Research Article

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Spectrophotometric Evaluation of Colour Stability of A Nanocomposite on Exposure to Commonly Consumed Fruits and Salads: An *In Vitro* Study

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ABSTRACT

Background: Resin composites can simulate the natural shade of the tooth. However, few commonly consumed fruits and salads can stain them due to the property of adsorption.

Aim: This study aims to evaluate the colour stability of composite resin on exposure to commonly consumed fruits and salads.

Material and Methods: Sixty disc-shaped specimens of a nanocomposite resin (Tetric N Ceram, Ivoclar, Vivadent AG, Schaan, Liechtenstein) were prepared with a template of 5mm diameter and 2mm thickness. They were randomly divided into six groups. Specimens were immersed into fresh juices of beetroot, carrot, mulberry, pomegranate, tomatoes and artificial saliva (control) for 15 days. Colour values were measured before and after the immersion of specimens, with CIE L*a*b* system using a Spectrophotometer (LabIndia Analytical, UV 3092).

Statistical analysis: The values obtained were statistically analyzed using ANOVA test followed by posthoc Tukey test, with the significance of $P < 0.05$, using IBM SPSS statistics for windows, version-19.0.

Results: The mean ΔE value of Group I (beetroot) after immersion was significantly higher than other groups, with a mean ΔE value of 4.4674±0.669.

Conclusion: Fruits and salads do have the potential to stain the resin composites due to the presence of organic pigments.

Keywords: Fruits; nanocomposites; salads; spectrophotometer; staining.

INTRODUCTION

Aesthetic dentistry aims at characterizing and personalizing smile, where colour, shape and surface texture play a major role[1]. Colour consistency and colour stability of the restorative material, which is generally a resin-based composite material, are one of the primary factors for a successful aesthetic restoration[2]. To meet the patient demands and to mimic the appearance of natural tooth, artistic abilities along with thorough

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knowledge of the underlying scientific principles of colour are essential[3].

Composite resins undergo discolouration due to extrinsic and intrinsic factors. Physicochemical discolouration reactions in the matrix, surface and deeper layers of the material, could be due to UV radiation, humidity or thermal energy. Series of responses involving the oxidation in the amine accelerator, unreacted methacrylate groups and structure of the polymer matrix contribute to the intrinsic factors of the material[4]. Rate of water sorption, surface roughness and surface integrity, polishing techniques, oral hygiene maintenance and dietary habits are some of the extrinsic factors resulting in the discolouration of the composite resin[5].

In order to address the critical issue of long term aesthetics, newer composites with combined properties of earlier used composites like hybrid and micro filled composites have been introduced namely "nano filled hybrid"composites. These being the recent and most widely used restorative materials. There has been a significant improvement in the surface texture, smoothness/polish retention of nanofilled hybrid composites as compared to the conventional restorative resins.

Restorations are continuously exposed to the oral environment, which may have an effect on their properties and lead to surface roughness, thereby causing discolouration. Discolouration due to extrinsic staining can be treated by polishing, but intrinsic stains cannot be removed superficially and might demand replacement of the restoration. Various studies showed discolouration of composites due to different oral beverages including tea, coffee, soft drinks, wine, fruit juices etc[6, 7]. But the effect of commonly consumed fruits and salads on colour stability of composites has not been discussed so far. Therefore, this study tested the null hypothesis that the colour stability of a nanocomposite (Tetric N Ceram, Ivoclar, Vivadent AG, Schaan, Liechtenstein) is not affected on exposure to commonly consumed fruits and salads such as beetroots, carrots, tomatoes, mulberries and pomegranate.

MATERIALS AND METHODOLOGY

Resin composite of shade A_1- a nanocomposite (Tetric N Ceram, Ivoclar, Vivadent AG, Schaan, Liechtenstein) was used in this study. A total of 60 disk-shaped specimens of 5mm in diameter and 2mm in thickness were prepared. The composite was placed into Teflon mould and covered with mylar strip. A glass plate was applied on the top of the mylar strip in order to remove excess material to obtain a flat surface and to protect the resin composite from oxygen inhibition. The composite was cured through the glass plate and mylar strip for 40 seconds with the visible light-curing unit (Hilux, Ledmax-550, Benlioglu, Turkey). The Teflon mould was reversed and the mylar strip was placed on it to cure the resin composite from the other side of the mould for another 40 seconds.

Sixty specimens were randomly divided into six groups. The specimens were stored in distilled water for 24 hours at 37^0 C before the baseline colour evaluation. Baseline colours of the resin composites were measured with UV-Visible Spectrophotometer (LabIndia Analytical, UV 3092) using the CIE L* a*b* (Commission Internationale de l' Eclairage) system. ΔE* denoted the colour difference and was determined using the following equation[7]:

$$\Delta E^* = ([\Delta L^*]^2 + [\Delta a^*]^2 + [\Delta b^*]^2)^{1/2}$$

Where,

L- Denotes the lightness (value),
a- Denotes the green-red chromatic coordinate, and
b- Denotes the blue-yellow chromatic coordinate.

Following the baseline measurements, specimens were randomly divided as follows: Group I- Beetroot; Group II- Carrot; Group III- Mulberry; Group IV- Pomegranate; Group V- Tomato; Group VI–Artificial saliva (Control). The specimens in each group were immersed in fresh juices of respective groups for 30 minutes/day at room temperature and were manually agitated. After each immersion, the specimens were washed with mineral water daily for 10 seconds and stored in artificial saliva where it was agitated manually in a periodic fashion of once per hour, during day time. This immersion cycle was conducted for 15 days.

The colour measurements were once again performed after 15 days. All the measurements were obtained by the same investigator. All the specimens were rinsed with mineral water and wiped dry using tissue paper. Baseline and 15th-day measurements were performed on the same surface of the specimens. Colour changes of the specimens were recorded using Spectrophotometer. Before each measurement, the Spectrophotometer was calibrated according to the manufacturer's recommendations using the supplied white calibration standard illuminate D65.

Table 1: Values of one-way ANOVA.

Group	Before immersion			After immersion		
	Mean ΔE	Std. Deviation	P –value	Mean Δ E	Std. Deviation	P –value
Group I	.8857	.04250		4.4674	0.6695	
Group II	.8923	.03855		1.5276	0.2708	
Group III	.8987	.05041	0.977	0.8505	0.0946	<0.001
Group IV	.8977	.04375		2.3198	0.2899	
Group V	.8906	.05876		0.9241	0.2172	
Group VI	.9015	.04610		0.9015	0.0461	

Table 2: Paired t-Test compared the values before and after the immersion.

Group	Mean	Std. Deviation	P values
Group I	3.58163	0.64780	0
Group II	0.63534	0.28325	0
Group III	0.04719	0.10265	0.180
Group IV	1.42106	0.28735	0
Group V	0.06783	0.20235	0.317
Group VI	0.04682	0.10378	0.172

Data were analysed by IBM SPSS statistics for windows, Version 19.0 (Armonk, NY: IBM Corp, USA) and summarized by mean ± standard deviation for continuous data. The comparison between groups was made by one-way analysis of variance test followed by the post hoc Tukey test, with the significant level set at $P < 0.05$.

RESULTS

A one way ANOVA, which was performed to test the mean ΔE along with the six groups before and after immersion, was statistically significant after the immersion (Table-1). Further, Tukey's post hoc analysis revealed that the mean of Group II (beetroot) was significantly higher than that of the other groups, after immersion. A paired t-test (Table-2) compared and revealed the colour difference between each group, before and after immersion.

DISCUSSION

A well done aesthetic restoration can still fail, after a given period of time, because of various reasons such as poor bond strength, wearing off of the restoration and discolouration. Amongst all these reasons, discolouration is the least acceptable reason for the patient. Post restoration, any discoloured tooth can mentally affect the patient's self-esteem and level of confidence. Discolouration could be either extrinsic or intrinsic. The most common cause of discolouration in an aesthetic restoration is extrinsic. This could be because of

habits like tobacco chewing, consuming beverages like carbonated drinks, energy drinks, wine, tea, and coffee. Indian spices and food colourants also cause discolouration[8]. Commonly consumed seasonal fruits and salads could also contribute to the discolouration of the teeth and restoration. No studies are available to quantify the staining potential of these fruits and salads on the tooth and restoration, especially composite restoration. The present study evaluates the colour stability of composites to commonly consumed fruits like mulberries, pomegranate and salads like beetroot, carrot and tomato.

Different antioxidants, in the form of pigments, present in each group are responsible for causing staining. Beetroots contain betanin, indicaxanthin and vulgaxanthins[9]; carrots contain beta-carotene[10], mulberries and pomegranates contain anthocyanins[11, 12] and tomatoes contain lycopene[10]. These groups stain the resin by both adsorption and absorption of its pigments into the organic phase of the resin composite[8]. Absorption is a process in which atoms, molecules or ions enter the bulk phase of a liquid or solid material. Whereas, adsorption is the adhesion of atoms, ions or molecules from a gas, liquid or dissolved solid to a surface. This creates a film on the surface of the adsorbent.

All the groups used in this study were selected due to their regular consumption in daily life. To simulate the clinical conditions, all the specimens were washed for 10 seconds under mineral water to depict the usual use of water after eating, and they were immersed in the artificial saliva in between the immersion cycles. A Spectrophotometer and the CIE L^* a* b* coordinate system were used due to its repeatability, sensitivity, objectivity and determination of small colour changes[13].

Methacrylate based nanohybrid composites (Tetric N Ceram–Ivoclar, Vivadent AG, Schaan, Liechtenstein) was used in the study. The manufacturer claims that the optimum combination of the glass fillers, spherical mixed oxides and reduced shrinkage ensures high strength and minimal wear - a sound basis for long-lasting restorations and consequently satisfied patients. The better surface finish of this composite is due to its relatively less hard filler constituents- barium glass, ytterbium. By using glass microfilter with a mean particle size of 0.6 µm, the wear of Tetric N Ceram is improved. Reduced shrinkage reduces microleakage, which in turn inhibits seepage of water or pigments into resin material. The other added advantages include their high radiopacity, wear resistance and excellent polishability with high glossy appearance[14]. No studies have referred the adsorption capacity of pigments present in fruits and salads into the resin material so far.

The Expert Committee of the Indian Council of Medical Research, taking into consideration the nutrient requirements, has recommended that every individual should consume at least 300gms of vegetables a day. In addition, fresh fruits (100gms) should be consumed regularly. This should include commonly consumed leafy greens, tomatoes and other vegetables, fruits that are rich in vitamin C and those who are yellow, red, deep red, purple coloured. Importance of fruits and salads in the daily diet is because they are rich in antioxidants.

According to the National Bureau of Standards (NBS) system of expressing colour differences, ΔE NBS Criteria- 0–0.5 Trace: Remarkably slight alteration; 0.5–1.5 Slight: Slight modification; 1.5–3 Noticeable: Observable change; 3–6 Appreciable: Apparent alteration; 6–12 Much Appreciable: Remarkably apparent alteration; 12 or more Very much Appreciable: Alteration to another colour (NBS unit = $\Delta E \times 0.92$)[2].

The colour difference (ΔE) produced in samples after immersion in beetroot juice (mean value: 0.8857±0.0425) was much higher than the clinically appreciable level. Mulberry juice also caused discolouration of composites after 15 days of immersion, if not to the clinically appreciable level, at least to clinically noticeable level. Carrot juice stained the resin more than pomegranate and tomato juice. Therefore, the null hypothesis was rejected based on the fact that fruits and salads stained the composite resins at the end of this experimental study.

The pigments found in all the experimental groups are commercially used as dyes for various purposes like dyeing of fabrics, papers, oils, as food colourants etc. indicating the chances of staining of the restorative material[15].

But within the oral cavity, more extended staining period may be required to cause a clinically

perceptible colour change. This could be due to the cleansing action of saliva in oral activity, and the daily rinsing and brushing action by an individual for oral hygiene maintenance. Therefore, patients should be advised to rinse the mouth after consumption of food products that could discolour the restoration. In addition, patients can also consume such food products in combination with those having bleaching action. For example, cucumber may have bleaching property when consumed raw, as they are generally used to reduce pigmentation of skin[16].

There are studies reporting that composites and stains behave differently with a time of immersion[1]. This experimental study has not taken into consideration the colour changes assessment at the periodic interval because the real consumption, amount, and frequency of these fruits and salads may vary based on their seasonal availability and different food habits.

Additionally, static solutions of immersions do not represent the dynamic nature of the oral cavity. Hence manual agitation was performed to simulate the oral environment to a possible extent. The pH of the solutions might also have an effect on the surface degradation of the composites, and polishing procedures, on the staining ability, were not included in the current study. Therefore, the aging process, pH and polishing procedures should be included in further education along with standardizing the temperature of the immersion medium.

CONCLUSION

Within the limitations of the study, it can be concluded that fruits and salads do have the potential to stain resin composites due to the presence of organic pigments. Further studies are required to correlate the other variables such as time, ageing and pH concentration of the staining solutions.

CONFLICTS OF INTEREST

The authors declare they have no potential conflict of interests regarding this article.

REFERENCES

1. Samra APB, Pereira SK, Delgado LC, Borges CP. Color stability evaluation of aesthetic restorative materials. Braz Oral Res. 2008;22(3):205-10.

2. Özdaşa DO, Kazakb M, Çilingirc A et al. Color stability of composites after short-term oral simulation: An in vitro study. The Open Dentistry Journal. 2016, 10, 431-7.

3. Sikri VK. Color: Implications in dentistry. J Conserv Dent. 2010;13:249-55.

4. Ashok NG, Jayalakshmi S. Factors that influence the color stability of composite restorations. Int J Orofac Biol. 2017;1:1-3.

5. Malekipour MR, Sharafi A, Kazemi S, Khazaei S, Shirani F. Comparison of color stability of a composite resin in different color media. Dent Res J (Isfahan). 2012 Jul-Aug; 9(4): 441-6.

6. Kumari RV, Nagaraj H, Siddaraju K, Poluri RK. Evaluation of the effect of surface polishing, oral beverages and food colorants on color stability and surface roughness of nanocomposite resins. Journal of International Oral Health. 2015;7(7):63-70.

7. Fontes ST, Fernández MR, Moura CM, Meireles SS. Color stability of a nanofill composite: Effect of different immersion media. J Appl Oral Sci. 2009;17(5):388-91.

8. Usha C, Rao SR, George GM. A comparative evaluation of the staining capacity of microhybrid and nanohybrid resin-based composite to Indian spices and food colorants: An in vitro study. Indian J Dent Res. 2018;29:201-5.

9. Rahimi P, Abedimanesh S, Mesbah Namin SA, Ostadrahimi A. Betalains, the nature-inspired pigments, in health and diseases. Critical Reviews in Food Science and Nutrition. 2018.

10. Llorente B, Martinez-Garcia JF, Stange C, Rodriguez-Concepcion M. Illuminating colors: Regulation of carotenoid biosynthesis and accumulation by light. Current Opinion in Plant Biology. 2017,37:49–55.

11. Yuan Q, Zhao L. The mulberry (Morus alba L.) fruit- A review of characteristic components and

health benefits. J. Agric. Food Chem. 2017,65,10383−94.

12. Dorris MR, Voss DM, Bollom MA, Krawiec-Thayer MP, Bolling BW. Browning index of anthocyanin- rich fruit juice depends on pH and anthocyanin loss more than the gain of soluble polymeric pigments. J Food Sci. 2018, Apr;83(4):911-21.

13. Malhotra N, Shenoy RP, Acharya S, Shenoy R, Mayya S. Effect of three indigenous food stains on resin-based, microhybrid-, and nanocomposites. J Esthet Restor Dent. 2011 Aug;23(4):250-7.

14. Palani Swamy UK, Amravai AR, Mandadi SR, Habeeb A. Effect of alcoholic beverages on shear bond strength of composites to enamel. J Conserv Dent. 2018;21:542-5.

15. Anna Marzec. The effect of dyes, pigments and ionic liquids on the properties of elastomer composites. Polymers. Université Claude Bernard - Lyon I. 2014.

16. Kumar D, Kumar S, Singh J, Narender, Rashmi, Vashistha B, Singh N. Free radical scavenging and analgesic activities of Cucumis sativus L. fruit extract. J Young Pharm. 2010 Oct;2(4):365-8.