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ORIGINAL ARTICLE

# A SPECTROPHOTOMETRIC EVALUATION OF COLOUR STABILITY OF COMPOSITE RESINS EXPOSED TO DIFFERENT LIQUIDS COMMONLY CONSUMED BY CHILDREN – AN INVITRO STUDY

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## ABSTRACT

**PURPOSE**: The purpose of this study was to assess the colour stability of three different composites under various staining solutions

**METHOD**: 100 disks (3mm thick and 10mm in diameter) were prepared from three types of composites: (1) Micro hybrid composites (2) Nano composites (3) Hybrid composites. After polishing and obtaining the baseline data, they were equally divided into 4 groups and immersed into 1 of 4 liquids at 37 degree Celsius, (1)Fanta (2) Bournvita (3) Grape Juice (4) Distilled Water. After 1week, 1 month, 2 months they were measured for colour change. Colour difference of each specimen were measured by spectrophotometer.

**RESULT**: The datas were compiled, and statistical analysis were performed, using one –way ANOVA and Tukey – HSD procedure at 5%significant level.

**CONCLUSION**: The results of the study indicated that Nanocomposite is more stain resistant when compared to other 2 composite resins. Maximum staining was present in Grape juice followed by Bournvita, Fanta, and Distilled Water over an extended period of time.

**KEYWORDS**: Microhybrid composite resins, Nanocomposites, Hybrid composites, Spectrophotometer, Beverages

## INTRODUCTION

Dentists and patients have developed a more discerning eye and a preference for proper shade match and more aesthetic results. Resin composite materials have been used for many years in dentistry with great success and high patient acceptance[1]. An important factor in the success of an aesthetic restoration is the colour stability of the material over time[2,3,4,5].

Several factors are known to impact colour stability of the composites. Different factors can precipitate the staining of samples during polymerization, finishing and storage[6,7]. Although a high-gloss surface is generally considered to be less susceptible to staining, other surface conditions, such as incomplete polymerization of the resin matrix, may lead to the surface staining of composites[8]. Microcracks, Microvoids or interfacial gaps located at the interface between the filler and the matrix are the most likely penetrating pathways of stains[9].

The oral environment, however, is exposed to a variety of challenges and the change in the dietary patterns of children which influences the colour stability of composites[10]and most of the staining occurs within the first 7-10 days[11], during which most of the water sorption takes place[12,13]. Actual staining in the mouth would require a longer period of time to occur because of dilution by saliva and daily oral hygiene practices[13]. The effect of staining solution on colour changes of composite resins is material dependent[14] considering these facts, the present study was conducted to assess the colour stability of Microhybrid composites, Nanocomposites and Hybrid composites under various staining solutions like fanta, bournvita, grape juice and water was taken as control.

## METHODOLOGY

300 specimens of 100 in each group were prepared with (1) Microhydrid composites (3M ESPE Filteck Z250) (2) Nanocomposites (3M ESPE Filteck Z350) (3) Hybrid composites (3M ESPE Filteck Z100). The test specimens were made by injecting the resin into a split polytetrafluoroethylene mold 3mm thick & 10mm in diameter. The resin was carefully packed, ensuring that the mold was filled. Extra material was expelled by pressing down with a mylar/glass slide. The specimen's lower side was light cured with a halogen curing light according to manufactures instructions. This surface is used as the working surface. The specimens were turned over and the opposite side was also light cured. The intensity of curing light was monitored with a radiometer. The specimens were stored overnight in a 37° C incubator.

Following the preparation of the composite resin specimens, they were polished with a high-speed carbide no.7901 bur and sofulex(3M ESPE) composite resin polishing discs according to the following procedure. The carbide finishing bur was used to replicate the initial finishing in clinical situations. They were polished, in order,with a:1) black coarse sof-Lex discs for 90 seconds at a speed of 5000rpm; 2) dark blue medium disc for 30 seconds at a speed of 5000rpm; 3)medium blue fine disc for 30 seconds at a speed of 10,000rpm;4) light blue superfine disc for 30 seconds at a speed of 10,000rpm. New Sof-Lex disks were used with each specimen.

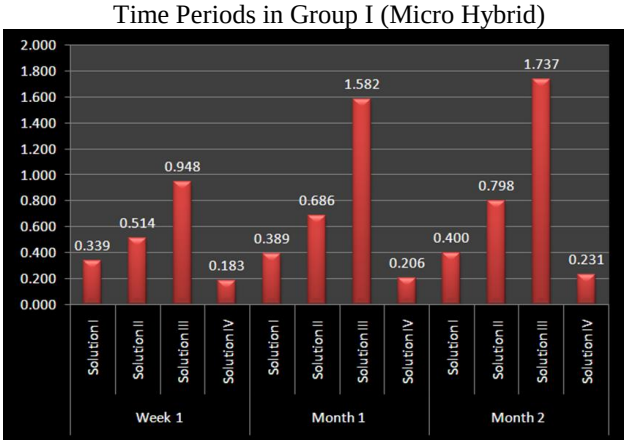
Hundred specimens were made from each of the 3 composite types and divided into 4 groups of 25 for immersion into one of the 4 liquids: (1) carbonated drinks(Fanta: a product of coco-cola company),(2) Malt drinks ( Bournvita: a product of Cadbury), (3) Fresh fruit juice (grape juice), (4) distilled water (as control). Prior to staining the color of the composite disks were measured with spectrophotometer for baseline data.

After baseline measurement, 25 samples were placed into a clean, dry Petridish and then completely immersed in their previously assigned staining liquids twice daily once in the morning and once in the evening for duration of 5 minutes each and the specimens are taken out from the solution and placed in artificial saliva. Following this immersion, the petridishes were covered and placed in an incubator at 37 ° C. After 1 week, the samples were removed from the incubator, drained, slightly rinsed with distilled water, partially dried with compressed air, and then allowed to completely air dry. The specimens were handled with powder free latex gloves and they were only held at the edges. Once dried, they were measured again for colour stability with spectrophotometer. Following the readings, the composites discs were again immersed in fresh staining liquids and replaced in artificial saliva and then placed in the incubator and measured after 1 month and 2 months for colour change and the results were noted. Data was compiled and was subjected to statistical analysis.

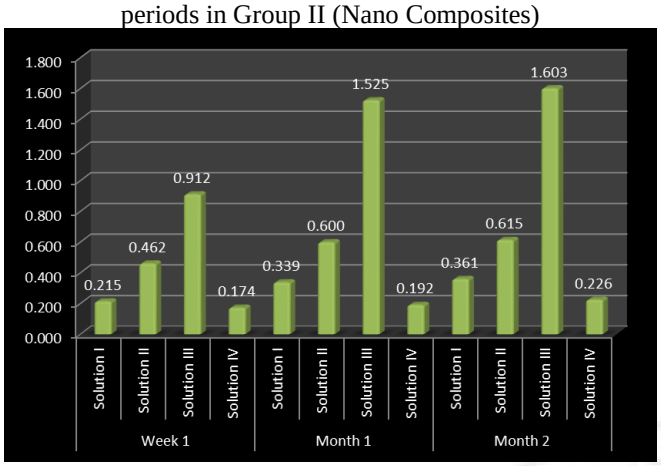
## RESULTS

The mean values in different solutions at various time periods are shown for microhybrid, nano composites and hybrid composites in graph 1, 2 and 3 respectively. Table 1, 2. 3 and 4 shows the comparison of mean values among different study groups for all the four different solutions.

Graph 1: Mean Values in Different Solutions at Various Time Periods in Group I (Micro Hybrid)



Graph 2: Mean values in different solutions at various time periods in Group II (Nano Composites)




Graph - 3 Mean Values in Different Solutions at Various Time Points in Group III (Hybrid Composites)

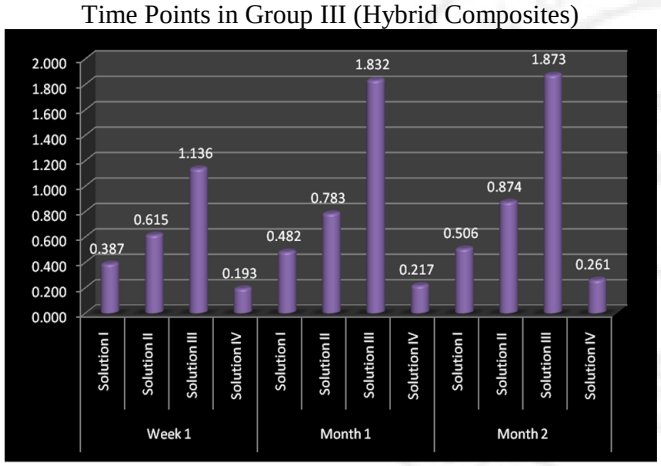



TABLE - 1

Comparison of mean values among different study groups for solution- I (Carbonated Drink - Fanta)

| Time Point | Group | Mean ± S.D. | Overall P-value* | Significant Groups$ |
|---|---|---|---|---|
| Week – 1 | I | 0.339 ± 0.025 | <0.0001 (Sig.) | I vs. II, III<br>II vs. III |
| | II | 0.215 ± 0.014 | | |
| | III | 0.387 ± 0.008 | | |
| | | | | |
| Month – 1 | I | 0.389 ± 0.045 | <0.0001 (Sig.) | I vs. II, III |
| | II | 0.339 ± 0.016 | | II vs. III |
| | III | 0.482 ± 0.016 | | |
| | | | | |
| Month – 2 | I | 0.400 ± 0.046 | <0.0001 (Sig.) | I vs. II, III<br>II vs. III |
| | II | 0.361 ± 0.011 | | |
| | III | 0.506 ± 0.019 | | |

*One Way ANOVA was used to calculate the P-value.
$Tukey – HSD procedure was employed to identify the significant groups at 5% level.
Nano composite stained least with fanta when compared to the other materials throughout the study period.

TABLE - 2

Comparison of Mean Values among Different Study Groups for Solution- II (Malt Drink - Bournvita)

| Time Point | Group | Mean ± S.D. | Overall P-value* | Significant Groups$ |
|---|---|---|---|---|
| Week – 1 | I | 0.514 ± 0.023 | <0.0001 (Sig.) | I vs. II, III<br>II vs. III |
| | II | 0.462 ± 0.048 | | |
| | III | 0.615 ± 0.009 | | |
| | | | | |
| Month – 1 | I | 0.686 ± 0.046 | <0.0001 (Sig.) | I vs. II, III<br>II vs. III |
| | II | 0.600 ± 0.042 | | |
| | III | 0.783 ± 0.018 | | |
| | | | | |
| Month - 2 | I | 0.798 ± | <0.0001 | I vs. II, III |

| | | | | |
|---|---|---|---|---|
| | | 0.014 | (Sig.) | II vs. III |
| | II | 0.615 ± 0.043 | | |
| | III | 0.874 ± 0.017 | | |

Grape juice caused maximum staining of the Microhybrid composite throughout the study period followed by Bournvita and Fanta and least by distilled water. The amount of staining increased with time and was rapid upto 1 month followed by gradual increase in the amount of staining

*One Way ANOVA was used to calculate the P-value.

$Tukey – HSD procedure was employed to identify the significant groups at 5% level.
Nano composite stained least with bournvita when compared to the other materials throughout the study period.

TABLE - 3

Comparison of Mean Values among Different Study Groups For Solution- III (Fruit Juice – Grape juice)

| Time Point | Group | Mean ± S.D. | Overall P-value* | Significant Groups$ |
|---|---|---|---|---|
| Week – 1 | I | 0.984 ± 0.085 | <0.0001 (Sig.) | I vs. II, III<br>II vs. III |
| | II | 0.922 ± 0.017 | | |
| | III | 1.136 ± 0.039 | | |
| | | | | |
| Month – 1 | I | 1.582 ± 0.127 | <0.0001 (Sig.) | I vs. II, III<br>II vs. III |
| | II | 1.525 ± 0.025 | | |
| | III | 1.832 ± 0.065 | | |
| | | | | |
| Month - 2 | I | 1.737 ± 0.057 | <0.0001 (Sig.) | I vs. II, III<br>II vs. III |
| | II | 1.603 ± 0.110 | | |
| | III | 1.873 ± 0.034 | | |

*One Way ANOVA was used to calculate the P-value.

$Tukey – HSD procedure was employed to identify the significant groups at 5% level.
Nano composite stained least with grape juice when compared to the other materials throughout the study period.

TABLE 4

Comparison of Mean values among different study groups for solution- IV (Distilled Water)

| Time Point | Group | Mean ± S.D. | Overall P-value* | Significant Groups$ |
|---|---|---|---|---|
| Week – 1 | I | 0.183 ± 0.006 | <0.0001 (Sig.) | I vs. II, III<br>II vs. III |
| | II | 0.174 ± 0.008 | | |
| | III | 0.193 ± 0.006 | | |
| | | | | |
| Month – 1 | I | 0.206 ± 0.008 | <0.0001 (Sig.) | I vs. II, III<br>II vs. III |
| | II | 0.192 ± 0.007 | | |
| | III | 0.217 ± 0.011 | | |
| | | | | |
| Month - 2 | I | 0.231 ± 0.011 | <0.0001 (Sig.) | I vs. III<br>II vs. III |
| | II | 0.226 ± 0.012 | | |
| | III | 0.261 ± 0.006 | | |

Rapid staining took place within 1st month followed by a gradual increase in the amount of staining, but the pattern of staining with different solutions remained the same i.e, maximum staining with grape juice followed by bournvita, fanta, distilled water. With respect to materials Nano composites showed minimal color change compared

with other 2 materials.

## DISCUSSION

In aesthetic dentistry, composites play a major role both adults as well as for children. The long term success of these materials will be influenced by variety of factors one among them is the colour stability which will be directly influenced by dietary habits of children. With effect of media and change in the culture, altered food pattern with more attraction toward the coloured beverages and candies ultimately caused some amount of staining on the restorative materials. Nandhini G Ashok[15] in her review article discussed about the role of various dietary materials like tea & coffee, beverages, grape juice, cherry juice, soya sauce on the staining of composites. Hanisha Adusumilli[16] tested the role of liquids and beverages consumed by the children on the colour stability of aesthetic (tooth coloured) restorative materials. Hence the present study included the beverages with wide spectrum of colours and their influence on 3 commonly used restorative materials that is the microhybrid composite, nano composite and hybrid composites.

Colour determination in dentistry can be divided into two categories: Visual and instrumental[17]. Colour perception by visual assessment of object is a subjective, physiologic, psychologic process that varies between and within persons. This variability is a result of several factors, including observed object and illuminant position relative to the observer and to each other, colour characteristics of the illuminant, metamerism, fatigue, aging and emotional state of the observer[18].

Instrumental Calorimetry can potentially eliminate subjective errors in colour assessment. Calorimetry is more accurate and exact than naked eye in measuring slight differences in coloured objects in flat surfaces[17].

Since instrumental measurements eliminate the subjective interpretation of visual colour comparison, colorimeters and spectrophotometers have been commonly used to measure colour change in dental materials[19,20,21]. Spectrophotometers have been shown to be more accurate in measuring the colour change than colorimeters[22].

A Spectrophotometer is a photometer (a device for measuring light intensity) that can measure intensity as a function of the colour, or more specifically, the wavelength of light[22].The Spectrophotometer measures quantitatively the fraction of light that passes through a given sample.

In the present study, the CIELAB system was used for colour measurement. According to Okubo.S and Kanawati[22], the use of CIE L*a*b* system is recommended for dental purpose[23]. The CIE L*a*b* colour system characterizes colour based on human perception. It is a method developed in 1976 by the Commission Internationale de I'E clairage for characterizing the colour. It designates colour according to 3 spatial coordinates, L*a*b* where L represents the brightness (value) of a shade, a* represents the amount of red – green colour and b* represents the amount of blue- yellow color[24].

The thickness of the disc prepared in the study was 3mm thick & 10mm in diameter because, the effect of increasing thickness on colour depends on the colour of the background. For a white background as might be represented by human enamel, an increase in thickness of resin resulted in decreasing values of luminous reflectance and excitation purity. Clinically, the resin might appear darker and less chromatic as thickness increases.

The clinical effect of increasing the thickness of the direct restorative resin studied from 1.3-3.9mm is to increase dramatically the opacity of the resin as measured by the contrast ratio[26].

Similar study done by Joseph A.Curtain,Huan Lu[1], compared 3 types of composites, submicron, nanocomposite and microhybrid composite restoration and showed the maximum stain resistant with Nanocomposite ( Tetric evo ceram) and staining was more with grape juice than drinking water.Bagheri. R, M.F. Burrow[17,26,27,28]conducted a study to determine the surface staining of resin based composites and GICs after immersion in red wine,coffee,tea,soy sauce & cola, and concluded that staining was minimal with resin based composites and coffee, tea, red wine stained more when compared to soy sauce & cola.

Gupta. R, Prakash. H[22]conducted a study to compare the colour stability of tooth coloured veneers after exposure to commonly used beverages. He compared the colour stability of porcelain and 2 universal composites (Z250 & Tetric Ceram) after exposure to tea, coffee, coco-cola and distilled water and concluded that all the 3 materials showed a statistically significant change in all the solutions after a period of 1 month as well as after 4 months when compared with the value at 1st day. Similar findings were observed by Maria Luisa de Alencar etal[29]with more staining of the restorative materials made of grapes compared to carbonated drinks. Ahmed Nour El-din Ahmed Habib[30]in their study concluded that the clinically unacceptable colour changes of the tested resin dental composites immersed in chocolate milk, orange fizzy and mango juice.

In present study, the colour measurement was done at 1 week, 1 month, and 2months intervals. The results were statistically analysed using One Way ANOVA and Tukey-HSD test, it revealed that colour change was more with Grape Juice followed by Bournvita, Fanta and Distilled water. Hybrid Composite showed highest colour change when compared with the other composites while Nano Composite showed minimal colour change when compared with the other two groups.

## CONCLUSION

Nano composite (Z250) was found to be the most

stain resistant material among the 3 dental composites tested; Fruit juice (grape juice) stained materials more than malt drinks & carbonated drinks. This is an invitro observation, the same should be confirmed invivo, with different clinical scenario were the contact of the liquid on the tooth surface is minimal, when liquids are consumed by cups or when liquids and tooth surface are in contact for a longer time if they are consumed by bottle using solutions with known specific pH range.

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**CONFLICTS OF INTEREST:**

There are no conflicts of interest.

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