

Comparative Evaluation Of The Effects Of Different Alcoholic Beverages And Sports/Energy Drinks On The Surface Roughness Of A Recently Marketed Universal Nanohybrid With A Nano-Filled Composite Resin

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Abstract

AIM: This study evaluated the effects of different commonly consumed sports/energy drinks and alcoholic beverages on a nanohybrid composite resin - NeoSpectra™ST and a nano-filled composite resin - FiltekZ350XT. **MATERIALS AND METHOD:** 40 disc-shaped specimens of each composite material were fabricated of 2 mm thickness and 1 cm diameter. Initial surface roughness was evaluated using a profilometer. These specimens were immersed in four solutions – Red bull, Sting, Vodka, and Whiskey for a test period of 30 days for 5 min daily. The specimens were removed from solutions, cleaned, dried, and tested for surface roughness using a profilometer. **RESULTS:** Among the sports/energy drinks, Sting showed more surface roughness than Red bull and among alcoholic drinks, Whiskey showed more surface roughness than Vodka in both composite groups. Comparison between both the composite groups showed that NeoSpectra™ST showed less surface roughness in all the beverages compared to FiltekZ350XT. Independent t-test showed that surface roughness when immersed in Vodka showed a significant difference between the two groups. **CONCLUSION:** All the beverages assessed in this study showed increase in the roughness of both the composite resin.

KEYWORDS: Beverages, Surface Roughness, Composite resin, Surface properties, Immersion

INTRODUCTION

Due to growing social acceptance and increased health consciousness among the younger population, there has been an increase in the consumption of alcoholic beverages as well as health/energy drinks. ⁽¹⁾ Energy drinks are beverages that give you more energy, improve your athletic performance, keep you awake and aware, and improve your mood. ⁽²⁾ They are caffeinated drinks, shots, or drops that typically contain sugar as well as a combination of additional substances that boost energy, such as taurine, ginseng, guarana, and B vitamins. ⁽³⁾

The search for the ideal restorative material has prompted manufacturers to regularly develop new materials. Researchers are working to produce novel materials with improved mechanical and physical characteristics that will strongly bond to the tissue of the enamel and dentin. ⁽⁴⁾ Among the numerous materials, the usage of composite restorative materials has grown due to their excellent aesthetic appearance, ease of handling, and capacity to bond to the tooth structure. ⁽⁵⁾ The degradation process may change the material's properties like the integrity of tooth-restoration interface, aesthetic quality, bond strength, wear resistance, decreased hardness, and surface roughness. This impacts the longevity of the restorations in clinical settings. ⁽⁶⁾ Consumption of certain drinks may have an adverse effect on the resin composite's aesthetic and physical qualities, lowering the quality of restorations. ⁽⁷⁾ Chemicals from certain beverages may cause composite restorations to deteriorate and degrade over time. Ethanol is one such component in these beverages that alter certain properties of composite restoration due to its low pH and erosive nature. ⁽⁸⁾

A variety of factors including the composition of the matrix, the filler content and its distribution, and surface treatments such as silane treatments affect the degradation process of resinous materials. ⁽⁹⁾ Conventional resin-based composites' mechanical and aesthetic qualities have been improved by modifying the fillers. Less water sorption is seen by increasing the filler content which results in lower surface degradation. ⁽¹⁰⁾ In recent years, nanotechnology is applied to manufacturing better quality resin composites. ⁽¹¹⁾

NeoSpectra™ST (DentsplyDeTrey, Konstanz, Germany) is a recently marketed nanohybrid universal resin composite made with SphereTEC technology. It is manufactured with spherical prepolymerized filler. The company claims that manufacturing microscaled, spherical prepolymerized filler's shape and size distribution enhances certain properties like handling, aesthetics, and longevity. ⁽¹²⁾ FiltekZ350XT (3M ESPE, Minnesota, USA), is a nano-filled composite with filler content 76.5% w/w or 60% v/v. According to the manufacturer, it has better polish retention, superior wear resistance and gloss retention. ⁽¹³⁾

Numerous studies have been done to evaluate the effects of various solutions on the surface of resin composites. ^(14 15 16) The new SphereTEC technology used is not compared with the previously tested nano-filled composite. Thus, the primary goal of this study was to measure the surface roughness of this nanohybrid and compare it to nano-filled composite resin after it is kept in different solutions.

MATERIAL AND METHOD

The surface roughness of two different composite restorative materials was assessed in this study- Group 1 - NeoSpectra™ST (DentsplyDeTrey, Konstanz, Germany) and Group 2 - FiltekZ350XT (3M ESPE, Minnesota, USA). The composition of these composite is shown in table 1. We evaluated the effects of Redbull, Sting, Vodka, and Whiskey on these composite resins.

Specimen preparation

Disks were fabricated from the composite resin using a mold made of acrylic that had a thickness of (2 mm \pm 0.1 mm) and an interior diameter of (1 cm \pm 0.1mm). 80 specimens were created with a standardized dimension of 1 cm diameter and 2mm thickness. (Figure 1) The composite material was inserted in a single increment using a Teflon coated instrument in the acrylic mold. A mylar strip was kept on the material and covered with a microscopic slide. Minimum pressure was used on the microscopic slide to expel the extra material. The samples were then light-cured using a light curing unit Woodpecker I-LED plus (Woodpecker Medical Instrument Co., Guilin, China), with a light intensity of 2100 mW/cm² for 3-4 s. The light intensity was analyzed using a radiometer LM-1 Woodpecker LED Light Meter (Woodpecker Medical Instrument Co., Guilin, China) before curing. (Figure 2)

40 specimens prepared from each composite material were evaluated for surface roughness after immersing in four beverages - Redbull, Sting, Vodka, and Whiskey (10 samples each) (Figure 3). All specimens were evaluated to record initial surface roughness using profilometry SurfTest SJ-210 (Mitutoyo America Corporation, Aurora, Illinois) before immersing in various beverages. (Figure 4) The specimens from each composite were distributed into four groups and were immersed in the beaker containing different beverages for a study period of 30 days for 5 min at room temperature daily. The specimens were stored in distilled water at 37 °C when they were not immersed in the beverages.

The specimens were removed from the immersion solution and cleaned by dipping in distilled water. The surface of the specimens were dried using an absorbent paper.

A profilometer was used to evaluate the surface roughness and results were subjected to statistical analysis.

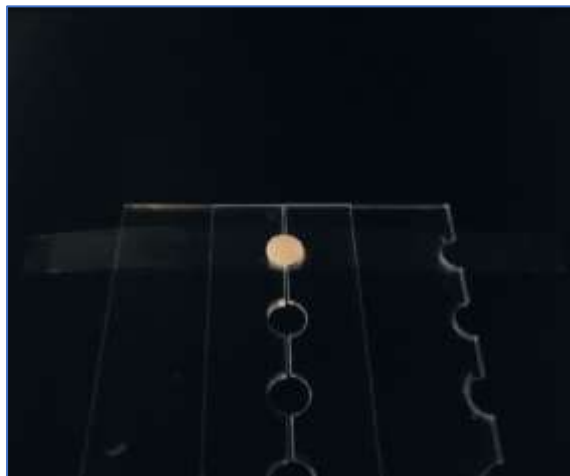


Figure 1



Figure 2



Figure 3



Figure 4

Figure 1: composite disk with a diameter of 1 cm and thickness of 2 mm 300 DPI

Figure 2: light intensity checked before curing, 300 DPI

Figure 3: Beverages used in the study 300 DPI

Figure 4: surface roughness checked using a profilometer. 300 DPI

RESULTS

The Statistical Package for Social Sciences (SPSS) version 20.0, IBM Corporation, USA, for MS Windows, was used to examine the data that had been gathered. Mean, Standard Deviation (SD), and Standard Error (SE) are the measures used to present continuous data. The Shapiro-Wilk test was used to determine if the data were regularly distributed. The Tukey HSD post hoc test was used to compare groups pairwise. Probabilities of less than 0.05 were considered statistically significant, and probabilities less than 0.01 were considered extremely significant. Table 2 shows the mean surface roughness values for NeoSpectra™ST (Group 1) after immersion in various beverages. Among the alcoholic drinks, Whiskey with a mean value of 1.05 shows more surface roughness compared to Vodka with a mean value of 0.83. Sting with a mean value of 1.2 shows more surface roughness compared to Red bull with a mean value of 1.02. Table 3 shows the mean surface roughness values for Filtek Z350XT (Group 2) after immersion in various beverages. Among the alcoholic drinks, Whiskey with a mean value of 1.01 shows more surface roughness compared to Vodka with a mean value of 0.91. Sting with a mean value of 1.1 shows more surface roughness compared to Red bull with a mean value of 1.01. Pairwise comparison

among the various beverages in group 1 and group 2 showed a significant difference between Sting and vodka. (Table 4) (Table 5) Intergroup comparison between the two groups showed a significant difference in surface roughness when immersed in Vodka. (p-0.05) (Table 6)

Table 1: Composition of the resin composites used.

Materials	Shade	Manufacturer	Content
Neo Spectra™ ST	A2	DentsplyDeTrey, Konstanz, Germany	Organically modified ceramic- Methacrylate modified polysiloxane dimethacrylate resins, Ethyl-4 (dimethylamino) benzoate and Bis(4-methyl-phenyl) iodoniumhexafluorophosphate. Filler load: 78–80% by weight Spherical, pre-polymerized SphereTEC fillers (d3,50 ≈ 15 μm), non-agglomerated barium glass and ytterbium fluoride (≈0.6 μm)
Filtek Z350 XT	A2	3M ESPE, Minnesota, USA	UDMA, TEGDMA, bis-GMA, bis-EMA resins Filler load: 72.5% by weight Aggregated zirconia/silica cluster filler, non-agglomerated/non-aggregated 4 to 11 nm zirconia filler, and non-agglomerated/non-aggregated 20 nm silica filling (comprised of 20 nm silica and 4 to 11 nm zirconia particles)

Table 2: Mean surface roughness values for Group 1 after immersion in various beverages

Group 1	N	Mean	SD	SE	Minimum	Maximum
A-Red Bull	10	1.02	0.15	0.05	0.86	1.30
B-Sting	10	1.20	0.26	0.08	0.89	1.66
C-Vodka	10	0.83	0.08	0.02	0.67	0.93
D-Whiskey	10	1.05	0.11	0.03	0.92	1.28

Table 3: Mean surface roughness values for Group 2 after immersion in various beverages

Group 2	N	Mean	SD	SE	Minimum	Maximum
A-Red Bull	10	1.01	0.09	0.03	0.89	1.20
B-Sting	10	1.10	0.11	0.04	0.90	1.23
C-Vodka	10	0.91	0.05	0.02	0.84	0.99
D-Whiskey	10	1.01	0.12	0.04	0.91	1.30

Table 4: Pairwise Comparison of three groups by Tukey HSD post hoc multiple comparisons in group 1

GROUP(I)	GROUP(J)	Mean Difference (I-J)	P value	95% Confidence Interval	
				Lower Bound	Upper Bound
A-Red Bull	B-Sting	-0.18	0.096	-0.38	0.02
	C-Vodka	0.19	0.064	-0.01	0.39
	D-Whiskey	-0.03	0.980	-0.23	0.17
B-Sting	A-Red Bull	0.18	0.096	-0.02	0.38
	C-Vodka	0.37*	0.000	0.17	0.57
	D-Whiskey	0.15	0.205	-0.05	0.35
C-Vodka	A-Red Bull	-0.19	0.064	-0.39	0.01
	B-Sting	-0.37*	0.000	-0.57	-0.17
	D-Whiskey	-0.22	0.026	-0.42	-0.02
D-Whiskey	A-Red Bull	0.03	0.980	-0.17	0.23
	B-Sting	-0.15	0.205	-0.35	0.05
	C-Vodka	0.22	0.026	0.02	0.42

*. The mean difference is significant at the 0.01 level.

Table 5: Pairwise Comparison of three groups by Tukey HSD post hoc multiple comparisons in group 2

GROUP(I)	GROUP(J)	Mean Difference (I-J)	P value	95% Confidence Interval	
				Lower Bound	Upper Bound
A-Red Bull	B-Sting	-0.09	0.244	-0.20	0.03
	C-Vodka	0.10	0.097	-0.01	0.22
	D-Whiskey	0.00	1.000	-0.11	0.12
B-Sting	A-Red Bull	0.09	0.244	-0.03	0.20
	C-Vodka	0.19*	0.001	0.07	0.30
	D-Whiskey	0.09	0.217	-0.03	0.20
C-Vodka	A-Red Bull	-0.10	0.097	-0.22	0.01
	B-Sting	-0.19*	0.001	-0.30	-0.07
	D-Whiskey	-0.10	0.112	-0.22	0.02
D-Whiskey	A-Red Bull	0.00	1.000	-0.12	0.11
	B-Sting	-0.09	0.217	-0.20	0.03
	C-Vodka	0.10	0.112	-0.02	0.22

*. The mean difference is significant at the 0.01 level.

Table 6: Comparison of two groups by Independent t-test

*. The mean difference is significant at the 0.05 level.

SD: Standard Deviation SE: Standard Error P value: Probability value

DISCUSSION

Groups	Group 1				Group 2				Mean Difference	P value
	N	Mean	SD	SE	N	Mean	SD	SE		
A-Red Bull	10	1.02	0.15	0.05	10	1.01	0.09	0.03	0.01	0.917
B-Sting	10	1.20	0.26	0.08	10	1.10	0.11	0.04	0.10	0.283
C-Vodka	10	0.83	0.08	0.02	10	0.91	0.05	0.02	-0.08*	0.011
D-Whiskey	10	1.05	0.11	0.03	10	1.01	0.12	0.04	0.04	0.456

Dental composite resins are constantly subjected to thermal changes and changes in pH in the oral cavity due to the beverages and meals consumed. (17) These chemical changes from the beverages affect the composite resins, leaving a rough surface. (18) Surface roughness of composite resin influences its clinical longevity. Rough surfaces of restoration are prone to bacterial build-up, increasing the risk of periodontal diseases, and dental caries and may reduce the aesthetic properties. Surface roughness is therefore commonly assessed in material research as it is believed to aid professionals in selecting the ideal restorative material. (19)

Surface roughness is typically assessed using microradiography, scanning electron microscopy, atomic force microscopy, and profilometry. In this study, profilometry was employed because it accurately predicts surface roughness values by using a contact probe to quantify the roughness of a specific area's surface in nanometers. (20 21)

The surface roughness of composite resin is influenced by the material's composition and porosity. (22) Nanohybrid composite is one of the recently discovered aesthetic restorative materials. (23) In the present study, NeoSpectra™ST (Group 1) has shown less mean surface roughness value in all four beverages. This may be due to the application of the Sphere TECTM technology in the manufacturing of this material. The micro-granulated structure of these fillers allows them to bind more free resin than conventional fillers can. Additionally, more filler by weight also results in reduced material degradation in various beverages. (24) Filtek Z350 is a nano-filled composite resin with an average cluster particle size of 0.6 to 10 microns. (25) Filtek Z350 (Group 2) showed more surface roughness compared to NeoSpectra™ST (Group 1) in all four beverages.

In the present study, whiskey with a mean value of 1.048 in group 1 and 1.01 in group 2 showed maximum surface roughness among alcoholic beverages. Vodka with 42.8% of an alcohol concentration showed less surface roughness with a mean value of 0.827 in group 1 and 0.910 in group 2 when compared to whiskey. Low pH and alcohol concentrations of these beverages affect the surface properties. The alcohol molecules from the beverages get absorbed into the resin and cause softening of the composite matrix. (26) This high alcohol concentration could be the reason for Whiskey showing more surface roughness by creating voids and irregularities on the surface.

In the present study, among the energy drinks beverages, Red Bull having a pH of 3.4 showed less surface roughness with a mean of 1.019 in group 1 and 1.013 in group 2. Sting having a pH of 3.2 showed more surface roughness with a mean of 1.197 in group 1 and 1.095 in group 2. These drinks have citric acid which is a strong inorganic acid in their composition. The presence of this strong citric acid and low pH is responsible for the change in surface roughness. The acid in these drinks enters the matrix of resin composites and releases the unreacted monomer. (27)

Since this study was done in vitro, it is acknowledged that the results cannot be fully extended to clinical practice. The present study was done for a period of 30 days, more research can be done to study the effects of these beverages on the nanohybrid and nano-filled composite for a longer duration of immersion time.

CONCLUSION

In light of the present study's limitations, it may be said that immersion of composite resin in alcoholic and non-alcoholic beverages increases surface roughness. Among the sports/energy drink, immersion in Red bull shows less surface roughness change than Sting, and in alcoholic beverages, immersion in vodka shows less surface change.

NeoSpectra™ST, a nanohybrid showed less surface roughness changes after immersion in all four beverages as compared to Filtek Z350.

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