



## ***The Effect of Storage Media on The Degree of Conversion of Different Types of Composite Resin***

### **ABSTRACT**

**Aims:** This study was performed to evaluate the effect of Pepsi, orange juice and coffee as storage media on the Degree of Conversion (DC) of three types of composite resin.

**Materials and Methods:** Three types of visible light-curing composite restorative material (Te-Econom, Tetric ceram and VOCO) were used in this study, The specimen disks of composites were prepared using Polyethylene mold 5mm in diameter and 1mm in height, The degree of conversion was measured for each group after storage for 7days in light-proof boxes containing storage media, The degree of conversion of the samples was measured by Fourier transform infrared spectroscopy (FTIR), One way analysis of variance and paired differences tests were used for statistical analysis.

**Results:** The results revealed that there was a significant difference in the degree of conversion of the three types of composite resins when stored in all type of storage media as compared to dry samples(control group).

**Conclusions:**The degree of conversion of the three types of composite resin was increased when stored in different storage media.

**Key words:** Storage Media, degree of Conversion, composite Resin.

### **الخلاصة**

**الأهداف:**الهدف من هذه الدراسة هو لتقييم تأثير البيبسي، عصير البرتقال والقهوة كأساط خزن على درجة التحول (DC) لثلاثة أنواع من الراتنج (composite resin) المواد وطرق العمل:تم اختيار ثلاثة أنواع من مادة الراتنج التي تتصلب ضوئياً وتم تحضير النماذج باستخدام قوالب ذات أبعاد(العرض= 5 ملم، لارتفاع= 1 ملم) تم قياس درجة التحول لكل مجموعة بعد تخزينها لمدة 7 أيام في حافظات لا تسمح بمرور الضوء من خلالها وتحتوي على أوساط الخزن، تم قياس درجة التحول باستخدام جهاز قياس الأطياف بالأشعة تحت الحمراء(FTIR)، وبعد ذلك تم تحليل البيانات احصائياً، النتائج: أظهرت النتائج أن هناك فرق معنوي في درجة التحول لكل أنواع الراتنج المستخدم وفي كل أوساط الخزن مقارنة بالنماذج الجافة، الاستنتاجات: هناك زيادة في درجة التحول لكل أنواع الراتنج المستخدم عند تخزينها في أوساط خزن مختلفة.

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### **INTRODUCTION**

Visible light cured resin-based composites are the predominant restorative materials for both anterior and posterior restorations. In 2000, 94% of U.S. dentists used visible-light curing units<sup>(1)</sup>. Light-cured composites allow the dentist to actively initiate the polymerization step being a significant advantage compared to auto cured composites<sup>(2,3)</sup>.

The term composite material may be defined as a compound of two or more distinctly different materials with properties that are superior or intermediate to those of individual constituents <sup>(4)</sup>.

Modern composite materials consist of four major components: organic polymer matrix, inorganic filler particles, coupling agent, and the initiator-accelerator system <sup>(5)</sup>.

Ideally, dental restorative resin would have all of its monomer converted to polymer during polymerization. However, all dimethacrylate monomers exhibit considerable residual unsaturation in the final product <sup>(6)</sup>. Many studies examined the degree of conversion of resin by using the technique of fourier transform infrared spectroscopy (FTIR), <sup>(7,8-10)</sup> since this technique can be done under room conditions and the sample preparation is simple without the problem of specimen thickness and nondestructive approach <sup>(11)</sup>.

The final DC of a resin depends on the chemical structure of the dimethacrylate monomer and the polymerization conditions, i.e. atmosphere, temperature, light intensity and photoinitiator concentration <sup>(12)</sup>. The DC is one factor that affects clinical performance of resin composites <sup>(13)</sup>. It is important to evaluate the DC of polymeric adhesives, because with a low DC, a release of toxic substances is possible due to the development of a weak polymer network. This parameter is also considered a key factor in modulating the profile of the material, including a wide array of mechanical properties and potential biological adverse reactions <sup>(14)</sup>.

Fourier Transform Infrared Spectroscopy (FTIR) is an analytical technique used to characterize and identified the structural make-up of molecules. This technique measures the absorption of various infrared light wavelengths by the material of interest. These infrared absorption bands identify specific molecular components and structures. The majority of FTIRs operate in mid-infrared radiation at region lies between 4000-400 cm-1.

## MATERIALS AND METHOD

The materials used in this study were three types of visible light-curing composite restorative material (Te-Econom, Tetric ceram and VOCO). Table (1)

Table 1. The material name, specification, composition and manufacturer

Material brand name	Specification	Composition	Manufacturer
Tetric ceram	Hybrid resin-composite	The organic part: Bis-GMA, urethane dimethacrylate and Schaan, triethylene glycol (20.2% by weight). Liechtenstien 3 The inorganic part: Barium glass, ytterbium trifluoride Ba-Al-fluorosilicate glass, highly dispersed silicon dioxide and spheroid mixed oxide (79% by weight). The Filler size is (0.7µm).	Ivoclar vivadent
Te-econom	Hybrid resin-composite	The organic part; Bis-GMA, urethane dimethacrylate and triethylene glycol dimethacrylate (18.8% by weight) and a small amount of catalyst, stabilizers and pigments (0.21% by weight). The inorganic filler (81% by weight). The filler size is (0.7µm).	Ivoclar vivadent
Arabesk	Nano hybrid composite	60% by volum(76.5% by weight) inorganic fillers micro fillers 0.05µm small particle fillers 0.5-2 µm	VOCO Germany

For the determination of the degree of conversion; sixty samples were prepared and divided randomly into three groups(n=20) according to the type of composite resin used. Each group was subdivided into four subgroups(n=5) according to the storage media, the reminder subgroup was kept dry(control group).

The specimen disks of composites were prepared using Polyethylene mold 5mm in diameter and 1mm in height to determine DC. The composite resin material were directly applied into the mold over glass slab then covered by a celluloid strip and cured by conventional LED light curing unit according to the manufacturers' instructions. The light outputs of the curing units were measured before each testing procedure using radiometer directly to samples with exception of the thickness of the celluloid strip<sup>(15)</sup>.

The degree of conversion was measured in this study for each group after storage for 7days in light-proof boxes containing storages media(Pepsi, coffee and orange juice) to avoid further exposure to light irradiation. Each specimen was individually pulverized into fine powder with a mortar and pestle and 50 micrograms were mixed with 5mg of potassium bromide powder this mixture was poured into a metal mold and compressed into a disc shape by Bruker press at a load of 10 tons and the samples become ready for measurement. While the uncured samples were prepared by placement on a special cell supplied by the manufacturers of Fourier transform infrared spectroscopy (FTIR), and becomes ready for measurement.

The degree of conversion of the samples were measured by Fourier transform infrared spectroscopy (FTIR) . The degree of conversion on the tested samples was calculated according to the formula:

$$DC = ((A_o - A_t) / A_o) * 100$$

Where A0 is peak area of the uncured composites (1607 cm-1), At is the absorption of the peak immediately after polymerization (1637 cm-1) and after 7days storage period<sup>(15,16)</sup>.

## RESULTS

In this study, one way analysis of variance at level (p<0.05) was performed. The degree of conversion values in (%) of storage samples were measured and compared with control group by Paired Differences test. (Table 2).

Table 2: Paired Differences Test for storage samples compared with control group(dry media).

Storage Media	Paired Differences			t	df	Sig.	State
	Mean	Std. Deviation	Std. Error Mean				
COFFEE - DRY	10.65333333	13.9811	3.6099	2.9511	14	0.01	Sig
ORANGE - DRY	14.302	10.861	2.8043	5.1	14	0	Sig
PEPSI - DRY	12.44133333	13.166	3.3994	3.6598	14	0	Sig

The results revealed that all samples of the three types of composite resin stored in orange juice, Pepsi, and coffee have a significant difference(p<0.05) in the DC from dry samples (control group).

It was obvious from analysis there was no significant difference(p>0.05) in the DC of composite resin between orange juice and Pepsi, and between coffee and Pepsi, but there was a significant difference between orange juice and coffee.( Table 3)

Table 3: Paired Differences Test compared to samples stored in orange juice, Pepsi and coffee.

Storage Media	Paired Differences			t	df	Sig.	state
	Mean	Std. Deviation	Std. Error Mean				
ORANGE- COFFEE	3.648666667	5.9818	1.5445	2.3624	14	0.03	sig
ORANGE - PEPSI	1.860666667	3.97541	1.0264	1.8127	14	0.09	not sig
COFFEE - PEPSI	-1.788	3.95979	1.0224	-1.7488	14	0.1	not sig

Duncan's New Multiple Range Test showed the effect of storage media on three types of composite resin. It was obvious from this analysis that there was a non significant difference ( $p > 0.05$ ) in DC of Tetric ceram and Voco composite resin stored in all storage media, but they significantly differed ( $p < 0.05$ ) from Te-Econom composite resin samples. (Table 4)(Fig.1)

Table 4: Duncan's New Multiple Range Test showed the effect of storage media on three types of composite resin

	Materials	Mean Square	F	Sig.
Between Groups	TE-ECONOM	81.33760667	1.33000479	0.299
Between Groups	VOCO	351.4011267	9.13480202	0.000
Between Groups	TETRIC- CERAM	327.3153333	12.03520061	0.000

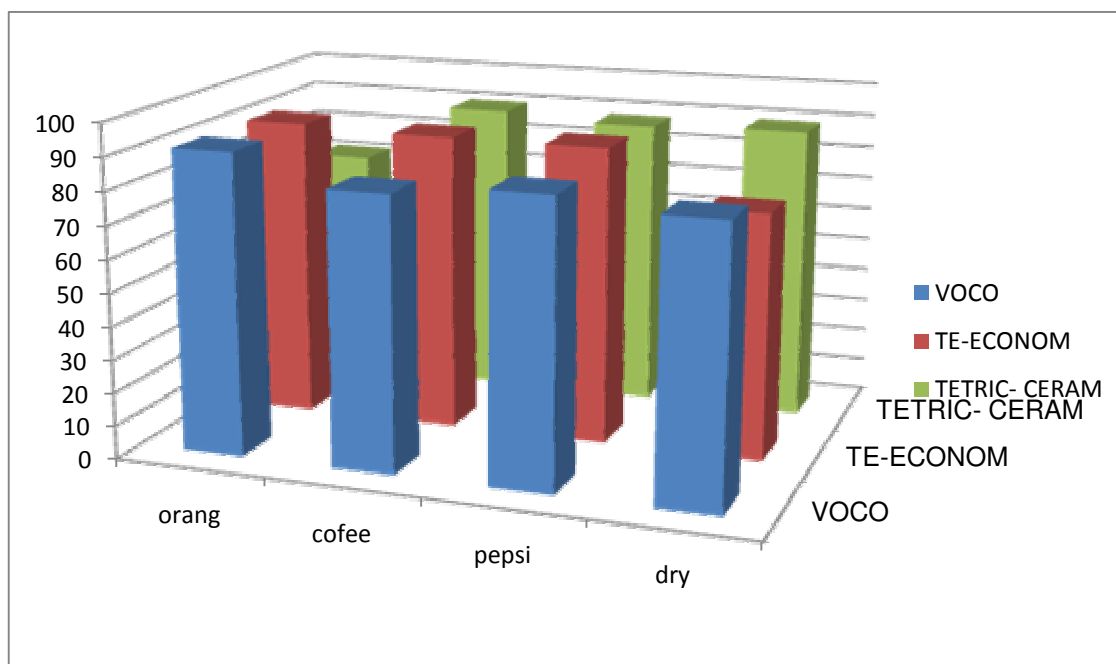


Figure 1. The effect of storage media on the degree of conversion of three types of composite resin

## **DISCUSSION**

The physical, mechanical and biological properties of composite resin are strongly influenced by the DC achieved by organic matrix<sup>(15)</sup>. Ideally, a resin material would have all of its monomer converter to polymer during polymerization<sup>(15)</sup>.

Fourier transformation infrared spectroscopy (FTIR) has been proven to be a powerful technique for measuring the DC and has been widely used as available method<sup>(17)</sup>.

The DC is one factor that affects clinical performance of resin composites<sup>(13)</sup>. This parameter is also considered a key factor in modulating the profile of the material, including a wide array of mechanical properties and potential biological adverse reactions<sup>(14)</sup>.

The DC of three types of composite resin (Te-Econom, Tetric ceram and VOCO) was significantly increased when the samples stored in orange juice, Pepsi and coffee as compared to dry samples (Table 2). This result may be attributed to lower pH value of the storage media than neutral, this result agree with Tosun et al<sup>(15)</sup> who found that the DC of resin material was increased when stored in different pH .

The result also revealed that the three types of composite resin samples stored in orange juice showed a significant difference ( $p < 0.05$ ) in the DC when compared to samples stored in coffee (Table 3) this is because the lower pH value of orange juice than coffee, where as samples stored in Pepsi showed a non significant difference ( $p > 0.05$ ) in the DC as compared to samples stored in orange juice and coffee (Table 3). This is due to the pH value of Pepsi lies between that of orange juice and coffee<sup>(18,19)</sup>. This finding agree with Chadwick et,al<sup>(20)</sup> who found that there was a non significant difference between composite resin samples stored in Pepsi and coffee.

Finally, the result found that there was a non significant difference in DC of Tetric ceram and VOCO composite resin samples stored in all storage media, but they significantly different from Te-Econom composite resin samples (Table 4). This is due to the difference of organic matrix of Te-Econom from Tetric ceram and VOCO composite resin (Table 1). This result agree with the findings of Filho et al<sup>(22)</sup> who found that differences in the viscosity of organic matrix have an influence in the DC of composite resin material.

## **CONCLUSIONS**

Within the limitations of this in vitro study the following conclusions were drawn:

There was a significant difference in the DC of the three types of composite resin when stored in different media as compared with dry samples.

The three types of composite resin that stored in Pepsi showed a non significant different in the DC when compared to that stored in orange juice and coffee.

Samples stored in orange juice showed a significant difference in the DC when compared to that stored in coffee.

The DC of Tetric ceram and VOCO composite resin samples significantly differ from Te-Econom composite samples when stored in different pH.

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