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Original Article

ASSESSMENT OF COLOUR STABILITY OF FOUR DIFFERENT COMPOSITE RESINS IN THE PRESENCE OF DIFFERENT BEVERAGES AND VARIABLE IMMERSION TIME : AN INVITRO STUDY

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ABSTRACT

Background: The present study was undertaken to evaluate the most suitable recent Compositematerial for restoration of anterior teeth.

Materials and methods:Thirty discs of composite samples were made using fibermould rings of 2 mm thickness and 10 mm diameter, in each composite group.GC Solare X GC ASIA ,Stellite Sigma TOKYUAMA DENTAL, Tetric Evo-Ceram IVOCLAR VIVADENT, SwissTEC COLTENE.All the 120 samples were not exposed to any beverages and were taken as the control group. Once the baseline values are obtained, the specimens were exposed to coffee, tea and saline with 10 samples from each group for each beverage. After every 8 hours old beverages were changed with freshly prepared beverages, after 24 hours of exposure the samples were tested using a spectrophotometer and reimmersed in the beverages for another 24 hours and the samples were tested

Results:Staining at 24 hours are as follows –GC Solare X followed by Tetric Evo-Ceram showed least staining.Staining at 48 hours are as follows –Tetric Evo-Ceram followed by GC Solare X.

Conclusion: The commonly consumed beverages coffee and tea produced colour changes on the composites tested in this study, with coffee producing more clinically significant colourchange.

Keywords: Beverages, Composite, micro-filler composite, nano-filler composite, nanohybrid composites, reflectance, spectrophotometry, supra-nano spherical hybrid.



INTRODUCCION:

Composite resins are among the most frequently used dental materials for aesthetic restorations in dental practice due to their ability to bond to enamel and dentine, resemblance to tooth structures in colour.^[1] Though the quality of composite resin restorations has improved with the advent of new technology in material sciences in recent years, discoloration of the composite resin materials remains to be a major problem in long-term clinical studies.^[2]

A major disadvantage of resin composites is their tendency to discolor, which may be a major factor in the replacement of restorations. Three types of discoloration are described in the literature: (1) External discolorations due to plaque accumulation and surface stains, (2) surface or sub-surface alterations resulting in a superficial degradation or a slight penetration and adsorption of staining agents to the superficial layer of composite resins and, (3) intrinsic discolorations due to physicochemical reactions in the composite matrix, in surface and deeper layers of the material, triggered by UV irradiation, thermal energy, or humidity.^[1]

The null hypothesis tested will be that there will be no difference in colour change in different composite materials in different staining solutions.

MATERIALS &METHOD:

In this in-vitro study we investigate the cumulative effect of the colorant solutions on the dental composite GC Solare X GC ASIA ,Stellite Sigma TOKYUAMA DENTAL, Tetric Evo-Ceram IVOCLAR VIVADENT, SwissTEC COLTENE, after 24Hours & 48 Hours in beverages such as Tea, Coffee & Normal Saline. Beverages were changed every 8hours.

Hundred and twenty disk shaped material specimens (10mm in diameter x 2mm in thickness) were prepared using a fiber mold (ring), with the desired dimensions the specimen. Were divided into four groups of 30 each. (Group I: NF Resin Composite; Group II: NHO Resin Composite; Group III: NHO Resin Composite; Group IV: NF Resin Composite). These Groups were divided into twelve subs groups (Subgroup I A: Coffee ; Subgroup I B: Tea; Subgroup I C: Normal Saline; Subgroup II A :Coffee ; Subgroup II B: Tea, Subgroup II C: Normal Saline: Subgroup III A: Coffee; Subgroup III B ; Subgroup III C : Normal



saline. Subgroup IV A: coffee subgroup IV B: Tea; Subgroup IV C: Normal saline.) Baseline colour measurements were done, all the samples were immersed in respective drinks for a period of 24 & 48 hours and color differences were measured using ultraviolet spectrophotometer. Every 8 hours old beverages were replenished with freshly made beverages. Measurements were made according to the CIE L a x b x color space relative to the CIE standard illuminant D65. The color changes of the specimens were evaluated using the following formula

$$\Delta E = \sqrt{(\Delta L)^2 + (\Delta a)^2 + (\Delta b)^2}.$$

Statistical analysis was performed. The data was analyzed using the one way ANOVA using IBM SPSS Statistics professional software at a significance level of 0.05.

SPECIMEN PREPARATION:

One twenty discs (2mm thickness, 10mm diameter) were made in total by inserting the composites into the mould. A polyester strip was pressed onto the mould surface with the glass plate in order to obtain a flat surface without bubble formation. Another glass slab with polyester strip placed over the mould. When the mould got squeezed, the excess composite was removed; uniform density

and bubble free surface was obtained. Each specimen was exposed to blue light and polymerized for 20 seconds from each sides using a LED source. It has the power density of 1400 mW/cm², 440- 480nm wavelength). The light source fixed at a distance of 1mm from each specimen. A uniform light intensity mode was used for all specimen. To prevent variations in intensity, the light curing unit was charged for 2 minutes after every 80 seconds of exposure. The values are tabulated and statistically analyzed by one-way ANOVA.

RESULTS

INFERENCES:

INTERGROUP ANALYSIS: AT 24 HOURS IN COFFEE

GC SOLARE X showed least staining values than the other three groups which were statistically not significant (p=7.3354) followed by TETRIC EVO CERAM, STELLITE SIGMA and lastly SWISSTEC COLTENE.

INTERGROUP ANALYSIS: AT 24 HOURS IN TEA

STELLITE SIGMA showed least staining values all the other groups which was statistically not significant (p= 0.079909) followed by GC SOLARE X, TETRIC EVO CERAM and lastly SWISS TEC COLTENE.



INTERGROUP ANALYSIS: AT 48 HOURS IN COFFEE

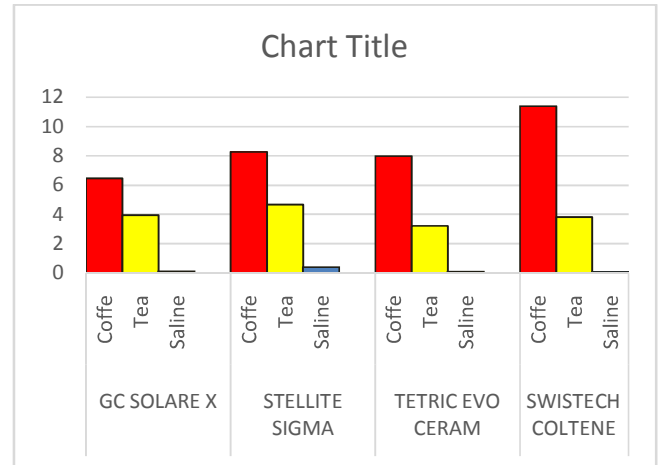
TETRIC EVO CERAM showed least staining values than all other groups which was statistically not significant ($p=7.34$) followed by STELLITE SIGMA, GC SOLARE X and lastly GC SOLARE X.

INTERGROUP ANALYSIS: AT 48 HOURS IN TEA

Group I –GC SOLARE X showed higher staining values than STELLITE SIGMA but lesser than the other groups which were statistically not significant ($p=2.74$) GROUP II- TETRIC EVO CERAM showed least staining values than all other groups which was statistically not significant ($p=2.74$). Followed by GC SOLARE X, STELLITE SIGMA and lastly SWISSTEC COLTENE.

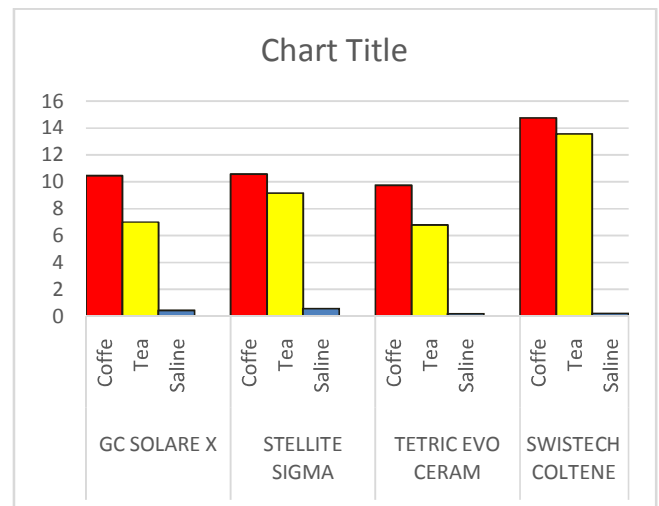
GRAPH I

COMPOSITE COMPARISON IN BEVERAGES EΔ24 HOURS



GRAPH II

COMPOSITE COMPARISON IN BEVERAGES EΔ48 HOURS





ΔE – 24

		N	Mean	Std Dev	Std Error	95% Confidence Interval for Mean		Min	Max
						Lower Bound	Upper Bound		
GC SOLARE	COFFEE	10	6.454733	0.866591	0.27404	5.917624251	6.991841458	4.693404	7.425969
	TEA	10	3.955964	1.206054	0.381388	3.208457797	4.7034706	2.562125	6.486276
	Normal Saline	10	0.11947	0.163509	0.051706	0.018127752	0.220811573	0.016	0.5679
	Total	30	3.510056	2.777687	0.507134	2.516091219	4.504019924	0.016	7.425969
STELLITE SIGMA	COFFEE	10	8.258513	1.368999	0.432916	7.410014291	9.107011911	6.833679	11.77223
	TEA	10	4.678625	0.942932	0.298181	4.094200491	5.26305007	3.453835	6.027558
	Normal Saline	10	0.409056	0.31286	0.098935	0.215147177	0.602965721	0.137117	1.167492
	Total	30	4.448732	3.396819	0.620172	3.233217755	5.664245465	0.137117	11.77223
TETRIC EVO CERAM	COFFEE	10	7.967318	1.340892	0.424027	7.136239329	8.798395716	6.778173	10.99286
	TEA	10	3.205452	1.341242	0.424138	2.374157114	4.036747086	1.361089	5.206094
	Normal Saline	10	0.093317	0.035935	0.011364	0.071044622	0.115589661	0.040175	0.139115
	Total	30	3.755362	3.458719	0.631473	2.517698369	4.99302614	0.040175	10.99286
SWISTECH COLTENE	COFFEE	10	11.38028	1.582923	0.500564	10.39919285	12.36136888	8.472978	13.31197
	TEA	10	3.806938	1.363879	0.431297	2.961612253	4.652263673	2.018677	5.602432
	Normal Saline	10	0.075441	0.05301	0.016763	0.042585916	0.108297003	0.012689	0.159684
	Total	30	5.087553	4.923253	0.898859	3.325822295	6.849284566	0.012689	13.31197

ΔE – 48

		N	Mean	Std Dev	Std Error	95% Confidence Interval for Mean		Min	Max
						Lower Bound	Upper Bound		
GC SOLARE	COFFEE	10	10.44649	1.318934	0.417084	9.629025886	11.26396364	8.422145	12.21338
	TEA	10	6.999188	1.43723	0.454492	6.108399823	7.889976452	3.649142	8.662285
	Normal Saline	10	0.42739	0.421387	0.133254	0.16621687	0.688563729	0.119273	1.470119
	Total	30	5.957691	4.37086	0.798006	4.39362766	7.521754474	0.119273	12.21338
STELLITE SIGMA	COFFEE	10	10.55889	0.870882	0.275397	10.01911725	11.09865369	8.821418	12.01694
	TEA	10	9.155084	1.332647	0.42142	8.329115923	9.981052068	7.855544	11.76421
	Normal Saline	10	0.558003	0.274627	0.086845	0.387791073	0.728215533	0.17657	1.180386
	Total	30	6.757324	4.585642	0.83722	5.116403544	8.398244969	0.17657	12.01694
TETRIC EVO CERAM	COFFEE	10	9.736409	0.876486	0.277169	9.193167506	10.27965026	8.678565	11.46563
	TEA	10	6.774163	2.004881	0.633999	5.531547777	8.016778126	4.235911	11.46994
	Normal Saline	10	0.18002	0.087422	0.027645	0.125835871	0.234203642	0.109334	0.406751
	Total	30	5.563531	4.24169	0.774423	4.045689162	7.081371898	0.109334	11.46994
SWISTECH COLTENE	COFFEE	10	14.74351	1.289056	0.407635	13.9445621	15.54246373	13.05754	17.24372
	TEA	10	13.57654	2.125169	0.672037	12.25936963	14.89370743	9.583949	15.99603
	Normal Saline	10	0.208245	0.075731	0.023948	0.16130776	0.255182726	0.101341	0.328792
	Total	30	9.509432	6.848468	1.250354	7.058784355	11.96008011	0.101341	17.24372

DISCUSSION

Colour is the property possessed by an object producing different sensations on

the eye as a result of the way it reflects or emits light.^[03] The three factors that determine colour of an object are (a) the



properties possessed by the object (b) the visual potential of the viewer and (c) the quality and quantity of light incident on the object.

When light is incident on an object some colours are reflected and some are absorbed by the object. Our eyes only see the colours that are reflected. So the reflected light from an object determines its colour. For example, sun's rays contain all the colours mixed together. This mixture is white light. When white light strikes a white crayon, it appears white to us because it absorbs no colour and reflects all colours equally. A black crayon absorbs all colours equally and reflects none. So it looks black to us. While artists consider black as a colour, scientists do not because black is the absence of all colour^[56].

Research reveals that people usually make a subconscious judgment about a person, product, or environment within 90 seconds of initial viewing and 62% to 90% of that assessment is based on colour alone.

It has been estimated, for example, that 28% of adults in the UK are dissatisfied with the appearance of their teeth^[5] and that 34% of adults in the USA

are similarly dissatisfied^[6]. A more recent survey in the UK reported that up to 50% of adults perceived that they had some tooth discolouration.^[7]

RESULTS

GC SOLARE X demonstrated the least colour change compared to other groups at 24 hour interval with immersion in coffee and tea followed by Tetric Evo-Ceram, Stellite Sigma and SwisstecColtene.

TETRIC EVO-CERAM demonstrated the least colour change compared to other groups at 48 hour interval with immersion in coffee and tea followed by GC Solare X Stellite Sigma and SwisstecColtene.

Solare X incorporates the use of diverse filler technologies to deliver exceptional aesthetic outcomes. Layering techniques in composite restorations are minimally required when using GC Solare X. Containing nanofillers, glass fillers and pre-polymerised filler materials this composite material replicates the aesthetic properties of the natural tooth. They imitate natural tooth characteristics such as complex light transmission, diffusion and reflection. The pre-polymerized fillers containing lanthanoid fluoride nanoparticles contribute to the chameleon effect and the natural tooth like properties.



TetricEvoCeram is a universal, hybrid composite.

This light-cured composite consists of particles ranging in size from 40 to 3000 nm with an average particle size of about 550 nm.

Layering is especially important in teeth that are discolored. The manufacturers claim that the filler particle size which ranges in nanometers usually plays an important role in maintaining colour stability. Nanotechnology advancements resulted in composites having filler particles measuring 0.1 – 100 nm (1nm = 10⁻⁹ meters) As the particle size is smaller, resins made with this type of particles give the restorations a better finish, which is observed in its surface texture.

The lower particle size also leads to less curing shrinkage (less matrix percentage), creates less cusp wall deflection and reduces the presence of micro fissures in the enamel edges, which are responsible for marginal leakage, colour changes, bacterial penetration and possible post-operative sensitivity. The esthetics of **TetricEvoCeram** was excellent at recall. Out of 637 recalled restorations, 93% received an excellent rating and 7% received good to very good rating and did

not require replacement. Only three restorations (0.5%) required replacement because of poor esthetics.

Stellite sigma is a supra nano spherical hybrid composite resin. It shows high polishing ability due to smaller and uniform particle size of mean – 0.2 μm and range of 0.1 μm -0.3 μm . Composites that contain mainly the oligomers of bisphenol A glycidyl methacrylate (Bis-GMA) may exhibit higher hydrophilicity and increased water sorption than those that contain mainly urethane dimethacrylate (UDMA). Addition of small amount of triethylene glycol dimethacrylate (TEGDMA) into a Bis-GMA based resin matrix may significantly increase the water sorption of the composite material.^[52]

The presence of supra-nano spherical hybrid particles is not capable of providing exceptional results compared to the other composites and the latest technology of Radical Amplified Photopolymerization Technology" (RAP), is only capable for reducing the curing time and can also be responsible for incomplete polymerization. Resulting in poor results in staining.

This group showed the highest staining and increased absorption due to biggest particle size among all other composites.



SwisstecColtene is a micro filled composite resin with the biggest particle size compared to other groups of this study. Mean particle size of 1 μ m range (0.4 μ m-2.4 μ m).

TEGDMA contains a central repeating ethoxy group that has high affinity with water molecule through hydrogen bonding to oxygen,^[35] thus resulting in increased surface hydrophilicity of composite materials. Composite resins with high water sorption and hydrophilicity are more susceptible to discolouration as colourants are likely absorbed with water into the resin matrices. It has also been speculated that the inorganic fillers in the composite materials affect colour stability as their size, type, distribution and affinity with resin matrix may influence adsorption and absorption of colourants to composite materials.

Study using principal component analysis (PCA), Manojlovic D et al (2015)^[8] had found that the absorption of coffee in the 380-780 nm spectral range is mainly governed by the absorption of melanoidins which is present in coffee (Moreitra et al).^[9] These high-molecular weight nitrogenous and brown-coloured compounds are formed during coffee roasting as the final products of the

Maillard reaction. (The Maillard reaction is a chemical reaction between amino acids and reducing sugars that give browned food its distinctive flavor).

The discolouration effect produced by tea is not as great as coffee. This conclusion in this study is in contradiction to studies by Prodan et al^[10], Malekipour et al (2012)^[63], Tecke N et al (2015)^[11], and Nasim et al (2015)^[12]. This may be due to the tea variety used in this study. The Red Label tea by Brooke Bond contain less tannic acid than the black tea used in the above studies. Further, few studies have used tea at higher temperatures whereas, this study used tea in 37 degree centigrade to remove bias between other beverages.

The limitations of this in vitro study are

(a) in clinical situation at least one surface of composite is unexposed to beverages due to adhesion to the cavity walls. Whereas, in in vitro experiments the beverages influence both sides of the specimen.^[13]

(b) the surface properties of composites also influence staining properties which is not included in this study



(c) a single colourant was usually used separately in this static immersion model, while in reality a multitude of dietary colourants may dynamically interact with composite resin restorations in an oral environment on a daily basis.^[14]

(d) Other factors like pH changes in oral cavity, thermal stress that happen along with beverage consumption, dynamic nature of salivary flow in cleansing cannot be simulated in this in vitro study.

After 24 hours & 48 hours of immersion, all the beverages showed colour change in all the composites tested. However, actual staining in the oral cavity would very likely require a longer period because of the intermittent nature of stain exposure, saliva and other fluids diluting the staining media, and polishing of the restoration surfaces by brushing.

According to Mundim et al, patients routinely ask dentists how long an esthetic restoration should last, and whether their eating habits may influence the quality and longevity of the restoration. Knowledge of the effects of staining potential on the surface of a composite resin could guide clinicians as regards to the instructions they give their patients after the operatory procedure, to assure better colour stability

and long-term maintenance of the restoration.

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