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COMPARATIVE EVALUATION OF SORPTION AND SOLUBILITY OF ESTHETIC RESTORATIVE MATERIALS IN VARIOUS MEDIA - AN INVITRO STUDY

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Abstract:
Aim: The aim of the study was to compare and evaluate the sorption and solubility values of Beautifil II LS, Cention N, FiltekZ250 restorative material in various liquid media such as coffee, coca-cola, medicated syrup**.**
Method: A total of sixty samples of restorative material were prepared using a metallic mould and divided into three groups of twenty samples each (n=20); Group I: Beautifil II LS, Group II: Cention N ,Group 3: FiltekZ250.The weight before immersion in the test media (M1) was measured using digital analytical scale. Each group was subdivided into four subgroups (n=5) based on the test media they were immersed in; Subgroup 1: Coffee, Subgroup2:coca-cola, Subgroup 3: medicated syrup, Subgroup 4: Distilled water (control group). Five specimens each of the restorative material were kept immersed in the test media for seven days. The weight of the samples after immersion (M2) in the test media after seven days and the final dry weight of the samples (M3) were measured. Sorption and solubility of these restorative materials were calculated using ISO guidelines. The data obtained was statistically analysed using one way ANOVA Test.
Result: Among the media tested coca-cola showed both sorption and solubility values greater than the other medias. Beautifil II LS was found to have highest sorption and solubility values than other two restorative materials.
Conclusion: The composition of material and low pH carbonated drinks can influence the properties of tooth colored restorative materials.
Keywords: Sorption, solubility, Beautifil II LS, Cention N, Filtek Z250

Introduction

The success of restorative dentistry is determined on the basis of functional results and esthetic outcomes[1]. Dental composites are extensively used in dentistry due to their esthetics ,good in physical and mechanical properties.[2] Composites are modified immensely to improve their physical and mechanical properties by incorporating new technologies to overcome polymerization shrinkage, improve compressive strength and antibacterial action. However in aqueous environment of oral cavity it may absorb water, saliva, food components or beverages which can lead to degradation of composites by having deleterious effect on structure of resin inturn leading to shortened service life of composite[2].

Water sorption and solubility are two important physical properties of restorative material which influence its clinical durability. Water sorption can increase the volume of the material and it can act as a plasticizer and cause deterioration of the matrix structure of the material[3].Sorption and solubility of tooth colored restorative materials depend on various factors such as type of material, composition of matrix, filler particles, efficiency of polymerization, immersion media used [4,5]

Beautifil II LS is a newly introduced tooth colored light curable giomer which has been developed based on proven Beautifil II Restorative material. It exhibits extremely low polymerization shrinkage, superior esthetics, fluoride protection with good physical and chemical durability[6] Cention N is a tooth-coloured, dual cure restorative material used for direct posterior restorations. It is an “alkasite” restorative material which is a new category of filling material and is essentially a subgroup of the composite resin.[16,17] FiltekZ250 is a tooth coloured, visible light activated nanohybrid composite designed for use as both anterior and posterior restorative material.[10]

Most of invitro studies focus on immediate mechanical properties, evaluated under dry conditions. However, material degradation by oral fluid and bacteria have significant impact on physical, biological, chemical properties. So this present study was conducted to compare and evaluate the sorption and solubility of three tooth colored restorative materials in various test media

Material and Methodology

Twenty disc shaped specimens of each restorative material to be tested, measuring 15 ± 0.1mm in diameter and 2mm thickness were prepared in a stainless steel split mould. Products were handled following the manufacturer’s instructions. Five samples of each material were immersed in 10ml of each test media at 37°C for seven days. The test media were grouped as: Subgroup 1: Coffee Subgroup 2:cocacola Subgroup 3:medicated syrup, Subgroup 4:Distilled water The test media were freshly prepared and

replaced, every twenty four hours. All the sixty samples were cleaned and transferred to a desiccator maintained at 37°C with silica gel for 24 hrs. They were stored in a desiccator at 23°C for 1hr, then weighed to an accuracy of 0.1mg in a digital analytic balance. The cycle was repeated till a mass of loss not more than 0.1mg in any twenty four hour period is achieved. This is the sample weight before immersion (M1). Two measurements of diameter were taken at right angles to each other using dial caliper and mean diameter was calculated. Area was calculated in 2 millimeter from the mean diameter and volume was calculated in 3 millimeter. After seven days, the specimens were removed, washed in distilled water and the surface adherent water was gently blotted away with a tissue paper. The samples were waved in air for fifteen seconds and weighed in the balance (M2).This was followed by reconditioning the specimens to constant weight in the desiccator using the earlier cycle. The sample weight after immersion and dessication (M3) was recorded. The solvent uptake and solubility were determined in µg/mm3 using the Oysaed and Ruyter formula.

$$\text{Sorption} = \frac{M2 - M3}{V}$$

$$\text{Solubility} = \frac{M1 - M3}{V}$$

M1 = Sample weight before immersion

M2 = Sample weight after immersion and

M3 = Sample weight after immersion and desiccation

Results

The data obtained was statistically analyzed using one way analysis of variance (One way ANOVA) .P values less than 0.05 were considered statistically significant. According to the test results Beautifil II LS showed highest sorption values and was statistically significant, followed by FiltekZ250 and Cention N showed least sorption values which was statistically not significant .These results are summarized in table 1 and are presented graphically in Fig.1 and 2.

Discussion

Chemical stability is one of the main factor that determine the durability of restorative material used in the oral cavity [3] Water sorption and solubility are important properties of composite resins which has its influence on its strength, abrasion resistance, volume and color stability. [4]

When the restorative materials are exposed to or stored in water, two different mechanisms occur. Firstly, water molecules diffuse into the polymer network and occupy the free volume between polymer chains and microvoids, causing plasticization and swelling of polymer matrix and also initiate the chains scission causing monomer elution. Secondly, the water molecules tend to degrade the siloxane bonds via a hydrolysis reaction, causing filler debonding.[2,8,10.] ISO 4049 is a standard method which is commonly used by researchers to determine water sorption and solubility of restorative dental composites The standard limits for water sorption and solubility are 40µg/mm3 and 7.5µg/mm3 respectively.[2,8]

The pH of oral cavity varies from acidic to alkaline depending on the foods consumed as well as the salivary changes in each individual. The modern dietary habit of frequent consumption of low pH carbonated drinks can alter the oral environment to an acidic range.[3]There are data showing that the pH of oral fluids return to neutral 1-3min after 1 single sip of acidic beverages. However Prolonged frequent consumption will have an negative affect on teeth or restoration.[9,11]

In this present study beautifil II LS showed higher sorption value and it was statistically significant compared to other restorative materials ,this may be because of inclusion of S-PRG Filler particles in resin. These particles are capable of fluoride release and as well as recharge ,this release of fluoride is known to be mediated by capacity of water diffusion.[6,7,9]Similarly, It seems likely that pre reacted zones on filler surface are responsible for generating the osmotic effect which leads to water absorption, swelling and pressure.[7,8]It is possible that hydrophillic monomer content may influence degree of water sorption. Beautifil IILS contains Bis -GMA and TEGDMA which are known to be hydrophillic and cause water sorption.[7,10]

In the present study the three material tested showed higher value of sorption and solubility in coca cola compared to coffee, medicated syrup, distilled water. Coca cola drink has pH of 3.1,and presence of carbonic acid and phosphoric acid may the reason for sorption and solubility.[2,11]The material which is exposed to acid would provide less barrier for water molecules to enter the polymer network, thereby increase water sorption.[2] Studies have also shown that any drink having a pH of 5.5 or below will wear away the enamel.[12]

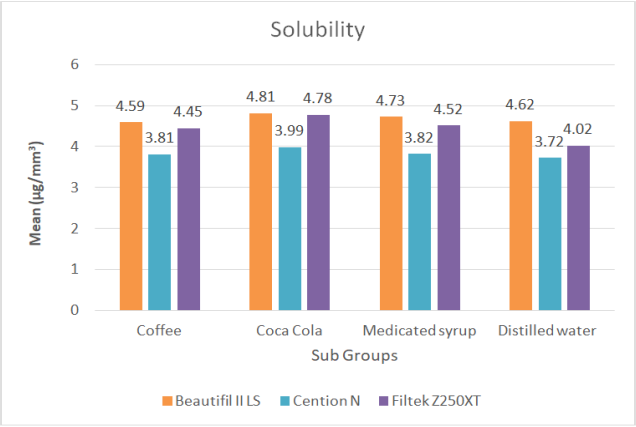
In the current study, Cention N showed comparatively least sorption and solubility values but the difference were not statistically significant. Cention N in this study was dual cured, Studies have shown that dual cured material are more hydrophobic than self-cured material.[16] Cention N does not contain Bis-GMA, HEMA or TEGDMA which are proved to be more hydrophilic than UDMA, presence of Urethane Dimethacrylate (UDMA) which are hydrophobic , create rigid networks, and absorbs less water and releases higher unreacted monomer could be the reason for the lower solubility and sorption of Cention N in this study. [16,17]

In the present study, FiltekZ250 showed sorption values comparatively greater than Cention N but it was not statistically significant. Presence of TEGDMA And Bis GMA which are hydrophillic, may be the reason for increased water sorption.[13,10] Cention N basically has glasss fillers in their composition Filtek Z250 has silica –Zirconia filler particles which can be responsible for critical sialinization and could be the reason for increased sorption of Filtekz250.[14] Archegas et al[14] and Curtis et al[15] has made a study on water sorption of FiltekZ250 and has is in agreement with this study.[15] All values obtained in this study were within ISO standards. The solubility values of three tested material in coca-cola, coffee, medicated syrup did not vary significantly, though highest solubility was seen in coca-cola followed by medicated syrup.

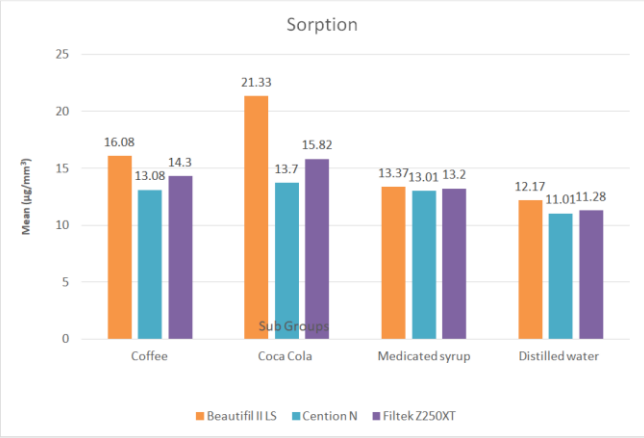
FIGURES AND TABLES

Table 1:

Property	Material	Immersion Media: Group A Coffee	Group B Coca Cola	Group C Medicated Cough Syrup	Group D Distilled water	P Value
Solubility	Beautifil II LS	4.59±0.32	4.81± 0.12	4.73 ±0.63	4.62± 0.45	0.33
	Cention N	3.81±0.12	3.99±0.36	3.82±0.58	3.72±0.4	0.19
	Filtek Z250XT	4.45±0.34	4.78±0.98	4.52±0.87	4.02±0.35	0.09
Sorption	Beautifil II LS	14.37±0.66	21.33±0.76	14.08±0.99	12.17±0.36	<0.001**
	Cention N	11.29±0.63	11.52±0.75	11.18±0.57	11.01±0.45	0.07
	Filtek Z250XT	12.2±0.26	12.42±0.45	12.31 ±0.9	11.99± 0.6	0.14



Graph 1:



Graph 2:

Conclusion

-With the limitations of this invitro study, it can be concluded that the composition of material and low pH carbonated drinks can influence the properties of tooth colored restorative materials.

- So selection of better restorative materials, dietary habits and maintainance of oral hygiene is needed for the longetivity of restoration..

However, this result cannot be generalized since the study was conducted only for a period of seven days and the restorative materials are intermittently exposed to these immersion media. So further studies have to be conducted to know the effect of these solutions on the restorative materials.

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