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A spectrophotometric evaluation for colour stability of resin composites after immersion in two different food colorants - An in-vitro study

[1]Dr. Sumayah Salma Muneer, Post graduate student, Department of Conservative Dentistry & Endodontics M.R. Ambedkar Dental College & Hospital.

[2]Dr. Ananthakrishna. S, Professor and HOD, Department of Conservative Dentistry & Endodontics M.R. Ambedkar Dental College & Hospital.

[3]Dr. Vijay Shankar L.V, Reader, Department of Conservative Dentistry & Endodontics M.R. Ambedkar Dental College & Hospital.

[4]Dr. Pradeep P.R, Professor, Department of Conservative Dentistry & Endodontics M.R. Ambedkar Dental College & Hospital.

[5]Dr. Deepthi. M, Post graduate student, Department of Conservative Dentistry & Endodontics M.R. Ambedkar Dental College & Hospital.

[6]Dr. Syam Prasad. T, Post graduate student, Department of Conservative Dentistry & Endodontics M.R. Ambedkar Dental College & Hospital.

Corresponding Author: Dr. Sumayah Salma Muneer, Post graduate student, Department of Conservative Dentistry & Endodontics M.R. Ambedkar Dental College & Hospital.

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Abstract

Background & Objective: The aesthetic quality of restoration may be as important to the mental health of the patient as the biological & technical qualities of the restoration are to his physical or Dental health. Discoloration of composite resins can be caused by internal or external factors. The consumption of food & drinks which has colouring components affects the restoration of the composite resin leading to discolouration. This study is aimed at investigating the effects of different common drinks consumed by patients on two of the most common composites in dentistry.

Methods: This study was conducted with a sample size of 30 in each group and further sub-divided into three groups. A total of 60 composite disc specimen was fabricated. The immersion solutions were prepared and

specimens were immersed in their respective test solutions for 10 minutes, twice a day, for 30 days at 37c. Then the specimens were rinsed with distilled water for five minutes & blotted dry with tissue paper before colour measurement. Colour measurements were made just before & after immersion in solutions.

Results: All tested resin composites showed colour change after a period of 30 days. The colour change exhibited by the two groups was significantly different for the two beverages. The highest discoloration was caused by tea in [MH] is 0.359 & [NH] 0.289, followed by black jamun [syzygium cumini] [MH] is 0.176 & [NH] is 0.122 & artificial saliva.

Conclusion: The colour stability of micro-hybrid composite resin was found to be inferior than the nano resin composite irrespective of immersion medium & time.

Keywords: Micro-hybrid composite, Nano-hybrid composite, spectrophotometric evaluation, food colorants, colour stability

Introduction

The aesthetic quality of restoration may be as important to the mental health of the patient as the biological & technical qualities of the restoration are to his physical or dental health. Nowadays patients seek better colour – matching restorations & composite resins to satisfy this need. Hence, the proper colour match to the adjacent tooth is important not only in the first period of service, but also over a longer period of time. Composite resin restorations are widely used as an aesthetic restorative material in anterior & posterior teeth.

Discoloration of composite resins can be caused by internal or external factors. Many investigations have been done on colour stability of composites resin. The consumption of food & drinks which has colouring components affects the restoration of the composite resin leading to discolouration.

There is extensive research that has reported the harmful effects of tea on dental composite resins. Black jamun/plum (syzygium cumini) is minor fruit in India which is a good source of nutrition & pharmaceuticals properties. [1] Highly perishable & nutritious. It has been used for extracting juice or to prepare jam, jelly, squash etc, whereas seeds having its own medicinal value for curing diarrhoea & diabetics & is good for the digestive system.

Hence, the present study is aimed at investigating the effects of tea and black jamun common drinks consumed by patients on two of the most common composites in dentistry. [nano composite 3m espe (Filtek z250 xt) , micro hybrid composite, 3m (z-100).

Materials & methodology

Materials Used

Resin based Nanocomposites, nano filled resin composites, Micro-hybrid composite, composite polishing kit, artificial saliva, Tea (Taj Mahal), Black jamun (B-Natural).

Sample size calculation

The sample size for this study was estimated using the software G*Power and were divided into two groups of 30 samples each. The composition and the product category explained in supplementary table 1. Each group is further subdivided into three groups according to the staining solution used. Table 1 represents the consort study flow diagram.

Group I (Control Group) - [Z 100] Micro-hybrid composite, 3M			Group II (Experimental Group) - [Filtek Z250 XT] Nano composite, 3M		
Subgroup 1	Subgroup 2	Subgroup 3	Subgroup 1	Subgroup 2	Subgroup 3

Artificial Saliva	Black Jamun	Tea	Artificial Saliva	Black Jamun	Tea

Table 1: Consort Study Flowchart

Methodology

A total of 60 disk shaped specimens were fabricated by condensing the composite resin of A2 shade in the custom-made silicone mold, having a circular shaped hole (8mm in diameter x2mm in thickness). The specimens were polished using Shofu polishing kit. (Fig 1)

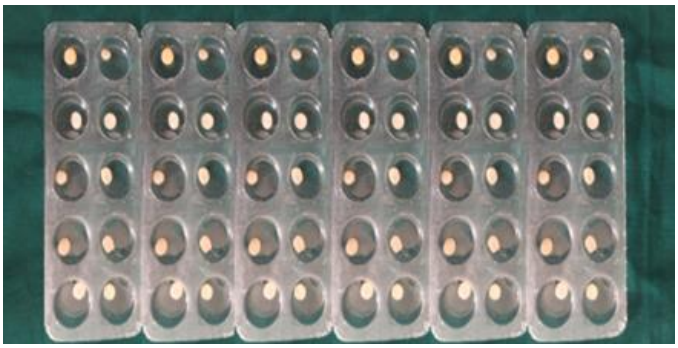

Figure 1: Prepared Composite discs

Preparation of the Solutions

Tea - 15g of tea powder (Taj mahal) was added to 150ml of boiling water & 150ml of milk. Solutions were boiled for 3 mins, 3 cubes of sugar were added, the solution was stirred until sugar dissolved, filtered through a sieve & used. 150 ml of black jamun fruit juice was used. 200 ml of Wet Mouth used as artificial saliva. (Supplementary figure 1)

Immersion of the composite discs

Specimens were immersed in their respective test solutions for 10 minutes, twice a day, for 30 days at 37c. Then the specimens were rinsed with distilled water for five minutes & blotted dry with tissue paper before colour measurement. Colour measurements were made just before & after immersion in solutions. Colour evaluation & differences for each specimen were measured using microplate absorbance spectro photometer, with a standard illumination & standard observer under daylight conditions. (Fig 2) Readings were taken 3 times (8 hourly) for each specimen & recorded to evaluate the colour changes.

The tip of the light- curing unit was positioned at 2mm distance from the material without contacting the material. The composites were cured for 40 seconds using a woodpecker light- cure unit Led. Finishing & polishing of the composite resin was done. Polishing was carried out using a slow speed handpiece with the different grits of the disks, using a Shofu composite polishing kit.

Figure 2: Notable Colour changes in all the subgroups

All experimental data were analyzed by CF using SPSS vision 22.0 software with specific reference to recommendations by Lesaffre and co-workers. First, Colour changes (ΔE) (mean values and standard deviations) for composites with staining solutions after three hours/day × 30 days was recorded (Table 2). Then mean values of colour change (ΔE*) of Group-I i.e., Micro Hybrid & Nano hybrid group after exposed to two staining solutions for three hours/day for 30 days was compared using the Turkey HSD Post-hoc test (Table 3&4). The observed colour change among various types of composites was subjected to one way ANOVA (Table 5). The p value <0.05 was considered to be statistically significant.

Composite resins	Artificial saliva (control group) mean (sd)	Group i (tea) Mean (sd)	Group ii (jamun) Mean (sd)	P value
Micro hybrid	0	0.359 (.001)	0.176 (.002)	<.002* Significant
Nano filled	0	0.289(.001)	0.122 (.002)	<.001* Significant

Table 2: Colour changes (ΔE) (mean values and standard deviations) for composites with staining solutions after three hours/day × 30 days

Micro hybrid	Mean	Sd	Mean±SD difference	P value
Control group	0	0	0.359±.001	<0.002* Significant
Tea group	0.359	.002		
Control group	0	0	0.176±.002	<0.001* Significant
Jamun group	0.176	.001		

Table 3: mean values of colour change (ΔE*) of Group-I i.e., Micro Hybrid after exposed to two staining solutions for three hours/day for 30 days

Nano Filled	Mean	SD	Mean±SD difference	P value
Control group	0	0	0.289±.001	<0.001* Significant
Tea group	0.289	.001		
Control group	0.122	0	0.122±.001	<0.001* Significant
Jamun group		.001		

Table 4: mean values of colour change (ΔE*) of Group-I i.e., Nano- Hybrid after exposed to two staining solutions for three hours/day for 30 days

Material	Immersion time	Immersion medium	N	Mean	SD P VALUE
Micro hybrid (Filtek z 100) Group i	30 days	Artificial saliva Tea Jamun	10 10 10	0 0.359 0.176	0.001 <0.002 .002
NANOFILLED (FILTEK Z 350) GROUP II	30 DAYS	Artificial saliva Tea Jamun	10 10 10	0 0.289 0.122	0.001 <0.001 .001

Table 5: Observed colour change among different resin-based composites

Results

All tested resin composites showed colour change after a period of 30 days. The colour change exhibited by the two groups was significantly different for the two beverages. The highest discoloration was caused by tea in [MH] is 0.359 & [NH] 0.289, followed by black jamun [syzygium cumini] [MH] is 0.176 & [NH] is 0.122 & artificial saliva.

Discussion

Initially composite restorations were developed for aesthetic restoration though these composites had several drawbacks such as, inability to bond to tooth structure. Tooth coloured restorative dental materials are continuously exposed to saliva, foods & other beverages in the oral cavity. So, it is important to determine their susceptibility to colour change. Specimens were immersed in concentrated staining solutions daily & continuously for a specific period, i.e., 10mins /twice a day for 30days. Also, the soaking time is of immense importance, as it affects the composite colour stability as well. In the present study change of colour was noted which is in accordance with Malekipour et al. [2]

Unacceptable staining/discoloration are commonly encountered in tooth-colored restorations and is a

frequent reason for their regular replacement (Malhotra et al., 2011). So, one of the reasons for long term success of composite restorations is colour stability. Colour stability is one of the major criteria for selection of composite during its service (Kolbeck et al., 2006) (Han L et al., 2000).

According to Asmussem E and Diets chi D et al., there are three types of composite resin discolorations:

- **Extrinsic discoloration**: This is caused by the accumulation of plaque and superficial pigments.
- **Intrinsic discoloration**: This is caused by the aging of material itself.
- **Alteration of the surface colour**: due to superficial degradation or mild penetration and reaction of the staining agents on the inner side of superficial composite resin layer. Apart from the technique and the finishing and polishing procedures used, microleakage occurs, facilitating the inlet of water and accelerating degradation and discoloration of the material (Olio G et al., 1992).

There is extensive research that has reported the harmful effects of coffee, tea, grape juice, yerba mate and cola drinks on dental composite resins (Geraldo et al., 2011). The effect of pH of different media on the surface texture of commonly used resin composites have also been investigated (Fontes et al., 2009). Recent literature reported the colour changes promoted by lemon juice, carrot juice, red wine, snow cone syrup and grape drink (Guler AU et al., 2009)

According to Chittem et al., 2017, Spectrophotometers are more accurate in measuring the colour change than colorimeters, as they contain monochromators & photodiodes that measure the reflectance curve of a products colour every 10nm or less. Hence this instrument Microplate absorbance was used. It has been revealed that different beverages are the contributing factors to composite colour stability. If the resin matrix is capable of absorbing water, it is also capable of absorbing any other fluid, which ultimately leads to discoloration. Water sorption is mostly due to direct absorption in the resin matrix. [3]

The Nanohybrid Composite comprises of BIS-GMA, UDMA, BIS-EMA, PEGDMA, TEGDMA, surface-modified zirconia/silica (3u or less) non-agglomerated/ non-aggregated with a particle size of 20 nm surface-modified silica, 68% by volume. The Micro hybrid composite restorative material is composed of BIS-GMA, UDMA, BIS EMA, Zirconia/silica fillers with a particle size of 0.01-3.5mm, 66% by volume. (Supplementary Table 1)

Glass filler particles cannot absorb water, yet they can contribute to water adsorption at the surface of the material. The filler average particle size is 0.6 µm. Moreover, it has been noted that a composite with large filler particles, are more prone to water aging discoloration than a composite with small filler particles, which is in line with hydrolytic degradation matrix filler interfaces. [4] Hence this study used lesser particle size in nano composite which was less prone to water aging & thereby produce less discoloration this is in accordance with this chittem et al. Different studies have shown that the presence of TEGDMA in materials cause a high amount of hydrophilic capacity & more sensation of BIS-GMA to tonality & water absorption in comparison to ultra-DMA (UDMA). [5,6]

UDMA is more resistant to stain the BIS-GMA. Also, lower water sorption happens in the same situation. Thus, a composite with larger filler particles has more colour permeability than a composite with smaller filler particles. [7] Accordingly, we can conclude that the Z100 composite, in the presence of small-to-large filler particles, with a BIS-GMA & TEG-DMA resin base, is

more prone to colour discoloration & water sorption. As we know composite z 100 is a micro hybrid composite with small & large filler particles, so after finishing & polishing procedure, many voids are left on the composite surface, which affect its quality & also increases the external discoloration. In the present study the colour changes in tea & black plum were different after 30 days of immersion. Discoloration by tea due to adsorption of polar colorants onto the surface of the resin composite materials could be removed by brushing the teeth.

The black jamun (Syzygium cumini L.) is an important indigenous plant of the family Myrtaceae originally from Indonesia and India. It is a big, evergreen tree widely distributed in different agro-climatic conditions in South Asia but remains underutilized. The leaves and fruits of black jamun have medicinal properties. The fruit pulp and seeds are sweet, acrid, sour, tonic and cooling, and are used in diabetes, diarrhoea and ringworm. The bark is astringent, sweet, sour, diuretic, digestive and anthelmintic (Benherlal and Arumugam 2007). Discoloration by jamun is due to the presence of anthocyanins, oxalic acids, gallic acid, tannic acid and certain alkaloids which deposit onto the surface of teeth and difficult to remove without professional oral prophylaxis.

Conclusion

With the limitations of this study, colour stability of micro-hybrid composite resin was found to be inferior than the nano resin composite irrespective of immersion medium & time. The current study showed that among the staining solution used, tea showed maximum staining for all the tested resin-based composites. Least stainability was observed in nano composite 3m espe (filtek z250 xt). Whereas micro hybrid composite 3m showed higher amount of stainability by all the tested solutions used. Daily intake of food with staining ability such as tea & black plum can compromise aesthetics of restorative materials. All efforts should be made to minimize discoloration of composite restorations by adopting excellent polishing techniques. Patients (especially in younger age) should also be educated on the possibility of the restoration to stain under the influence of beverages. However further studies are required to throw light upon the discoloration caused by our daily food & beverage intake.

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Supplementary Figure 1

Artificial Saliva Black Jamun Tea (Taj Mahal)

Supplementary Table 1

Material	Product	Category	Composition	Manufacturer
Resin-based composites	Z 250 xt	Nano hybrid universal restorative.	Bis-gma, udma, bis-ema, pegdma, tegdma, surface-modified zirconia/silica (3u or less) non-agglomerated/ non-aggregated 20 nanometre surface-modified silica particles 68% by volume.	(3m espe, St. Paul, min, USA).
	Z 100	Universal micro hybrid composite.	Bis-gma, udma, bis ema, zirconia/silica fillers (0.01-3.5mm) 66% by volume.	(3M ESPE, ST. PAUL, MN USA)

Supp Table 1: Composition & product category of resin-based composites.