using a portable Reflective spectrophotometer. Microhardness measurements was determined using Vickers Microhardness Tester.

Results: Two groups demonstrated interfacial microleakage, susceptibility to discoloration and decrease in microhardness at the same time in all beverages. microleakage and color change was greater in resin modified glass ionomer than compomer there was no statistically significant difference ($P > 0.05$) between the two groups regarding microleakage except in water subgroup ($P \leq 0.05$) and statistical significant difference ($P \leq 0.05$) between the two groups regarding color change. Furthermore, microhardness values in compomer was higher rather than resin modified glass ionomer with significant difference ($P \leq 0.05$). Regarding beverages used, Pepsi subgroup showed the higher microleakage value, greater color change and least microhardness value in comparing with other subgroups: orange juice, Chocolate milk and distilled water.

Conclusion: Coloring beverages particularly pepsicola adversely affect microleakage, color change, microhardness of esthetic restorative materials used in this study. otherwise, compomer is less affected than resin modified glass ionomer.

Key Word: compomer, resin modified glass ionomer, microleakage, color stability, microhardness.

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I. Introduction

Primary teeth are extremely important in early physical, emotional, and social development of the child, improving esthetics and function, maintaining arch space integrity. Today, improvements in the physical properties of tooth-colored filling materials afford a diversity of esthetic restorative materials obtainable to restore primary teeth which offer using more esthetic and durable resin-based restorations, requiring save teeth integrity, these restorative materials include glass ionomer cements, resin-modified glass ionomer cements, polyacid-modified resin composites (compomers) and composite resins⁽¹⁾. Consuming of acidic food and beverages excessively or extraordinary for long time have proven to increase the acid challenge to teeth due to low pH and high titrable acidity⁽²⁾. Otherwise the longevity of dental restoration depends on the durability of the material and its properties such as wear resistance, integrity of the tooth restoration interface, microhardness, color stability and surface roughness⁽³⁾.

Microleakage around dental restorative materials is a major dilemma in clinical dentistry. Increase concern about Insufficient sealing between tooth and restoration due to reported post-operative sensitivity, tooth discoloration, recurrent caries, subsequent pulpal injury and accelerated deterioration of restorative materials⁽⁴⁾.

Color change have been considered as the major problems after using dental restorative materials for long duration due to the intrinsic factors which involve changes within the material itself, or extrinsic factors which might be interpreted by the absorption and adsorption mechanisms of stain in the oral cavity⁽⁵⁾.

Surface hardness is an important factor to determinant mechanical strength and resistance against intraoral softening of restorative materials. Reduction in surface hardness value imply worsened wear resistance and tendency to scratching, which compromise fatigue strength and lead to restoration failure⁽⁶⁾.

II. Materialand Methods

In this experimental study, compomer (Composanglass) and resin modified glass ionomer (Riva)were the materials used for evaluation of Microleakage, Color change, Microhardness.

product	Composition	manufacture
Composan glass light curing compomer	Fillers: Fluoro-alumino-silicate glass Dimethacrylatemonomer:UDMA,BIS-GMA,TEGDMA, Difunctional resin: TCB resin Photo-activator and initiator: Camphorquinone, Tertiary amine Hydrophilic monomers: Glycerol dimethacrylate	Promedica, Germany
Riva light cure resin modified glass ionomer	Polyacrylic Acid, Tartaric Acid ,2-Hydroxyethyl Methacrylate, Dimethacrylate Cross-linker , Acidic Monomer Fluoroaluminosilicate glass powder	SDI:Southern Dental Industries,Australia
Distilled water	(neutral medium)	Faculty of pharmacy, Alexandria
Orange juice	Fruit content not less than20% orange concentrator, sucrose, citric acid (E330), acidity regulator,natural color (E160a), natural flavor, stabilizer (E440), ascorbic acid (E330), antioxidant.	Juhayna Food Industries, 6 th October City, Egypt
Pepsi	carbonated water, high fructose corn syrup, caramel color, sugar, phosphoric acid, caffeine, citric acid, and natural flavor(Emulsifier: gum Arabic).	Pepsi Cola, Cairo, Egypt
chocolate milk	Natural standardized sterilized flavored sweetened cow's milk, sugar, milk powder, cocoa powder, emulsifier (E471), food stabilizer (E407), fat, total solids.	Juhayna Food Industries, 6 th October City, Egypt

Table (1): Materials, beverages, composition, and manufacturers

Specimen Preparation for microleakage assessment:

Extracted eighty primary molarsindicated for serial extraction or over-retention reason with sound buccalsurfaces were collected from children attending Outpatient Clinic of Pedodontic Department, Faculty of Dentistry, Tanta University. Teethwere cleaned thoroughly under running waterand kept in distilled water at room temperature till be used for microleakage assessment. Standard Class V cavities were prepared 1mm above the cemento-enamel junction (CEJ). The cavity preparation was standardized using a periodontal probe. The dimensions of the cavity were 3mm mesio-distally, 2mm occluso-cervically and 2 mm in depth. Following cavity preparation, eighty teeth were randomly divided into two experimental groups according to material used:**Group I:**light-curing compomer (n=40) and **Group II:**resin modified glass ionomer (n=40).In each group the cavity was restored with its respective restorative material according to the manufacturer's instructions.

Specimen Preparation of color change and microhardness assessment:

A total of 160 disks (80 each test), a 5-mm diameter and 2-mm thickness discs were prepared from each material using teflon mold, in turn, each material was injected by their own syringes and condensed within the teflon mold. The materials surfaces were covered by a Mylar strip, pressed flat with a microscopic glass slide to squeeze the excess material then were divided into four subgroups according to immersion beverages.

Immersion of specimens in beverages:

The pH of each immersion beverages was measured using pH meter(Beckman, Instrument Fullerton, Germany) All samples of each material were randomly divided into four subgroups according to immersion beverage.Each subgroup was immersed separately in a closed individual container containing 100 ml of the immersion solution for three hours every day and stored in distilled water at room temperature the rest of the day. All beverages were renewed daily. This immersion regimen was repeated in uninterrupted manner for 7 days.

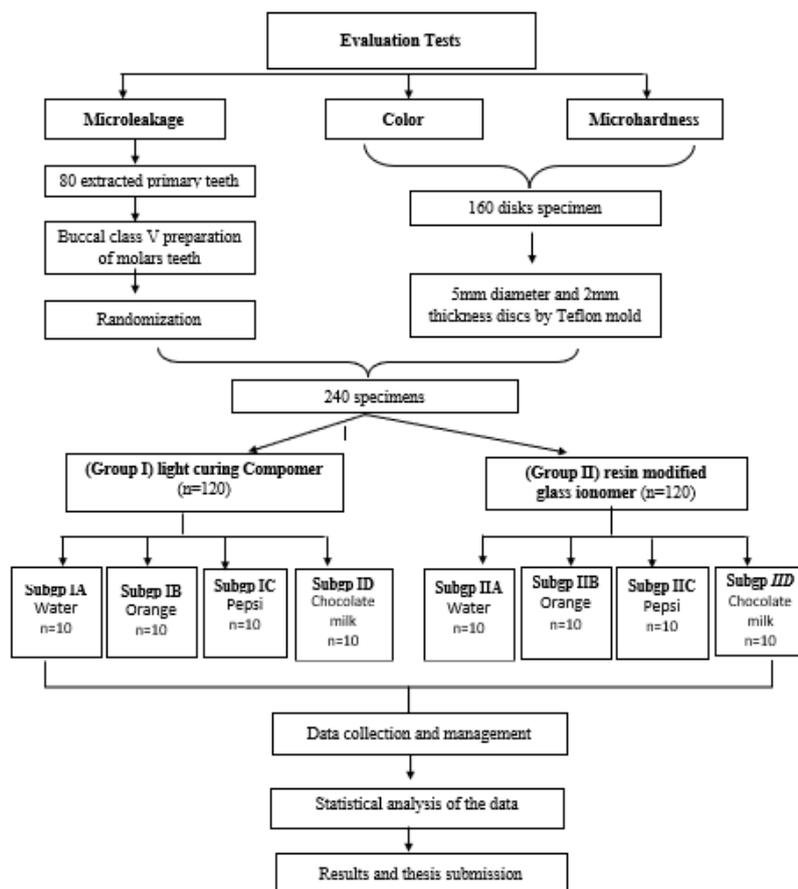


Fig1: Flow Chart of the Study Design

Microleakage testing Procedure:

The apices of the teeth were sealed with sticky wax and all teeth surfaces were covered with two coats of nail polish except 1mm around the restoration and allowed to air dry. The teeth immersed in 1% methylene blue dye in small, dark closed bottles for 4 hours away from light. Samples were mounted in self-curing acrylic blocks and sectioned bucco-lingually through the centre of the restoration with a low-speed diamond saw. Surfaces were dried and photographed under standardized conditions using a digital camera attached to a stereomicroscope (WILD Heerbrugg wild, Switzerland) at magnifications of 25x. The photographs were imported to the AutoCAD software and dye penetration was calculated in millimeters then the mean of microleakage was recorded. Microleakage test was done after 7 days of immersion.

Color Stability testing Procedure:

Color measurements of all subgroup's specimens were compared after seven days of immersion in accordance to control group, each specimen was measured in its centre side using a portable Reflective spectrophotometer (X-Rite, model RM200QC, Neu-Isenburg, Germany), white background was selected, and measurements were made according to the CIE L*a*b* color space and color changes (ΔE) of the specimens were evaluated using the following formula:⁽⁷⁾ $\Delta E_{CIELAB} = (\Delta L^*2 + \Delta a^*2 + \Delta b^*2)^{1/2}$ Where, L^* = lightness (0-100), a^* = (change the color of the axis red/green) and b^* = (color variation axis yellow/blue).

Microhardness testing Procedure:

Post immersion hardness values after 7 days of immersion in beverages were calculated using Vickers Microhardness Tester (Model ZHV μ 2016, Indentec Hardness Testing Machine Limited.UK). A load of 100g was applied to the surface of the specimens for 20 seconds and three indentations, which were equally placed over a circle and not closer than 0.5 mm to the adjacent indentations, were made on the surface of each specimen. Microhardness was obtained using the following equation:⁽⁸⁾ $HV = 1.854 P/d^2$ Where, HV is Vickers hardness in Kgf/mm^2 , P is the load in Kgf and d is the length of the diagonals in mm .

Statistical analysis

Data was collected, tabulated, and statistically analyzed using (SPSS) version 24 for windows with one-way ANOVA test and Student t-test. P Value <0.05 was considered statistically significant.

III. Result

Table (2): pH of the beverages

Beverages	pH
Water (control group)	7
Orange juice	3.4
Pepsi	2.5
Chocolate Milk	6.4

Microleakage measurements

comparison between Compomer and RMGI groups regarding Microleakage, indicated to slightly less difference between two groups. There was no significant difference in microleakage between groups IB, IC, ID and its corresponding IIB, IIC, IID. The statistical significant difference was found between IA and IIA groups. Table (3)

Table (3): Comparison between Compomer and RMGI regarding microleakage in mm

	Group I Compomer	Group II RMGI	t-test	P value
Subgroup A(Water) Range Mean±S.D	1.65-2.63 2.09±0.24	2.11-3.22 2.58±0.35	5.68	0.0010*
Subgroup B (Orange) Range Mean±S.D	2.22-4.51 3.80±0.64	3.65-4.31 3.97±0.23	2.13	0.2310 N.S
Subgroup C (Pepsi) Range Mean±S.D	3.65-4.65 4.22±0.30	3.98-4.89 4.43±0.29	0.895	0.0631 N.S
Subgroup D (Chocolate Milk) Range Mean±S.D	2.30-3.52 2.66±0.49	2.45-3.11 2.81±0.22	1.02	0.103 N.S

* Significant at level 0.05
N.S. not significant

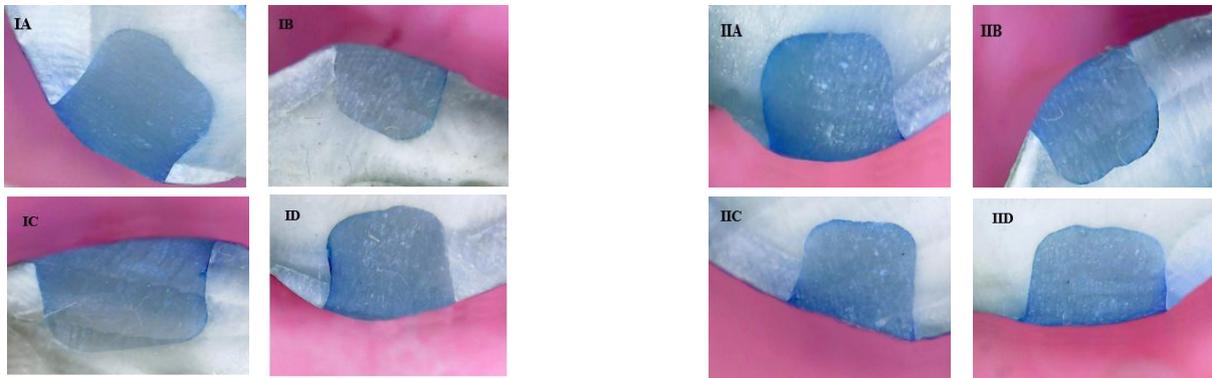


Fig2: microleakage of compomer in different subgroups

Color stability measurements

Color change indicated that ΔE was higher in Group II (RMGI) in all subgroups compared with all their corresponding subgroups of Group I (Compomer) with statistical significant difference (P ≤ 0.05). Table (4)

Table (4): Comparison between Group I (Compomer) and Group II (RMGI) regarding Color change.

	Group I Compomer	Group II RMGI	t-test	P value
Subgroup B (Orange) Range Mean±S.D	1.27-3.44 2.28±0.77	2.32-4.22 2.97±0.63	0.898	0.0046*
Subgroup C (Pepsi) Range Mean±S.D	1.39-4.62 3.12±1.07	2.73-5.20 4.10±0.75	1.96	0.0005*
Subgroup D (Chocolate Milk) Range Mean±S.D	0.67-2.65 1.90±0.61	1.02-4.08 2.34±0.93	1.03	0.0368*

* Significant at level 0.05

Microhardness measurements

Comparison between microhardness of all subgroups between Group I (Compomer) and Group II (RMGI) indicated that there was statistically significant difference ($P \leq 0.05$). **Table (5)**

Table (5): Comparison between Group I (Compomer) and Group II (RMGI) regarding Microhardness

	Group I Compomer	Group II RMGI	t-test	P value
Subgroup A (Water) Range Mean±S.D	39.17-60.20 47.78±5.477	35.22-49.32 41.93±3.492	1.76	0.001*
Subgroup B (Orange) Range Mean±S.D	33.20-46.20 39.50±3.909	27.59-43.75 36.68±4.774	0.911	0.044*
Subgroup C (Pepsi) Range Mean±S.D	30.17-42.91 36.56±4.284	28.20-36.20 34.27±2.174	1.42	0.038*
Subgroup D (Chocolate Milk) Range Mean±S.D	27.23-51.72 43.64±7.102	33.02-45.20 39.97±4.171	1.98	0.048*

* Significant at level 0.05

IV. Discussion

Over the last years, dentistry has experienced a remarkable scientific advance regarding the improvement of esthetic restorative materials. The ideal restorative material for primary teeth should be easy to apply and have adhesive properties which will limit the need for extensive preparation.

Beverages selected in this study; Orange, Pepsi, Chocolate milk are the most commonly consumed by children^(9, 10). Orange juice is valuable contribution to a healthy nutrition as it is rich with vitamin C to prevent common cold in winter. Soft drinks are attractive for children because its tasty, popularity and thoughts that is ease in digestion. Milk is widely considered an essential food to support bone growth and teeth formation among post weaning age children⁽¹¹⁾.

Distilled water was utilized in the current study as the control group rather than artificial saliva. Turssi et al⁽¹²⁾, reported that there was no statistically significant difference in micromorphology of resin based materials that stored in distilled water nor artificial saliva. Also, it did not show any significant color change which attributed to absence of coloring agents as stated by Prabhakar et al and Adusumilli et al^(13, 14).

Specimens preparation for color and microhardness measurements were disks prepared within the Teflon mold. A mylar strip pressed flat with a microscopic glass slide was used in this study to achieve the smoothest surface when compared to other finishing and polishing procedures⁽¹⁵⁾ also it could minimize inhibition of polymerization by (air) oxygen, which may influence the results.

In the present study, materials samples were immersed in beverages for 3 hours per day at room temperature then stored in distilled water for the rest of the day, over a period of seven days⁽¹⁶⁾. This regimen was carried out to stimulate washing action of saliva.

Microleakage is an important property that has been used in assessing the success rate of any restorative material especially in primary teeth because of wider dentinal tubules and small intertubular dentine area available for bonding leading to less bond strength⁽¹⁷⁾. Regarding the beverage used, Pepsi subgroup showed the high microleakage in comparing with other subgroups A, B, and D. This can be attributed to inherent acidity due to the presence of both phosphoric acid and citric acid. This came in accordance with findings of Bamise et al⁽¹⁸⁾; Trivedi et al⁽¹⁹⁾; Tahmassebi et al⁽²⁰⁾, who stated that soft drinks have an inherent acidity due to the presence of both phosphoric acid and carbonic acid, which tends to increase enamel decalcification, erosion and microleakage around the restoration. In contrast, this came in disagreement with Dinakaran⁽²¹⁾, who prove that fruit juices exhibited increase in microleakage than cola.

Regarding microleakage of the materials, the two materials used exhibited interfacial microleakage. Otherwise, microleakage in compomer was slightly less than Resin modified glass ionomer in all subgroups. This can be attributed to use of combo-bond NE which reinforced by nano fillers as a dentin adhesive with compomer according to the manufacturer might affects the amount of microleakage of compomer. This came in confirm with the results of the Dinakaran et al⁽²¹⁾, Gjorgievska et al⁽²²⁾, and Gerdolle et al⁽²³⁾.

In pediatric dentistry, color sustainability of restorative materials is critical because of esthetics, additional costs associated with replacement of restorations. Also, multiple visits needed for replacement might lead to behavior management problems and increase dental anxiety in children.

In the present study, the greatest changes in color were observed following immersion in Pepsi, followed by orange juice, and chocolate milk. These findings can be clarified as result of different beverages pH. The acidic

pH of Pepsi and Orange juice may have influenced the structure of the restorative materials tested. This is in agreement with Tunc et al⁽²⁴⁾, Hotwani et al⁽²⁵⁾ and Lopes et al⁽²⁶⁾. Regarding discoloration of the material, compomer and resin modified glass ionomer materials are susceptible to discoloration. However, color change was greater in resin modified glass ionomer than compomer. This may be explained by the higher water sorption of RMGIC. It has also been suggested that materials containing hydrophobic monomers, such as composite resin, are more stain resistant than materials containing hydrophilic monomers, such as RMGICs⁽²⁷⁾. These results are consistent with Iazzetti et al⁽²⁸⁾, and Mohan et al⁽²⁹⁾.

Surface hardness is an important indicator of a restorative material mechanical strength and resistance against intraoral softening, regarding type of beverage, pepsicola showed the least microhardness values followed by orange, chocolate milk and distilled water. These findings were in agreement with Lee et al⁽³⁰⁾ and Kumavat et al⁽³¹⁾, they reported strong potential erosive effect of cola drink to presence of phosphoric acid and low pH. On contrary, Erdemir et al⁽³²⁾ and Nicholson et al⁽³³⁾, reported that citric acid in orange juice had an aggressive effect on dental hard tissues and resin-based restorative materials. Regarding microhardness of the material, compomer showed minimal changes in microhardness values than resin modified glass ionomer. These results are similar to those of Ibrahim et al⁽¹⁶⁾ and Mohamed Tahir et al⁽³⁴⁾, The higher resin content may be the reason for the behavior of compomer being close to resin composites to be less affected by low pH⁽³⁵⁾.

V. Conclusion

Within limitations of the present study, it was concluded that:

1. Coloring beverages adversely affect microleakage, color change, microhardness of esthetic restorative materials.
2. Pepsicola showed the high microleakage, least microhardness values and greater color change of esthetic restorations in comparison with orange juice, Chocolate milk and distilled water.
3. Compomer showed slightly better performance after exposure to coloring beverages than resin modified glass ionomer.

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