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Evaluation of the Absorbance and Transmittance of the Optical Light for Three Different Types of Composite Resin Stored in Artificial Saliva (in vitro study)

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الخلاصة

الأهداف: لتقيم الإمتصاص وقابلية النقل للضوء البصري لثلاثة أنواع مختلفة لمكون راتنج الأسنان المخزون في اللعاب الصناعي. **المواد وطرائق العمل**: ٣٠ عينة تم تحضيرها من الراتنج المفعل ضوئيا تم تقسيمها الئ ثلاث مجاميع. المجموعة الاولى: ١٠عينات تم تحضيرها من الEls **المجموعة الثانية**:١٠عينات من الـ Tetric n ceram المجموعة الثالثة: ١٠ عينات من الـ Solitaire 2. تم قياس الإمتصاص بإستخدام المطياف الضوئي. حيث أستغرق تقييم العينات بعد مرور (صفر و ١ و ٧ و ٢٨) أيام مستمرة مخزونة في لعاب صناعي. **النتائج**: التحليل الإحصائي اظهر إختلاف ملحوظ ومهم بـ(P ≤ 0.05) بين المجاميع المختبرة وبنفس الوقت المستغرق بالغمر، اظهر الـ Solitaire 2 طرق إمتصاص أعلى بالمقارنة مع الـ Tetric و Els خاصة بعد مرور يوم واحد غمر في اللعاب الصناعي، ولم يكن أي إختلاف ذو دلالة مهمة P> 0.05 بأوقات الغمر المختلفة في اللعاب ضمن المجموعة الواحدة، ويظهر الـ Els نسبة امتصاص اقل ونقل أعلى T% مما هو عليه في مكون الراتنج Tetric وSolitaire2. **الإستنتاجات**: اظهر التحليل الاحصائي ان حشوة الراتنج منقبض البلمرة المنخفضة Els اقل امتصاص واعلئ نسبة نقل للضوء البصري، ويظهر Poly glass اعلئ إمتصاص واقل نسبة نقل للضوء مقارنة مع Tetric و الـ Els. وأيضاً أداء المجاميع لا يختلف إحصائياً من حيث الوقت المستغرق في الغمر باللعاب الصناعي

ABSTRACT

Aims: To evaluate the Absorbance and transmittance of the optical light for three different types of light activated dental composite resin stored in artificial saliva. **Materials and Methods**: 30 specimens were prepared from light activated composite resin and divided in to three groups, G1: 10 specimens prepared from Els, G2: 10 specimens prepared from Tetric n Ceram, G3: 10 specimens prepared from Solitaire2. Absorbance of the optical light measured using spectrophotometer. The specimens were evaluated after (zero,1,7,28) day immersion time in artificial saliva. **Results**: Statistical analysis shows significant difference at P ≤ 0.05 among tested groups at same immersion time, Solitaire 2 showed highest absorbance means compare to Tetric, Els specially after 1 day immersion in artificial saliva. No significant difference P> 0.05 in absorbance mean at various immersion time in artificial saliva for each group. Els shows low absorbance and highest transmittance percentage T% than Tetric and Solitaire composite resin. **Conclusion:** The Els extra composite resin has lowest absorbance and highest transmittance means for optical light, Solitaire2 showed more absorbance means with less amount of light transmittance through the composite resin compare to Tetric and Els. The performance of the experimented groups statistically not significant in terms of immersion time in artificial saliva.

Key words: Absorbance,Transmittance, composite resin, artificial saliva spectrophotometer.

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INTRODUCTION

Composite resin is a heterogeneous material that is composed of three major component (resin matrix, filler particles and saline coupling agent. Since 1960 dental composite has undergone a lot of changes in order to become a restorative material with acceptable aesthetic properties, recent advancement in direct dental restorative materials is the incorporation of the nanotechnology which is understanding and control mater at dimension of roughly 1-100nm, also new dental composite formulation reinforced by nano and micro filler dental restorative materials which include nanometric and micrometric inorganic particles as reinforcing fillers(1).

In recent years resin composite have been used extensively as an alternative to dental amalgam, With this increase in the use has come, the desire to improve the various properties (absorbance, optical, physical mechanical) properties for resin composite(2). In general, dental composite and other restorative filling materials used in dentistry are required to have long term durability in the oral cavity were the filling materials is in contact with saliva fluid, that contains a variety of inorganic species together with bacterial flora complex(2,3) .

Despite the substantial advances in direct esthetic filling materials, particularly light cured composite resins these materials still possess a number of properties that interface in their clinical performance such as compressive strength, hardness, abrasive strength, polymerization shrinkage, homogenization, translucence, absorbance for optical light superficial staining, elasticity modulus, and coefficient of liner thermal expansion, the inadequacy of these properties can cause a negative performance of a restoration with color instability resulting from superficial staining and internal discoloration among other faults(4).

Several factors can affect the esthetic result of the restoration with composite resin in anterior teeth, most of these factors involve the esthetic limitations of the filling material, such as absorbance which according to several authors can be modified by water absorption chemical degradation and micro fractures. Light cured composite resin are less absorbance and more transmittance than chemical cure activated resin because the former are less pigmented over all a reduction in transmittance is observed over time(5,6). However few studies have focused specifically on determining the absorbance of the optical light for composite resin materials which are so important for the esthetic success of a restoration(5).Optical properties of composite restorative materials both cured and uncured are obvious important in a procedure of reliant on photo activation since they may affect light transmittance and therefore materials conversion upon which effect on mechanical properties and ultimate clinical performance of composite(7). The aim of this study was to evaluate the absorbance and transmittance of the optical light for three different types of light activated composite resin (Els extra,Tetric n ceram, Solitaire 2 composite resin) after zero,1,7,28 days storage in artificial saliva using UV light spectrophotometer.

MATERIALS AND METHODS

The study was carried out in the department of conservative dentistry and dental basic science. A total of 30 specimens (bar) in shapes, 30 mm in length,10mm in width, less than 1mm in thickness (0.5mm) were prepared from three different types of light activated composite resin, composition as shown in Table (1). Group1: 10 specimens were prepared from light activated microhybrid Els extra (Saremco Dental), Group2: 10 specimens were prepared from light activated nanohybried composite resin Tetric-n ceram (Ivoclar Vivadent liechstenein), Group3: 10 specimens where prepared from light activated poly glass composite resin Solitaire 2 (Heraeus Kulzer Germany).

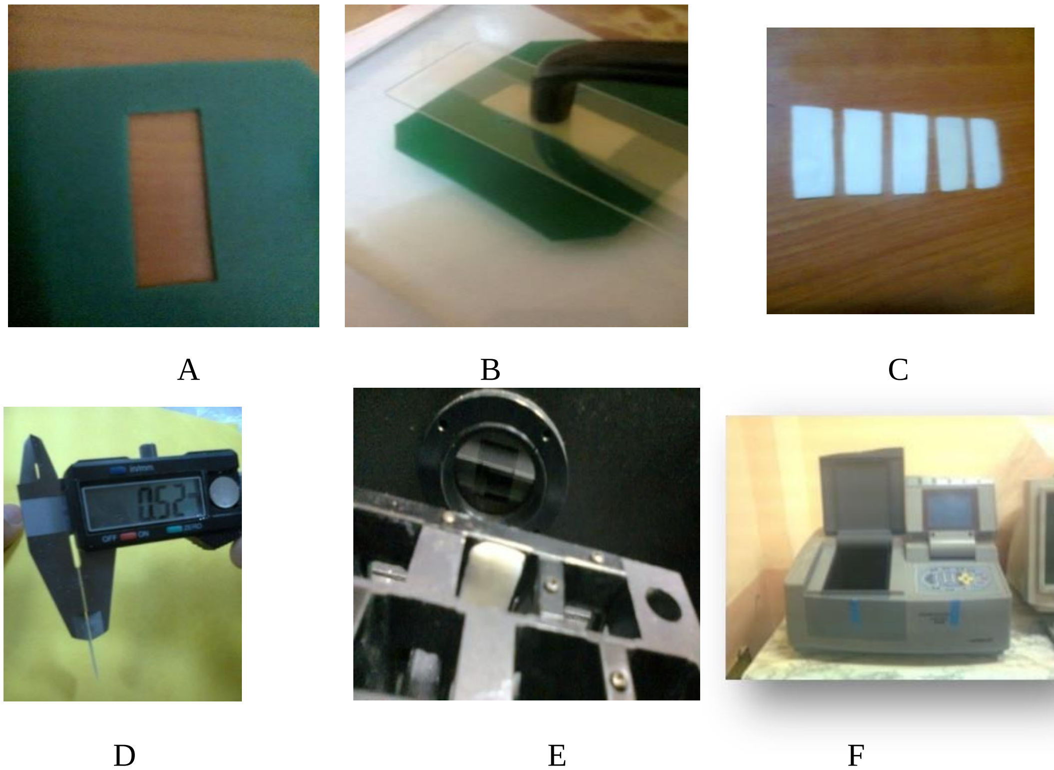
The specimens were prepared in plastic mold (30 mm in length,10 mm in width and less than 1mm in thickness (0.5mm) standardization measurement using digital vernier caliper (made in Germany).

The composite resins were packed in the mold using an incremental technique with a plastic instrument (then adapted as one layer), glass slide and celluloid strip were placed on the top and bottom of the mold to provide flat surface as shown in Figure (1), and facilitate light curing the specimens were cured with visible light cured (activation) was done with Blue-luxcer TM curing light (Model M 855 Halogen lamp monitex Taiwan 08H0151) for 40 seconds, with light tip was placed in contact with the glass slide (with exception of the thickness of glass slide and celluloid strip at a distance of 1.0mm from the specimens) from the top of the specimens.

Table(1): Compositions of three different types of light activated composite resin.

Composite resin	Composition	Particle size distribution.	Manufacture
Els extra	Barium glass, silanizen, Bis-GMA,Bis-EMA , catalyst , inhibitors , and pigments.	0.1- 2.8µm highly filled	Saremco Dental Switzerland
Tetric n – Ceram	Dimethacrylates (19-20 wt%) barium glass, ytterbium trifluoride, mixed oxide, copolymers (80-81 wt%), catalyusts, stabilizers and pigments (<1 wt%) inorganic filler 55–57 vol %	40 nm – 3000 nm	Ivoclar Vivadent
Solitaire 2	Multicross – linking urethane (meth) acrylatemonomers, BaAF – silicate glass, Porous silicon dioxide	0.02 - 23 µm ϕ 0.7 µm; max < 2µm ϕ 8 µm; max < 23µm	Heraeus – kulzer

Bis-GMA: Bisphenol Adiglycidyl methacrylate, Bis EMA: Bisphenol Apolyethylene glycol diether dimethacrylate. ϕ **:** mean percentage



Figure(1): Preparation of composite resin specimens

A: mold
B: Specimens in the mold
C: Specimens (composite resin bars)
D: Digital vernier caliper
E: Specimens under examination
F: Spectrophotometer

Light cure for the specimens through the glass slides and celluloid strip was exposed to light from upper, lower, right, left cover strip sides with light intensity of the curing light unit was standardized to at least 500nm(output),double the recommended time to ensure complete polymerization of the specimens which removed from the molds [4,5,6,8].

The resin bars were finished and polished to a uniform surface using carbide bur (Komet, UK) at medium speed for 10 second under water coolant for each of the surface to create base line finishing and polishing procedure include using (Sof -Lex) polishing system which include using multistep abrasive disc (Sof -Lex) ™ aluminum oxide disk Sof-Lex (3M ESPE Dental prouducts St. paul. USA) used for polishing composite bars[6,8], surface finishing and polishing attributed to the removal of the surface layer of resin rich inorganic matter and the staining susceptibility of composite resin depend on its composition and surface properties, the susceptible to staining showed that the lowest staining was generally correlated with lowest water absorption, low organic matrix content and satisfactory brightness after finishing and polishing, the composite bars washed in distilled water and dried with air syringe before taking the reading[6].

Absorbance values for the composite resin bar measured using an ultra-violate visible spectrophotometer (UV- UIS Dual 8 Auto CEIL CE UVS-2800 LABO MED Inc, UK)[6,9]. At wave length (245)nm through direct transmission absorbance was measured immediately after preparation of the bars (finishing and polishing) at zero time before immersion in artificial saliva. The other measurements for the bars were taken after (1,7,28) days immersion in artificial saliva (chemical compositions)[3] as shown in table (2). The spectrophotometer reads absorbance mean (A) in nm, absorbance define as the amount of light absorbed by the material or body, but transmittance can define as the process in which light travels or crosses a body or surface without being absorbed or scattered[5,6] and according to equation, transmittance percentage(T%) concluded from absorbance means.

Table(2): Chemical composition of artificial saliva medium[3]

Artificial saliva composition	Concentration (g/l)
NaCl	0.40
KCl	0.40
$CaCl_2.2H_2O$	0.795
$NaH_2\ PO_4.2\ H_2O$	0.780
$Na_2S_9\ H_2O$	0.005
$CO\ (NH_2)_2$ (Urea)	1.0
Distilled water	1000

RESULTS

Statistical analysis include One Way Analysis of Variance (ANOVA) and Duncan Multiple Range tests at ($P \le 0.05$) was performed to evaluate the statistical differences in the absorbance means among tested composite resin, One Way Analysis of Variance demonstrated significant difference in the absorbance means for the optical light among tested composite resin after immersion in artificial saliva as shown in Tables (3,4).

Table(3): One Way Analysis of Variance(ANOVA) for the differences in absorbance mean among tested composite resin at the same immersion time.

		Sum of Sequare	Df*	Mean Sequre	F value	**P value
Between group	1,2,3 at G	2338	2	1.160	6.423	0.005
Within group		4.914	27	0.182		
Total	Zero time	1.252	29			
Between group	1,2,3 at 1day G	2477	2	1.238	4.227	0.025
Within group	Immersion time	7.91	27	0.293		
Total		10.38	29			
Between group	1,2,3 at 7 day G	277	2	1.389	5.783	0.008
Within group	Immersion time	6.482	27	0.240		
Total		9.259	29			
Between group	G1,2,3 at 28 day	2443	2	1.221	5.532	0.01
Within group	Immersion time	5.961	27	0.221		
Total		8.403	29			

*Df=degree of freedom ,**P≤0.05 mean significant different exist.

Table (4): Duncan Multiple Range Tests for the Absorbance mean for the three different types of composite resin after storage in artificial saliva

TIME INTERVALES	TYPES OF COMPOSITE	MEAN ±SD	DUNCAN GROUP
Without immersion in artificial saliva	1. Els saremco	0.221±0.125	C
	2. Tetric	0 .259±0.227	B
	3.Solitaire 2	0.831±0.694	A
After 1 day immersion in artificial saliva	1. Els saremco	0.302±0.244	C
	2 .Tetric	0.398± 0.314	B
	3. Solitaire 2	0.954±0.848	A
After 7 day immersion in artificial saliva	1.Els saremco	0 .272±0.260	C
	2.Tetric	0.308±0.290	B
	3.Solitaire 2	0.935±0.752	A
After 28 day immersion in artificial saliva.	1.Els saremco	0. 247 ± 0.222	C
	2.Tetric	0.291±0.271	B
	3. Solitaire 2	0.873±0.733	A

p-value ≤0.05, Different letters mean significant different exist

Results showed that at the same immersion time in artificial saliva media, Solitaire 2 composite resin had the highest absorbance mean specially after 1day immersion in artificial saliva (0.954) nm followed by Tetric n ceram (0.398) nm, Els

Saremco (0.302) nm after 7,28 day immersion in artificial saliva, there are slight increase in absorbance means for Solitaire2(0.935,0.873), Tetric(0.308,0.291), Els (0.272,0.247) in compared with zero time(before immersion in artificial saliva) Solitaire (0.831), Tetric (0.259), Els(0.221). No significant differences in absorbance mean for each type of composite resin at different immersion time in artificial saliva as shown in Tables (5,6). Els extra showed the highest transmittance percentage followed by Tetric and Solitaire 2 composite resin as shown in table (7) Figure (2).

Table(5): One Way Analysis of Variance(ANOVA) for each type of composite resin at different immersion time in artificial saliva.

		Sum of Seq.	Df*	Mean Seq.	F value	**P value
	G1	0.011	3	0.004	0.072	0.975
Between group		1.869	36	0.052		
Within group		1.88	39			
Total						
Between group	G2	0.098	3	0.033	0.416	0.742
Within group		2834	36	0.079		
Total		2933	39			
Between group	G3	0.253	3	0.084	0.167	0.918
Within group		18.23	36	0.506		
Total		18.486	39			

*Df=degree of freedom ,**P≥ 0.05 mean no significant different exist

Table(6): Duncan Multiple Range test for absorbance mean for different types of composite resin at different immersion time in artificial saliva.

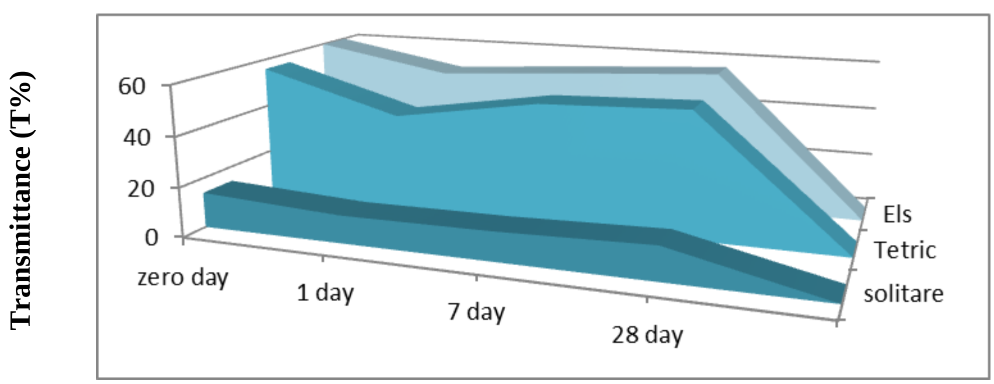
TYPE OF COMPOSITE	TIME INTERVALS	MEAN ±SD	DUNCAN GROUP
G1 Els	Without immersion	0.221±0.125	C
	After 1 day	0.302±0.244	C
	After 7 day	0.272±0.260	C
	After 28 day	0.247±0.222	C
G2 Tetric	Without immersion	0.259±0.227	B
	After 1 day	0.398±0.314	B
	After 7 day	0.308±0.290	B
	After 28 day	0.291±0.271	B
G3 Solitaire 2	Without immersion	0.831±0.694	Ả
	After 1 day	0.954±0.848	A
	After 7 day	0.935±752	A
	After 28 day	0.873±0.733	A

Same letters for each group mean no significant difference

Table (7): Transmittance values(T%) for three different types of composite resin at same immersion time.

Time intervals	Types of composite	Transmittance (T%)
Without immersion in arti. saliva	Els	60
	Tetric	56
	Solitaire 2	14.1
After 1 day immersion in art.saliva	Els	49.8
	Tetric	39.9
	Solitaire 2	11.1
After 7 day immersion in art.saliva	Els	53.4
	Tetric	49.2
	Solitair 2	11.6
After 28 day immersion in art. saliva.	Els	56.6
	Tetric	51.16
	Solitaire 2	13.3

Absorbance(A)=2-LogT% [24], $T\%=10^{(2-A)}$



Figure(2): Histogram showing differences in transmittance percentage (T%) for different types of composite resin.

DISCUSIONS

The search for direct restorative material combining excellent esthetic with superlative physical, mechanical and biological properties has driven researches to study various properties of different restorative materials[10].

For a long time, dental professionals were satisfied with restorations that showed excellent shape and contour, good marginal adaptation considering color and optical properties of secondary importance. Possibly due to the limited knowledge of dental professionals about optical and physical properties, include absorbance and transmittance for the optical light[10,11].
UV-Visible light spectrophotometer has been reported as an efficient method to verify the absorbance mean of the optical light for composite resin at wave length 245nm [5,6, 10,11].

The best results were achieved with specimens of composite that received surface finishing and polishing which attributed to the removal of the surface layer of the resin rich inorganic matter which susceptible to staining, also the specimens thickness standardized less then 1mm because increasing the specimens thickness effect on result and lead to increase light absorbance and reduce its light transmittance[5,6].

Several factors such as polymeric matrix, refraction index, type of monomer, filler type and content can influence the light absorbance, transmittance and opacity of composite resins, these properties must be thoroughly evaluated in order to ensure esthetic longevity of a restoration[12,13 ,14,15]. Optical properties of dental composite are not only vital for their effective in clinical used as esthetic restorative materials but also affect on their photo polymerization. composite composition, including choice of monomer filler and pigments effect on the matching of shade and transmittance between the final cured composite and adjacent natural teeth[7].

Also optical properties of composite restorative both cured and uncured are important in a procedure of photo activation since they may affect light transmission and therefore materials conversion upon which effect on mechanical properties and ultimate clinical performance are dependent[7]. Statistical analysis shown significant difference in the absorbance means for the optical light among tested different types of composite resin at the same immersion time (zero,1,7,28) days in artificial saliva media, there are significant difference in the absorbance means at P value ≤ 0.05 for the optical light among tested composite resin after immersion in artificial saliva at the same immersion time as shown in Table (3,4). Solitaire 2 composite resin showed highest absorbance mean because the inclusion of poly glass in composite resin reduce the amount of optical light transmittance increase the absorbance mean through the structure(6,16,17) and this fact agree with result of this study, specially after 1day immersion in artificial saliva (0.954) nm followed by Tetric (0.398) nm, Els extra (0.302) nm. After (7,28) day immersion there are slight increase in absorbance means for Solitaire 2 (0.935,0.873), Tetric (0.308,0.291), Els (0.272,0.247) in compare with zero time (before immersion) Solitaire 2 (0.831), Tetric n ceram (0.259), Els (0.221), as a result of storage in artificial saliva water sorption, stain, gain and loss in the weight of composite resin bars, changing in absorbance mean for optical light without significant differences during different immersion time, no significant differences in absorbance mean for each type of composite resin at different immersion time in artificial saliva as shown in Table (5,6).

Transmittance is a propriety of substance that permit the passage of the light through the structure(4,14,15),the transmittance of dental composite depend on their scattering and absorption coefficients of the resin, filler particles, pigment(4). Thus the inherent transmittance of the material may contribute to matching the shade of the underlining tooth and the tooth adjacent to it(4). There are many variables that may affect the transmittance of the material including polymerization shrinkage, saliva aging, filler particle composition and size (4,11).

Els extra composite resin, microhybrid showed the highest transmittance percentage as compared to other experimented composite resin at different immersion times in artificial saliva as shown in Table (7), Figure (1). This can be explained by fact that microhybrid particles resin are more transmittance than nano and poly glass hybrid composite resins and this agree with result of the study(16,17). Tetric n-ceram resin nanohybrid shows more transmittance percentage than Solitaire 2 poly glass hybrid composite resin. According to Santos *etal*(12)study, nano composites resin showed a higher gain in transmittance at a fixed thickness than poly glass hybrid resins, which attributed to the filler particle size and distribution of nano composite and this agree with result of this study. Therefore, filler particles size and content significantly affected the light transmittance characteristics and color of composite resin(12).

Nakamura *etal*(18) found that transmittance was not modified over time, in contrast, lambre *etal*(19) reported that transmittance diminished gradually over time with the longest immersion time leading to the lowest transmittance value. Lee *etal*(20)examined how transmittance is affected by storage in salivary enzyme versus a phosphate buffered saline solution for 9 week ,they concluded that transmittance value tend to decrease after 9weeks storage in solution, this is important because the results show that enzymes of saliva probably has little effect on transmittance of composite. Lea and lee[21] conclude that transmittance parameter tend to varying according to individual brand of composite resin. Some authors state that the transmittance decrease with aging and this should be taken in consideration during shade selection of resin composite, absorbance means not effect on degree of radio opacity of composite resin[22]. The incorporation of inorganic nano particales into polymer matrix can significantly influence the properties of the matrix and the obtained composite might exhibit improved thermal, mechanical and optical properties, the properties of polymer composite depend on the type of incorporated nano particals, their size, shape and interactions with the polymer matrix, the tensile strength and elongation decrease with increasing cerium oxide(CeO_2) nano particales composite resin up to 3.0 wt%. also the UV absorption properties was noticeable improved[23].

CONCLUSIONS

From results of this study we concluded that Els microhybrid composite resin less absorbance and high transmittance for the optical light from the Tetric n ceram nanohybrid composite resin, Solitare 2 poly glass composite resin showed more absorbance values with highest significant differences and with reduced amount of light transmittance compared to other experimented composite resin, also the absorbance of the experimented groups was similar no significant differences in terms of different immersion time in artificial saliva.

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