Effects of different children health drinks on stainability of anterior tooth colored restorative materials: An *in vitro* study

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ABSTRACT

The aim of this *in vitro* study was to evaluate the color stability of various anterior tooth-colored restorative materials by children's health drinks. Totally, 168 spherical shaped specimens of dimension of 12 mm in diameter and 1.2 mm in thickness were prepared from compomer (Dyract), resin modified glass ionomer (Vitremer), resin composite (Filtek Z350). Each group of 56 specimens of each material were divided into seven subgroups. Each subgroup was stored in a different solution (distilled water, milk, milk with sugar and bournvita, milk with sugar and horlicks, milk with sugar and boost, milk with sugar and complan, milk with sugar and maltova) for 48 h. The color change measurement was done using spectrophotometer (Minolta, CM-3301d) both before and after staining. For each group mean values (ΔE*) were calculated, and inter-comparison between health drinks and materials was done using one-way ANOVA. Intercomparison between materials was done with Tukey's *post-hoc* test. The level of significance for all the tests was chosen as $P < 0.001$. Resin composite showed the highest resistance to staining, and resin modified glass ionomer showed the least resistance. For all the materials, exposure to bournvita and boost resulted in high rates of color change than exposure to complan, maltova, horlicks, milk, and distilled water. All the health drinks tested did not show any visible effect on any of the esthetic restorative materials taken for study.

Key words: Color stability, Health Drink, Restorative Materials

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INTRODUCTION

Children feel more excited if they have a great smile on their face. In today's world, looking good is the prime concern. Appearance is closely linked to social acceptance and professional success. Amalgam was taught for decades as the best material for restoration in primary molars. Patient demand for better esthetics and parents scare of potential adverse effect of mercury on health and pollution of the environment, motivated manufactures of dental products to develop alternatives for amalgam. The decline in amalgam restoration really became apparent with the introduction of a variety of esthetic restorative materials.[1]

Tooth colored restorative materials are available in various forms with different physical properties and colors. Glass ionomer cements (GICs), resin modified glass ionomer cements (RMGIC), compomers, and resin compsite are the materials of choice for direct aesthetic restorations, but GICs are less acceptable than resin based materials and have poor abrasion as well as fracture resistance.

In pediatric dentistry compomers, resin modified glass ionomers and composites, these esthetically pleasing materials have tremendously changed the concept of today's practice. These tooth-colored materials are used for restoration of decay areas, and also to improve smile by changing the color of teeth and reshaping disfigured teeth.[2]

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Discoloration is the major esthetic failure of direct tooth-colored restorations, it results from surface staining, marginal staining because of micro-leakage, changes in surface morphology by wear, and internal material discoloration. Most of the studies till now detected that red wine, coffee, and tea affect color changes. These 3 beverages, however, are mostly adult beverages that children rarely drink. Therefore, this study's purpose is to evaluate the effects of various children's health drinks on the discoloration of various types of anterior esthetic restorative materials. Color estimation in dentistry can be done in two categories, visual, and instrumental.

Instrumental colorimetry can potentially eliminate subjective errors in color assessment. Colorimetry is more exact in measuring slight differences in colored objects on flat surfaces than the naked eye. In measuring slight differences in colored objects on flat surfaces.[3]

MATERIALS AND METHODS

Materials used in our study are as follows:

Table 1: Study solutions

Brand name	Manufacturing company	Ingredients	Suspected staining agent
Nandini pasteurized toned milk	Karnataka Milk Federation	Milk	Nil
Bournvita	Cadbury	Malt extract, sugar, cocoa solids, milk solids, caramel, liquid glucose, emulsifiers, vitamins, minerals, salt	Cocoa solids
Horlicks	GlaxoSmithKline consumer healthcare	Wheat flour, malted barley, dried whey, sugar, vegetable fat, milk solids, vitamins, minerals, salt, traces of soya beans	Nil
Boost	GlaxoSmithKline consumer healthcare	Wheat flour, wheat glucose syrup, dextrose, sugar, milk solids, vegetable fat, cocoa butter, cocoa powder, salt, emulsifiers	Cocoa powder
Complan	HJ Heinz	Milk solids, sugar, peanut oil, maltodextrin, caramel, beetroot juice powder, minerals, vitamins, flavors	Beetroot juice powder
Maltova	GlaxoSmithKline consumer healthcare	Malt extract, sugar, milk solids, maltodextrin, cocoa powder, acidity regulator, salt, fiber, minerals, nature identical flavoring agent, vitamins	Cocoa powder

Distilled water was used as control group

Restorative materials

Compomer (Dyract, Dentsply Caulk, Germany) of A3 shade. Resin-modified GIC (RMGIC) (Vitremer, 3M Dental Products, St Paul. MN) of A3 shade. Micro-hybrid composite resin (Filtek Z350, 3M Dental Products, St Paul. USA) of A3 shade.

Specimen preparation

Three spherical brass metal molds with a hole of 12 mm diameter and 1.2 mm in thicknesses were used to construct specimens. 56 spherical shaped specimens of each material of dimension of 12 mm in diameter and 1.2 mm in thickness were prepared. The specimens were made according to instructions for each material of the manufacturer and were polished with polishing disks (Sof Lex, 3M, St Paul, USA). After polishing, the samples were rinsed, dried with tissue paper, and the baseline color measurements were performed. The specimen were divided into seven subgroups (n = 8) and immersed in one of the seven solutions. Health drinks (test solutions) were prepared according to instructions of the manufacturer for a quantity of a cup of milk (125 ml).

The seven solutions were, distilled water (control), milk (M), milk (125 ml) with sugar (10 g), and bournvita (Bu) (20 g), milk (125 ml) with sugar (10 g) and horlicks (H) (30 g), milk (125 ml) with sugar (10 g) and boost (Bo) (20 g), milk (125 ml) with sugar (10 g) and complan (C) (33 g), milk (125 ml) with sugar (10 g), and maltova (Ma) (15 g).

All the specimens were exposed for 48 h in room temperature in test solutions and then the samples were brushed with soft toothbrush for 3 min. A new toothbrush used for each group and brushing was performed by one operator. The specimen were washed and dried with tissue paper.

Color change measurement

Specimen color was measured using spectrophotometer (Minolta, CM-3301d) before and after exposure to health drinks. The color stability was evaluated by the determination of color change (ΔE^*) between the final (F) and the baseline (O) color evaluations, using CIE L * a*b measuring system. The mean values (ΔE^*) were estimated for each subgroup and inter-comparison between health drinks and materials was done using one-way ANOVA. Intercomparison between materials was done with Tukey's *post-hoc* test. The level of significance for all the tests was chosen as $P < 0.001$. All statistical analysis was performed using the statistical software SPSS for Windows, version 12.0.1.

RESULTS

Among the three restorative materials tested, resin-modified glass ionomer (vitremer) showed the most color change followed by compomer (Dyract) and resin composite (Filtek Z350). Statistically among three restorative material groups ($P < 0.001$) there was highly significant differences [Table 2, Figure 1].

Table 2: This table shows multiple comparison of three restorative materials tested, RMGIC (vitremer) showed the most color change followed by Compomer (Dyract) and Resin composite (Filtek Z350). Where *P* < 0.001

	Distilled water	Milk	Bournvita +M+S	Horlicks +M+S	Boost +M+S	Complan +M+S	Maltova +M+S	Mean
Compomer	1.53	1.94	3.03	2.21	2.97	2.36	2.30	2.33
RMGC	1.63	2.17	3.20	2.31	3.15	2.91	2.73	2.58
Resin composite	1.52	1.62	2.62	1.74	2.63	2.25	2.08	2.06

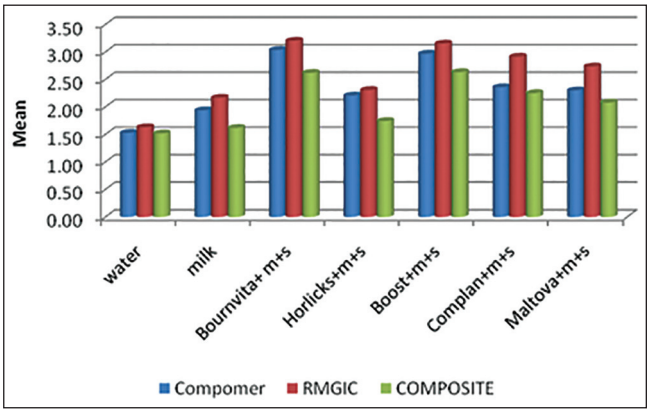

Figure 1: Multiple comparison of different health drinks in different esthetic restorative materials

Multiple comparison of different esthetic restorative materials in different health drinks.

For all restorative materials, the lowest ΔE values were recorded for specimens stored in Distilled water followed by M, H, Ma, C, Bo, and Bu health drinks [Table 3, Figure 2].

The color change produced when a pair-wise comparison between two materials with different health drinks. There was statistically significant difference in color change between RMGIC and composite for subgroup M (*P* = 0.03), RMGIC and composite for subgroup Bu (*P* = 0.02), RMGIC and composite for subgroup H (*P* = 0.02), compomer and RMGIC and composite for subgroup C (*P* = 0.005) and RMGIC and composite for subgroup Ma (*P* = 0.04). All other combination materials showed statistically insignificant color change [Table 4].

DISCUSSION

Many health drink powders are accessible in the market. Which one to select depends on the nutrition requirement of child and flavor added to it. Thus, one of the side effects of the health drinks could be a change in color of tooth-colored restorations. Because of this, the use of agents that do not induce staining of this kind are important.

Staining can be a result of surface staining, marginal staining from micro-leakage, and internal substance deterioration. Discoloration also can be ascribed to surface finish, finishing and polishing procedures, and

Table 3: Multiple comparison of different esthetic restorative materials in different health drinks, Where *P* < 0.001

	Compomer	RMGIC	Resin composite	Mean
Distilled water	1.53	1.63	1.52	1.56
Milk	1.94	2.17	1.62	1.91
Bournvita+M+S	3.03	3.20	2.62	2.95
Horlicks+M+S	2.21	2.31	1.74	2.086
Boost+M+S	2.97	3.15	2.63	2.62
Complan+M+S	2.36	2.91	2.25	2.5
Maltova+M+S	2.30	2.73	2.08	2.37

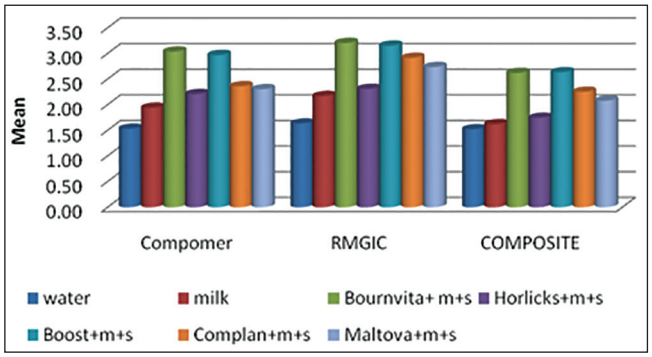

Figure 2: Multiple comparison of different esthetic restorative materials in different health drinks

surface crazing or molecular stresses. Many studies have evaluated the effects of cola, grape juice, tea, coffee, etc. However, the effects of health drinks used in this study has not been reported.[4,2]

In estimating chromatic differences, generally two color systems are utilized, Munsell Color System and Standard Commission International de L'Eclairage (CIE Lab). In our study, CIE Lab color system was used to estimate color stability because this color system can transform spectrophotometer data to an approximately uniform color space. In the color space L * indicates lightness, a * indicates (red-green), and b * indicates (yellow-blue) are the chromatically coordinates which indicate color directions.[5]

The quantitative estimation of color difference (ΔE) with a colorimeter endow with advantages such as repeatability, sensitivity, and objectivity, regardless of some limitations. In principle, if a material is completely color stable, no color difference will be detected before, and

Table 4: Pair-wise comparison between two materials with different health drinks

Solutions	Compomer		RMGIC		Composite		*P** value,sig	Significant pairs
	Mean	SD	Mean	SD	Mean	SD		
1	1.53	0.26	1.63	0.55	1.52	0.26	0.81 NS	–
2	1.94	0.35	2.17	0.53	1.62	0.15	0.03 S	II and III
3	3.03	0.45	3.20	0.47	2.62	0.18	0.02 S	II and III
4	2.21	0.43	2.31	0.42	1.74	0.28	0.02 S	II and III
5	2.97	0.28	3.15	0.90	2.63	0.43	0.23 NS	–
6	2.36	0.49	2.91	0.26	2.25	0.37	0.005 S	I and II, II and III
7	2.30	0.39	2.73	0.62	2.08	0.42	0.04 S	II and III

after its exposure to the testing environment (ΔE = 0). Various studies have reported different thresholds of color difference values above which the color change is perceptible by the human eye. A ΔE value of 3.7 or less is considered to be clinically acceptable.[6]

The ΔE values were acceptable for all materials (Fuji IX, Fuji II LC, Dyract Extra, and Filtek Z250) tested, with the exception of RMGIC (Fuji II LC) when stored in a different solution (distilled water, chocolate milk, cola, grape juice) for 24 h Therefore, the use of RMGIC should be avoided in anterior restorations in children due to esthetic reasons.[7] The present study showed compomer (Dyract), resin-modified glass ionomer (Vitremer), resin composite (Filtek Z350) with moderate discoloration when exposed to health drinks which were clinically acceptable.

In the present study, composite (Filtek Z350) showed least ΔE values among all materials after exposure to health drinks(distilled water, milk, milk with sugar and bournvita, milk with sugar and horlicks, milk with sugar and boost, milk with sugar and complan, milk with sugar and maltova). Similar results were obtained from previous studies, where the effect of fluoride varnishes on color stability of esthetic restorative materials. Where Z-100 (3M Dental Products, St Paul, MN, USA) and esthet-X (Dentsply Caulk, Milford, DE, USA), shades Al and A2 and a glass ionomer, GC Fuji IX GP Fast (GC Corporation, Tokyo, Japan), shade A2, were used as restorative materials.[8]

The study on effects of different drinks on stainability of resin composite provisional restorative materials, the results showed that for micro-hybrid composite materials and light-polymerized composite provisional material, when tea and coffee groups with and without sugar were compared both groups with sugar demonstrated a higher color difference than without sugar and therefore it was concluded that, the presence of sugar in coffee and tea increased the color difference compared to coffee or tea without sugar for light-polymerized composite provisional material and micro-hybrid composite.[9] In the present study, sugar was added to all health drinks so this added sugar may be responsible for staining of restorative materials.

An *in vitro* staining of resin composites (submicron, nano, micro-hybrid) by liquids ingested by children (distilled water, kool aid jammers, coca-cola, snow cone syrup).

The results showed that color change during the staining procedure was minimal (ΔE < 1.67) for all composites.[10] The results are similar to our study where ΔE < 2.06 which was also clinically acceptable.

In the present study all the resin based materials namely composite (Filtec Z350), compomer (Dyract) and RMGIC (Vitremer) showed significant color change with bournvita and boost which contain cocoa solids which may be co related to staining ability as seen in chocolate drink in a previous study done which also contained cocoa solids.[7]

The results of our study indicated that RMGIC (Vitremer) was more susceptible to staining than compomer (Dyract) and composite (Filtec Z350). This encouraging *in vitro* data suggests the need for a well-controlled clinical trial to evaluate further clinical effectiveness.

CONCLUSION

ΔE values were acceptable for all materials tested. Therefore, all the esthetic restorative materials tested here, compomer (Dyract), resin modified glass ionomer (Vitremer), resin composite (Filtek Z350) can be used successfully as esthetic restorative materials.

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