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Original Article

Dentistry Section

Effect of Salivary pH on Color Stability of Different Flowable Composites – A Prospective In-vitro Study

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ABSTRACT

Introduction: Scientifically and clinically there has been lot of development in the field of aesthetic dentistry. However, there is limited or restricted information regarding the color stability of flowable composite materials.

Aim: The aim of this study was to evaluate the spectrophotometric color stability of three different flowable composite materials with respect to three different pH of saliva.

Materials and Methods: The study included 90 different samples. Thirty samples in each composite group; (Group A: G-aenial universal flo; Group B: Z 350 XT flowable; Group C: Esthet x flow). All samples from each group were immersed in distilled water for 24 hours. Total color difference (ΔE) was recorded for each sample. After this 10 samples from each group were respectively immersed in 6.5, 7 and 7.5 pH of artificial saliva. All samples were kept in dark room for seven days and then ΔE for each sample was recorded and was compared to previous recorded ΔE for the same sample.

Results: Maximum color change was seen irrespective of material in 6.5 pH of saliva. G-aenial universal flo showed least change irrespective of pH of saliva.

Conclusion: Thus, the present study reveals that acidic pH level affects the coloration of composite resins by affecting the surface integrity and as reported in previous studies, various coloring agents in beverages and other dietary components assists the process due to absorption of these coloring substances into the resin matrix.

Keywords: Acidic medium, Artificial saliva, Spectrophotometer, Surface integrity

INTRODUCTION

Scientifically and clinically there has been lot of development in the field of aesthetic dentistry. However, with growing demand of aesthetic restorations the primary concern in the field of composite restoration remains the same that is color stability. Many researches in past had certain issues on color stability and water absorption of the present resin matrix [1]. Various factors are responsible for color change that includes chemical changes in resin matrix- filler particle content or at the matrix-particle interface, adsorption or absorption of dietary components, personal habits such as smoking habits, consumption of certain beverages such as tea, coffee, etc., [2].

Time to time, measures have been taken to improve quality of restorative materials. However, persistence of these problems makes the researcher to continuously work in this field to find the causes responsible for it.

Composite are available in two forms as restorative material that is packable and flowable. Flowable composite with less filler content have lower viscosity, and thus can be manipulated easily. Ideally this matrix thus should be more susceptible to color change [3]. Several researches Malekipour MR et al., Madhyastha SP et al., Omata Y et al., and Fontes ST et al., in past have proved that pH of different consumable media of various beverages and staining ability of different consumable media affect the color stability of packable composites [1,2,4,5]. There are limited or restricted information regarding the color stability of flowable composite materials.

Perception of color is a psychological matter and is influenced by the observer's ability and may be described differently on various occasions. It is one of the most important property of an aesthetic restorative material and influence of various intrinsic and extrinsic factors on color stability that governs the outcome of the restorative material [1].

Color change of any mass or media can be evaluated by two commonly used devices spectrophotometer or colorimeter. The basic difference in them is that the former can evaluate all the colors at a time while later evaluates individual color at a time. Photometric and colorimetric instruments measure shading and express it in terms of three direction values (L*, a*, b*), which find the article shading inside of the CIELAB shading space [5,6]. The L* stand for lightness, a* stands for red or green chroma, and the b* represents yellow or blue chroma. ΔE is calculated based on L*, a*, b* color differences and represents the distance of a line between the sample and standard [5]. The equation utilized for computing the shading contrasts in this framework is $\Delta E = \sqrt{(L_2-L_1)^2 + (a_2-a_1)^2 + (b_2-b_1)^2}$ where L*, a*, and b* are the distinctions of the shading parameters between the two examples measured for examination.

The present study evaluated the three different flowable composite materials in terms of color stability and the effect of salivary pH, as a factor responsible for color change of these composite materials.

MATERIALS AND METHODS

The present prospective in-vitro study was conducted at Manubhai Patel Dental College, Gujarat, India from September 2014 to September 2015 comprising of 90 samples, 30 sample of three different flowable composites [G-aenial universal flo (GC corporation, Tokyo, Japan), Filtek TM Z350 XT flowable (3M ESPE, USA), Esthet X flow (Dentsply, USA)] of A2 shade divided into three groups of 10 each and three different pH of artificial saliva (6.5, 7, 7.5).

Ethical clearance was obtained from the institutional ethical committee before the initiation of the study. Artificial saliva comprised of albumin (Sigma, Sigma-Aldrich CO, St Louis, MO USA), methyl cellulose (Sigma, Sigma Aldrich CO, St Louis, MO USA), sodium carboxymethyl cellulose (Sigma, Sigma-Aldrich CO, St Louis, MO USA), hydroxypropylmethyl cellulose (Sigma,

Sigma-Aldrich CO, St Louis, MO USA), potassium chloride (R&M chemicals, R&M Marketing, Essex, UK), di-potassium hydrogen phosphate (Merck, Merck KGaA, Darmstadt, Germany), sodium fluoride (Merck, Merck KGaA, Darmstadt, Germany), magnesium chloride (Merck, Merck KGaA, Darmstadt, Germany), glucose (R&M chemicals, R&M Marketing, Essex, UK), methyl paraben (Sigma, Sigma-Aldrich CO, St Louis, MO USA) [7].

Each sample of composite was made by using preformed wells of 10mm diameter and 1mm depth and was cured according to manufacturer's instructions. All samples were dipped into distilled water for 24 hours and were kept in dark room. After 24 hours ΔE was recorded for each sample by Spectrophotometer [Gretag Macbeth EFI ES 1000 UVcut i1 Eye-One Pro Spectrophotometer (X-Rite, USA].

All samples were marked and dipped respectively in such a way that 10 sample of each group were dipped in three different pH of saliva that is 6.5, 7 and 7.5. All of them were kept in dark room to prevent any extrinsic factors. After 7 days ΔE for each sample were recorded again. Data so obtained was analyzed using SPSS version-17. The spectrophotometric difference (ΔE) was compared for each sample using, one way ANOVA test for any difference within the groups, Tukey's HSD Post Hoc Tests for multiple comparison among different groups.

RESULTS

On comparison of G-aenial universal flo composite at three different pH of artificial saliva (6.5, 7, 7.5), maximum color change was noted at pH 6.5 followed by 7 and 7.5 [Table/Fig-1]. [Table/Fig-2] shows comparison among three different pH of artificial saliva (6.5, 7, 7.5) groups of G-aenial universal flo composite by Post Hoc Tests, significant difference was noted between the groups except pH 7 and 7.5 with p=0.990. On comparison of Z350 flowable composite at three different pH of artificial saliva (6.5, 7, 7.5), maximum color change was noted at pH 6.5 followed by 7.5 and 7 [Table/Fig-3]. [Table/Fig-4] shows comparison among three different pH of artificial saliva (6.5, 7, 7.5) groups of Z350 flowable composite by Post Hoc Tests, significant difference was noted between the groups except pH 7 and 7.5 with p=0.884.

Similarly, on comparison of Esthet X flow composite at three

pH	N	Mean	Std. Deviation	Difference between the groups
6.5	10	1.0509	0.81777	<0.001*
7	10	0.0081	0.37327	
7.5	10	-0.0230	0.12727	
Total	30	0.3453	0.71656	

[Table/Fig-1]: Comparison of G-aenial universal flo composite at three different pH of artificial saliva (6.5, 7, 7.5).
(* Statistically significant using ANOVA test)

(I) pH	(J) pH	Mean Difference (I-J)	Std. Error	p-value	95% Confidence Interval	
					Lower Bound	Upper Bound
6.5	7	1.04274*	0.23442	<0.001*	0.4615	1.6240
	7.5	1.07390*	0.23442	<0.001*	0.4927	1.6551
7	6.5	-1.04274*	0.23442	<0.001*	-1.6240	-0.4615
	7.5	0.03117	0.23442	0.990	-0.5501	0.6124
7.5	6.5	-1.07390*	0.23442	<0.001*	-1.6551	-0.4927
	7	-0.03117	0.23442	0.990	-0.6124	0.5501

[Table/Fig-2]: Comparison among three different pH of artificial saliva (6.5, 7, 7.5) groups of G-aenial universal flo composite
(* Statistically significant using Post Hoc Tests)

pH	N	Mean	Std. Deviation	Std. Error	Difference between the groups
6.5	10	1.8966	0.76560	0.24210	<0.001*
7	10	-0.0676	0.50824	0.16072	
7.5	10	0.0661	0.14523	0.04593	
Total	30	0.6317	1.04846	0.19142	

[Table/Fig-3]: Comparison of Z350 flowable at three different pH of artificial saliva (6.5, 7, 7.5).
(* Statistically significant using ANOVA test))

(I) pH	(J) pH	Mean Difference (I-J)	Std. Error	p-value	95% Confidence Interval	
					Lower Bound	Upper Bound
6.5	7	1.96419*	.24021	<0.001*	1.3686	2.5598
	7.5	1.83049*	.24021	<0.001*	1.2349	2.4261
7	6.5	-1.96419*	.24021	<0.001*	-2.5598	-1.3686
	7.5	-0.13370	.24021	0.844	-0.7293	0.4619
7.5	6.5	-1.83049*	.24021	<0.001*	-2.4261	-1.2349
	7	0.13370	.24021	0.844	-0.4619	0.7293

[Table/Fig-4]: Comparison among three different pH of artificial saliva (6.5, 7, 7.5) groups of Z350 flowable Composite.
(* Statistically significant using Post Hoc Tests)

pH	N	Mean	Std. Deviation	p-value
6.5	10	1.6784	1.04473	<0.001*
7	10	0.0120	0.28520	
7.5	10	0.0273	0.36342	
Total	30	0.5725	1.01859	

[Table/Fig-5]: Comparison of Esthet X flow composite at three different pH of artificial saliva (6.5, 7, 7.5).
(* Statistically significant using ANOVA test)

(I) pH	(J) pH	Mean Difference (I-J)	Std. Error	p-value	95% Confidence Interval	
					Lower Bound	Upper Bound
6.5	7	1.66640*	0.29494	<0.001*	0.9351	2.3977
	7.5	1.65109*	0.29494	<0.001*	0.9198	2.3824
7	6.5	-1.66640*	0.29494	<0.001*	-2.3977	-0.9351
	7.5	-.01531	0.29494	0.999	-0.7466	0.7160
7.5	6.5	-1.65109*	0.29494	<0.001*	-2.3824	-0.9198
	7	0.01531	0.29494	0.999	-0.7160	0.7466

[Table/Fig-6]: Comparison among three different pH of artificial saliva (6.5, 7, 7.5) groups of Esthet X flow composite.
(* Statistically significant using Post Hoc Tests)

Group	N	Mean	Std. Deviation	p-value
G-aenial Flo	10	1.0509	0.81777	.104 (NS)
Z350	10	1.8966	0.76560	
Esthet-X	10	1.6784	1.04473	
Total	30	1.5420	0.92797	

[Table/Fig-7]: Comparison of three composite groups at pH = 6.5.
ANOVA; NS: non-significant

Group	N	Mean	Std. Deviation	p-value
G-aenial Flo	10	0.0081	0.37327	0.882 (NS)
Z350	10	-0.0676	0.50824	
Esthet-X	10	0.0120	0.28520	
Total	30	-0.0158	0.38735	

[Table/Fig-8]: Comparison of three composite groups at pH = 7.0.
ANOVA; NS: non-significant

Group	N	Mean	Std. Deviation	p-value
G-aenial Flo	10	-0.0230	0.12727	0.705 (NS)
Z350	10	0.0661	0.14523	
Esthet-X	10	0.0273	0.36342	
Total	30	0.0235	0.23225	

[Table/Fig-9]: Comparison of three composite groups at pH = 7.5.
ANOVA; NS: non-significant

different pH of artificial saliva (6.5, 7, 7.5), maximum color change was noted at pH 6.5 followed by 7.5 and 7 [Table/Fig-5]. [Table/Fig-6] shows comparison among three different pH of artificial saliva (6.5, 7, 7.5) groups of Z350 flowable composite by Post Hoc Tests, significant difference was noted between the groups except pH 7 and 7.5 with p=0.999.

The spectrophotometric difference (ΔE) showed maximum change in 6.5 pH of saliva followed by 7 and 7.5 pH. When comparing among the composite material minimum change is seen in G-aenial flo at 6.5 and 7.5 pH, while minimum change is seen in Z350 XT flowable at 7 pH [Table/Fig-7-9].

DISCUSSION

Composite restorations are known for aesthetics and failure to attain the result for a long time is a big time worry for a practitioner. Color stability can be defined as color changes which cannot be recognized by a human being during day to day practice [5]. Our aim was to determine the color stability of flowable composite material and also to evaluate whether salivary pH is also responsible as one of the cause for color instability of composite matrix. We selected salivary pH as one of the important part of study as our teeth are always in contact with saliva and in fact immersed in it. Stephen's pH research chart also indicates that low salivary pH is responsible for dental caries [8]. Considering the fact that salivary pH can affect the teeth, we have stipulated that salivary pH can be one of the causes for color instability of composite restorations.

Flowable composite with less filler content (37-53%) has less viscosity [9]. In one of the study by Yu B et al., they evaluated optical properties such as color, translucency and fluorescence of flowable composite to packable composite of the same company and concluded that they are significantly different [10]. In another study, Santos PA et al., concluded that less filler content and higher proportion of resin matrix, can retain various dyes from intra-oral solution [11].

We have selected flowable composite as very little is known about them and they are newer to the family of conventional composites. The present study found that there was a significant color change seen in acidic salivary pH that is 6.5 irrespective of material. The low pH may affect the surface integrity of the material and soften the matrix that would further result in absorption of various dietary colors resulting in discoloration [12]. The color change of composite resins caused by staining solutions may be material dependent, and the staining susceptibility of a restorative material may be ascribed to its filler type or resin matrix [13]. The present study utilized CIE Lab system for evaluating color differences as this method is appropriate for recognizing even small color differences and offers benefit of sensitivity and repeatability [12].

Similar results were perceived in previous studies on comparing various beverages by Omata Y et al., Domingos PA et al., Lepri CP et al., and Tuncer D et al., compared coffee and cola at two different temperatures 70°C and 37°C and reported increased color change at high temperature solutions [4,14-16]. Fontes ST et al., reported that staining substances present in the grape juice resulted in color change of nanofill resin-based composite [5].

Radu MT et al., found that the erosion of composite resin surface is related to acidity level of the immersing solution [17]. Soderholm KJ et al., and Milleding P et al., also revealed that oral environment can interfere with the resin composite characteristics due to its aqueous medium and can also result in hydrolytic degradation with time [18,19]. Alawjali SS et al., also reported that type of composite, polishing method and the period of contact with the staining agent affects the color change [20].

Though in past many researchers have taken artificial saliva as control group; discoloration has been reported with time in respect to this group also with time [21]. This made us curious to find out whether any color changes in physical property of flowable composite also occur when composite is immersed in artificial saliva. Thus the present study reveals that acidic pH level affects the coloration of composite resins by affecting the surface integrity and as reported in previous studies, various coloring agents in beverages and other dietary components assists the process due to absorption of these coloring substances into the resin matrix.

LIMITATION

The limitation of the present study was that it compared the results of only one medium at different pH values, various alcoholic and non-alcoholic beverages should be compared at different pH values as their color influences the composites along with their acidity and alkalinity that further affects the pH of saliva. However, further in-vitro studies with large sample size and in-vivo researches are required to evaluate the effects of acidic pH on composite resins. As very little is known about flowable composite material; so further studies evaluating influences of various media at different pH on composites are required to enlighten the knowledge about clinical and chemical properties of the same.

CONCLUSION

The present study concludes that statistically significant spectrophotometric color changes are seen in artificial saliva with pH 6.5. The pH of saliva has a key role in discoloration of composite material therefore, it should be taken into consideration. Intake of beverages with acidic pH should be reduced to preserve esthetics and to increase the life of composite restorations.

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