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EFFECT OF CIGARETTE SMOKING AND CARBONATED BEVERAGES ON THE SURFACE ROUGHNESS AND COLOR CHANGE OF TWO SINGLE-SHADE RESIN COMPOSITE: IN-VITRO STUDY

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ABSTRACT

Purpose: This in vitro study aims to assess the impact of cigarette smoke and carbonated drinks on the surface roughness and color change of two distinct single-shade composite.

Materials and Methods: 96 specimens of Omnichroma and Vittra APS Unique RBC discs were prepared on a Teflon Mold. Each composite group was divided into four subgroups according to exposure material. Control where specimens were kept in distilled water, cigarette smoking, immersion in cola, and mixed group. The surface roughness and color change values were recorded using a profilometer and CIE L* a* b*, respectively. The recorded data were statistically analyzed.

Results: Significant difference in the mean surface roughness values among both resin composites tested was shown in all subgroups except the mixed subgroup where Vittra APS Unique revealed higher surface roughness than Omnichroma. There was an insignificant difference among different subgroups with the highest mean value for the mixed subgroup in Omnichroma and the Cigarette subgroup in Vittra APS Unique resin composite. Regarding the results of the color stability, there was a significant difference in the mean ΔE among both tested resin composites with higher values for Vittra APS Unique. Furthermore, there was a significant difference among different subgroups with the highest mean value for Cola subgroup in both resin composites.

Conclusion: Cigarette smoking and Cola intake harm the surface roughness and color stability of the Vittra APS Unique more than Omnichroma single-shade composite. Although the combined use of cola and cigarette didn't affect the surface roughness, it positively affected the color change values of both composites.

KEYWORDS: Single shade Resin composite, Cigarette smoking, Carbonated beverages, Surface roughness, Color change

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INTRODUCTION

Resin composite is one of the tooth-colored restorative materials most frequently used in dentistry. Numerous parameters, including matrix composition, filler, coupling agent, and bonding procedures, may still impact their qualities. Personal habits, including food, smoking, and parafunctional behaviors, can also impact the resin composite's characteristics [1]. Drinks' erosive activity harms composite restorations' surface qualities as well. It leaves a roughness that affects the material's optical qualities and promotes the growth of bacterial plaque and surface degradation. The term "surface roughness" describes the tinier variations in surface texture typically caused by the material's properties or the manufacturing process [2]. Additionally, surface roughness raises the possibility of secondary caries and irritates the gingiva. Most of the time, the necessity for a restoration replacement results from the dental restoration wearing down and the ensuing discoloration of the tooth structure. Therefore, the surface characteristics of a resin composite influence the mechanical, clinical, and aesthetic aspects of a restoration [3].

Since oral tissues are first exposed to heat and chemicals, cigarette smoke (CS) directly affects oral health, rendering smoking a public health concern[1,4]. Water absorption, resin solubility, and kinetic water diffusion can all be accelerated by the high temperature (55° C) [5]. Furthermore, cigarette fumes contain toxic chemicals such as carbon monoxide, ammonia, nickel, arsenic, and heavy metals including cadmium and lead [6]. Furthermore, teeth and resin-based restorative materials are susceptible to several detrimental impacts, including surface roughness and color instability. The aesthetics of the tooth and restoration surfaces are greatly impaired when this smoke encounters them, as smokers' teeth are contaminated by cigarette smoke and turn yellow or even black[7]. To shorten chair times and minimize technique sensitivity, clinicians frequently favor restorative materials and techniques that facilitate simplified restoration treatments. Shade selection is a unique challenge in restorative dentistry since it can be complicated and depends on the operator's experience and the surrounding circumstances [8].

Universal composites have been created to solve this problem and facilitate shade selection. These single-shade composites, which include Omnichroma as an example, are said to match all 16 VITA Classical shades, which range from A1 to D4®, allowing for shade matching for various tooth colors [9]. This development provides increased adaptability and effectiveness in producing aesthetically pleasing restorations.

Research on universal shade resin composites with chameleon effects seems to be a promising new area. The first single-shade universal RBC, Omnichroma, was introduced in 2019 and is an illustration of innovative chromatic composites, or the Chameleon effect. Because of its uniformly sized 260 nm spherical filler and absence of uneven edges, the manufacturer Tokuyama claims that Omnichroma can capture the shade color of the surrounding structure. As a result of its filler nature, polychromatic composites were created, which could produce a reddish-yellow hue as ambient light passed through the composite. Also, since it doesn't contain any pigments or colors, colourful foods or drinks won't cause it to gradually change color [10].

Conversely, Vittra APS Unique is a sub-micrometric composite that can replicate the tooth's tint from D4 to Bleach [11]. It produces great aesthetic results with simplicity, great shine, and polishing thanks to cutting-edge technology. Because shade selection is no longer necessary, the professional's output is increased. The chameleon effect of the FGM Dental Group's Vittra APS Unique composite was acknowledged.

Color change is one of the primary causes of composite restoration replacement, and aesthetics is a problem that the public is confronting these days. Furthermore, there isn't enough research comparing smart monochromatic resins, which restricts the conversation on available roughness values and color changes. The purpose of this work was to assess the in vitro surface roughness and color change of two distinct single-shade composites that were exposed to carbonated drinks and tobacco smoke. It was hypothesized that both single-shade composites' surface roughness and color change could be enhanced by exposure to carbonated beverages and/or cigarette smoke.

MATERIALS AND METHODS

In the present study, the effect of cigarette smoking and one carbonated beverage immersion and their combination on the surface roughness and color change of two single-shade universal resin composites was tested. The detailed composition of the selected materials is presented in Tables 1 and 2.

TABLE (1). Resin composite names, manufacturer, Monomeric composition, and filler content

Material	Composition*	Filler Type (wt/vol)	LOT no.	Manufacturer
Omnichroma (One Shade)	**Filler**: Uniform-sized supra-nano spherical filler (SiO_2-ZrO_2 260 nm), **Base resin:** UDMA, TEGDMA	Supra-Nanofilled. (79 wt%, 68 vol%)	085E23	Tokuyama Dental, Tokyo, Japan
Vittra APS Unique (One Shade)	**Filler:** Boron-aluminum-silicate glass. **Base resin**: A mixture of methacrylate monomers, UDMA, TEGDMA, photoinitiators with an advanced polymerization system (APS), co-initiators, stabilizers, and silane. Bisphenol A (BPA) free products UDMA, TEGDMA, photoinitiator composition (APS), Zr, Si, and BPA-free (72–82wt%/52–60vol%)	Nanohybrid (72–80 wt%, 52–60 vol%)	251022	FGM, Joinville, SC, Brazil

TEGDMA= triethylenglycol dimethacrylate; UDMA= urethane dimethacrylate.

APS = advanced polymerization system ****As provided by the manufacturers.***

TABLE (2) Manufacturers and ingredients of exposure materials

Material	Component
Marlboro cigarette Marlboro Red (Philip Morris Misr LLC)	Tobacco, Diammonium phosphate, Glycerol, Propylene glycol, Ammonium hydroxide sugar, cocoa, licorice extract, carob bean and water
Coca-Cola HBC, Egypt	Carbonated water, high fructose corn syrup, caramel color, phosphoric acid, natural Flavors (Cola), caffeine (Caffeine Content: 21 mg/7.5 fl oz)

Sample Preparation:

Using a prior study [12] as a guide, the study's sample size calculation was established. The study required at least 12 samples in each group if the mean ± standard deviation of surface roughness was 0.15±0.07 before immersion in cola and 0.21±0.06 after, with an effect size of 0.91. To account for the 20% dropout rate when the power was 80% and the type I error probability was 0.05, the total sample size was increased to 15 specimens per group. Using G. power 3.1.9.7, a Paired t-test was used to determine the sample size. Thus, there are 12 samples overall per group. The samples were split evenly between the two groups. Group A for Omnichroma and Group B for Vittra APS Unique resin.

Using a Teflon mold that was 8 mm in diameter and 2 mm thick, 48 test specimens were created from each type of composite. To provide surface smoothness and allow extra material to flow, a glass slide was placed on top of a polyester matrix that had been placed on the previous increment. The test specimens were then light activated (Elipar S10, 3M, ESPE) for 40s, per the manufacturer's recommendations, at a light intensity of 1000 mW/cm2 and a light wavelength in the band between 460 and 480 nm. To release the residual monomer, all specimens (Groups A and B) were submerged in distilled water for 48 hours at 37°C ± 1°C. Following the incubation period, the specimens were air-dried, and both groups were divided into four subgroups at random (n=12) as follows:

Subgroup I: Control (the control group where specimens were stored in 37°C distilled water).

Subgroup II: Exposure to Cigarette smoking

Subgroup III: Immersion in Carbonated beverages

Subgroup IV: Immersion in Carbonated beverages followed by exposure to Cigarette smoking.

Exposure of Specimens to Cigarette Smoking:

A custom-made chamber device consisted of a vacuum system directing the smoke to the specimen inside a plastic box (Fig (1)). The cold cure acrylic material (Acrostone Dental &Medical Supplies, Egypt) was used to stabilize the specimens, and it was positioned within the box 8 cm away from the smoke. To replicate the intraoral situation of restorations being exposed to smoke, the specimens were positioned vertically in the middle of the specially designed chamber. Both sides of the specimen were exposed to smoking fumes [13]. The study used conventional cigarettes (20 cigarettes each day; Marlboro, Philip Morris International Inc., New York, NY, USA). Every cigarette was smoked for almost five minutes. To avoid dryness, the specimens were gently rinsed with distilled water for a minute after each cigarette. Following the smoke exposure, the samples were kept in regular distilled water until surface roughness and color change were assessed. The previous steps were then all carried out again for thirty days. For all groups, though, fresh distilled water had to be provided every day.

Fig (1) A custom-made chamber device consisted of a vacuum system directing the smoke to the specimen inside a plastic box

Immersion of the Disk Specimen in Carbonated Beverages

For one hour per day [14], twelve composite disk specimens from each group were submerged in Coca-Cola. For thirty days, the process was repeated after immersing the sample for twenty-three hours in distilled water [15]. Every day, a fresh bottle was used, and the lids of the containers were tightly shut to stop carbonic gas leakage and maintain an appropriate level of carbonic gas. To remove any loose sediment that may have been created by the immersion solution during the incubation period, specimens were rinsed for 30 seconds in distilled water. Every day, an identical rinse procedure was carried out. For subgroup IV, the specimens will first be submerged in cola, and then they will be subjected to cigarette smoke following the same protocol mentioned above for 30 days.

Evaluation of Surface Roughness through Profilometer

Every disk was subjected to roughness measurements using a profilometer (SJ 210 Mitutoyo, Japan) with a 0.25 mm cut-off setting. Each specimen had three randomly different regions assessed to yield three surface roughness values (or Ra values). The arithmetic mean was the result used for each sample. These readings were recorded and then statistically examined.

Color measurement method

Color measurements were taken using a spectrophotometer (VITA Easyshade Advance, Zahnfabrik, Bad Sackingen, Germany) before surface roughness testing. After gently washing and drying each specimen with tissue paper, the instrument probe was placed in the calibration block holder, its tip was flush with and perpendicular to the calibration block, depressing the calibration block. After that, a successful calibration was completed at the top and bottom surfaces of each disk by positioning the instrument probe against a white background perpendicular to the disk surface. Following the measurement of every specimen, the average of the three measurements ΔL, Δa, and Δb was noted. The color change will be calculated in the form of ΔE using this formula:

$\Delta E = (\Delta L^2 + \Delta a^2 + \Delta b^2)^{½}$ [16].

Statistical analysis

Statistical analysis was performed with SPSS 16 ® (Statistical Package for Scientific Studies), Graph pad Prism & windows Excel presented in 4 tables and 4 graphs. Exploration of the given data was performed using the Shapiro-Wilk test and Kolmogorov-Smirnov test for normality which revealed that data originated from normal data distribution. Accordingly, a comparison between 2 different groups was performed by the Independent t-test. Comparison between different subgroups was performed by using Repeated Measures ANOVA followed by Tukey`s Post Hoc test for multiple comparisons. Correlation between surface roughness and color changes was performed by using Pearson's Correlation Coefficient test. The values of color changes (ΔE) were obtained by calculating the difference in the color of the specimens from that of the control using the following formula: $\Delta ECIELAB = (\Delta L*2 + \Delta a*2 + \Delta b*2)^{½}$. The significance level was set at $p \leq 0.05$. Where: L* = lightness (0-100), a* = (change the color of the axis red/green), and b* = (color variation axis yellow/blue)

RESULTS

Surface roughness

Comparison between Omnichroma and Vittra APS Unique (Table 3 and Figure 2):

The comparison between Omnichroma and Vitra APS Unique revealed a significant difference between them, which was performed using the independent t-test shown in Table (3) and Figure (1), and it was found that:

In the control Subgroup, Omnichroma (0.76±0.13) was significantly lower than Vittra APS Unique (1.1 ±0.43) with a (0.34±0.13) difference between them as P=0.01.

In the cigarettes Subgroup, Omnichroma (0.96±0.47) was significantly lower than Vittra APS Unique (1.51±0.49) with a (0.55±0.19) difference between them as P=0.01.

TABLE (3) Surface roughness in Omnichroma and Vittra regarding different subgroups, comparison between them using Independent t-test:

Subgroup	**Omnichroma**		**Vittra APS Unique**		**Mean Difference**	**Std. Error Difference**	**95% Confidence Interval of the Difference**		**P value**
	Mean	Standard Deviation	Mean	Standard Deviation			Lower	Upper	
Control	0.76	0.13	1.10	0.43	0.34	0.13	-0.61	-0.08	0.014*
Cigarettes	0.96	0.47	1.51	0.49	0.55	0.19	-0.95	-0.14	0.010*
Cola	0.85	0.40	1.52	0.53	0.66	0.19	-1.06	-0.26	0.002*
Cola+ Cigarettes	1.07	0.43	1.39	0.67	0.32	0.23	-0.80	0.15	0.173

Significant difference as P<0.05.

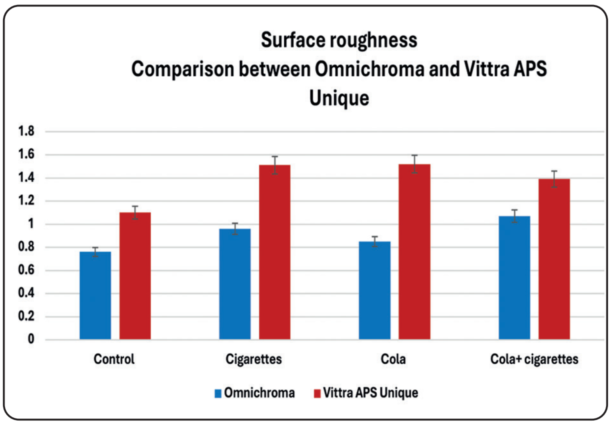

Fig. (2) Bar chart representing the Comparison between Omnichroma and Vittra APS Unique regarding surface roughness.

In the Cola Subgroup, Omnichroma (0.85±0.40) was significantly lower than Vittra APS Unique (1.52 ±0.53) with a (0.66 ± 0.19) difference between them as P=0.002.

In the Cola + cigarettes Subgroup, Omnichroma (1.07±0.43) was insignificantly lower than Vittra APS Unique (1.39±0.67) with (0.32±0.23) difference between them as P=0.17.

Comparison between subgroups (Table 4 and Figure 3):

Comparison between subgroups was performed by using the Repeated Measures ANOVA test which revealed that there was an insignificant difference between them in both groups as P>0.05, followed by Tukey`s Post Hoc test for multiple comparisons which revealed that:

In Omnichroma, the control subgroup (0.76±0.13) demonstrated the least surface roughness, then cigarette subgroup (0.85±0.4), then the cola subgroup (0.96±0.47), while the Cola + Cigarettes subgroup (1.07±0.43) demonstrated the highest surface roughness with insignificant difference between them.

In Vittra APS unique, the control subgroup (1.1±0.43) demonstrated the least surface roughness, then the cola +cigarette subgroup (1.39±0.67), then the cola subgroup (1.51±0.49), while Cigarettes subgroup (1.52±0.53) demonstrated the highest surface roughness with insignificant difference between them.

TABLE (4) Surface roughness in different subgroups, comparison between them using Repeated measures ANOVA followed by Tukey's Post Hoc test for multiple comparisons:

Group	Subgroup	Minimum	Maximum	Mean	Standard Deviation	P value
Omnichroma	Control	0.60	0.98	0.76 [a]	0.13	0.22
	Cigarettes	0.33	1.85	0.85 [a]	0.40	
	Cola	0.49	1.92	0.96 [a]	0.47	
	Cola+ Cigarettes	0.48	2.25	1.07 [a]	0.43	
Vittra APS Unique	Control	0.61	1.92	1.10 [a]	0.43	0.27
	Cigarettes	0.77	2.36	1.52 [a]	0.53	
	Cola	0.57	2.12	1.51 [a]	0.49	
	Cola+ Cigarettes	0.61	2.67	1.39 [a]	0.67	

***Significant difference as P<0.05.**

Means with different superscript letters were significantly different as P<0.05.

Means with the same superscript letters were insignificantly different as P>0.05.

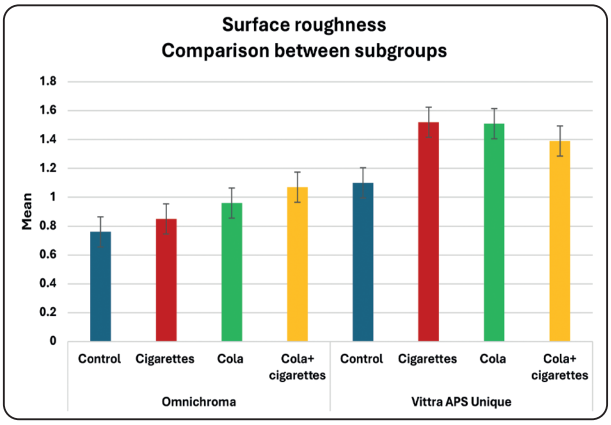

Fig. (3) Bar chart representing the Comparison between subgroups regarding surface roughness.

Color changes:

Comparison between Omnichroma and Vittra APS Unique (Table 5 and Figure 4):

Comparison between Omnichroma and Vittra APS Unique revealed that there was a significant difference between them was performed by using an Independent t-test and presented in table (5) and figure (3), and revealed that:

In the cigarettes Subgroup, Omnichroma (81.79±9.95) was significantly lower than Vittra APS Unique (98.16±11.57) with (16.37±4.4) difference between them as P=0.001.

In the Cola Subgroup, Omnichroma (111.39±19.92) was significantly lower than Vittra APS Unique (133.43 ±19.87) with (22.04±8.12) difference between them as P=0.01.

In the Cola + Cigarettes Subgroup, Omnichroma (73.19±11.86) was insignificantly lower than Vittra APS Unique (77.72±10.7) with (4.53±4.55) difference between them as P=0.33.

Comparison between subgroups (Table 6 and Figure 5):

Comparison between subgroups was performed by using the Repeated Measures ANOVA test which revealed that there was a significant difference between them in both groups as P= 0.0001, followed by Tukey's Post Hoc test for multiple comparisons which revealed that:

In Omnichroma, the cola subgroup (111.39 ±19.92) demonstrated significantly the highest color

TABLE (5): Color changes in Omnichroma and Vittra regarding different subgroups, comparison between them using independent t-test:

Color changes	Omnichroma		Vittra APS Unique		Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference		P value
	Mean	Standard Deviation	Mean	Standard Deviation			Lower	Upper	
Cigarettes	81.79	9.95	98.16	11.57	-16.37	4.40	-25.50	-7.23	0.001*
Cola	111.39	19.92	133.43	19.87	-22.04	8.12	-38.89	-5.20	0.013*
Cola+ Cigarettes	73.19	11.86	77.72	10.37	-4.53	4.55	-13.96	4.90	0.330

***Significant difference as P<0.05.**

TABLE (6) Color changes in different subgroups, comparison between them using Repeated measures ANOVA followed by Tukey`s Post Hoc test for multiple comparisons:

Group	Subgroup	Minimum	Maximum	Mean	Standard Deviation	P value
Omnichroma	Cigarettes	62.70	97.95	81.79 [b]	9.95	0.0001*
	Cola	78.30	143.19	111.39 [a]	19.92	
	Cola+ Cigarettes	51.08	91.84	73.19 [c]	11.86	
Vittra APS Unique	Cigarettes	77.34	120.86	98.16 [b]	11.57	0.0001*
	Cola	101.85	166.92	133.43[a]	19.87	
	Cola+ Cigarettes	60.93	96.95	77.72 [c]	10.37	

***Significant difference as P<0.05.**

Means with different superscript letters were significantly different as P<0.05.

Means with the same superscript letters were insignificantly different as P>0.05.

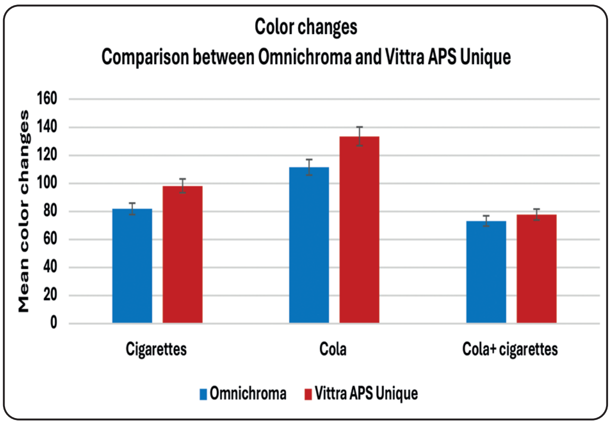

Fig. (4) Bar chart representing the Comparison between Omnichroma and Vittra APS Unique regarding color changes.

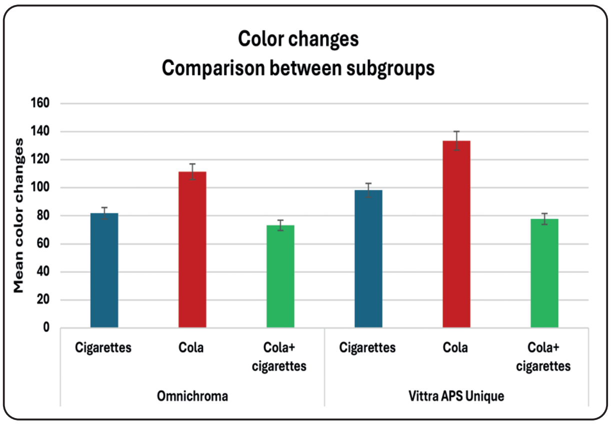

Fig. (5) Bar chart representing the Comparison between different subgroups regarding color changes.

changes, then the cigarettes subgroup (81.79 ± 9.95), while the Cola + Cigarettes subgroup (73.19±11.86) demonstrated significantly the least color changes.

In Vittra APS unique, the cola subgroup (133.43±19.87) demonstrated significantly the highest color changes, then the cigarettes subgroup (98.16±11.57), while the Cola + Cigarettes subgroup (77.72±10.37) demonstrated significantly the least color changes.

Correlation between color changes and Surface roughness (Table 7)

Correlation between color changes and surface roughness in all subgroups regarding Omnichroma and Vittra APS Unique using Pearsons's correlation coefficient (r). This demonstrated that there was an insignificant correlation between them in all subgroups as P>0.05, except in the cola + cigarette subgroup as there was a moderately significant correlation between surface roughness and color changes in both Omnichroma and Vittra APS unique.

TABLE (7): Pearson's Correlation coefficient between color changes and surface roughness in Omnichroma and Vittra APS Unique:

Groups	Subgroups	r	P value
Omnichroma	Cigarettes	-0.18	0.57
	Cola	0.27	0.39
	Cola+ cigarettes	-0.6	0.03*
Vittra APS Unique	Cigarettes	-0.43	0.15
	Cola	0.39	0.21
	Cola+ cigarettes	0.56	0.05*

Significant correlation as P<0.05.

DISCUSSION

New restorative resins are being developed at a quick pace due to the growing need for aesthetics in conservative dentistry [15]. Several reasons, including plaque buildup, the staining effect of colored foods and beverages on the composite resin structure, the degree of absorption, smoking, and the roughness of the restoration's surface, can result in color variations [17]. A good aesthetic repair depends largely on the composite resin's color stability and roughness [18]. Nevertheless, choosing a color extends the time spent in the dental unit and introduces subjectivity into the procedure. Recently, sophisticated technologies have been used to produce RBCs in a way that eliminates all of these drawbacks. It has been stated that the optical structure of this new dental composite made using Smart Chromatic Technology allows the particles to reflect the color of the surrounding tooth structure, thereby matching the tooth color [19,20]. Shade matching has been made even simpler by the introduction of single-shade composite resins by manufacturers [21]. It is said that these materials may blend in with any hue of teeth [22]. A single version can imitate the opacity, translucency, and optical properties of all teeth, negating the need for layering techniques and the shade selection process altogether [23]. This notion of a single shade that matches all shades has been referred to by several terms, such as "single-shade," "one-shade," "single-shade universal," "one-shade universal," "smart monochromatic composite," and others [24]. While there are many different brands of single-shade composites on the market (such as Tokuyama's OMNICHROMA®; Kulzer's Venus Diamond® ONE; Kulzer's Venus Pearl® ONE; Kuraray Noritake's CLEARFIL MAJESTYTM ES-2 Universal; Vittra APS Unique, FGM), most of them are merely advised for posterior restorations.

According to Saisho and Varga (2023), single-shade composite resin materials' capacity to blend is much diminished in darker hues and when a higher material thickness is needed. They are also unable to fix color deficiencies or block dark discolorations. A dentin-like substance, opaquer, or blocker is required to get around this. Since superficial staining has been recognized as one of the primary factors contributing to restoration replacement failures, it is also crucial to take its aesthetic effects into account [25]. In this in vitro investigation, the surface roughness and color stability of two single-shade resin composites, Omnichroma and Vittra APS Unique, were assessed and contrasted following exposure to cigarette smoke, cola immersion, or cola immersion followed by exposure to cigarette smoking.

Color changes can be assessed visually or with the use of instruments. The spectrophotometer was utilized in this investigation because instrumental measures remove the subjectivity associated with visual color comparison [26]. The CIELAB color system is often used to measure color. The widely used CIE L*a*b methodology offers a standardized method for reliably analyzing ΔE^* values. This technology has numerous benefits, such as objectivity, repeatability, and sensitivity, and it is capable of accurately identifying minor color changes [27]. In color science, the total color difference, or ΔE, is regarded as a standard instrument for assessing and contrasting color changes. The color changes in aesthetic restorations indicate that if $E < 1$, the naked human eye cannot detect it, and if $E > 3.3$, it is easily detectable by anyone, it is visible to the unaided eye, and not acceptable clinically [28].

These days' teens and younger generations are picky about how they look and how white their teeth are. Additionally, there is a rise in the use and consumption of items like coffee, acidic drinks, and tobacco that can leave stains on surfaces [29]. Smoking poses a significant risk for numerous health issues, most of which do not manifest until late age. These include diabetes mellitus, cardiovascular disease, lung conditions, and various malignancies [30]. It not only detracts negatively from the appearance of oral tissues but is also known to be the cause of certain oral health disorders. According to one study, smoking increases the severity and incidence of periodontal disease; According to a different American study, 10% of those with periodontitis had smoked in the past and 41% of those with the condition now [31]. The practical and aesthetic features of dental restorations have also been found to be impacted by smoking [32].

The study's chosen staining agents (cola or smoking) are frequently used and have a high propensity to discolor tooth-colored restoration materials [33]. Despite being a franchise, these products are made locally, therefore even while the components are from local suppliers, they are not exact duplicates of the same products sold all over the world.

The present study's design technique involved the use of a tiny apparatus that could only accept one cigarette at a time. This allowed the test specimen to be exposed to cigarette smoke at a uniform rate and time interval. This avoided the influence of smoke simultaneously released by other cigarettes and stopped the smoke from dispersing into broader regions [30].

The specimen is usually immersed for four weeks or longer in most in vitro color stability investigations to generate a cumulative staining effect and produce unique results [34]. Therefore, after repeating the technique procedures for 30 days, all measurements in the current study were completed.

Except for the mixed Cola and Cigarette exposure subgroups, all subgroups in the current investigation showed a significant difference in the mean surface roughness values between the two resin composites examined. Where Vittra APS Unique showed a higher surface roughness value than Omnichroma. It was explained by looking at the chemical constitution and structural characteristics of resin composite materials as shown in "Table 1." Considering that resin composite with smaller filler sizes as the supra-nano filled omnichroma have less color change and smoother surface characteristics (35, 36). Furthermore, the mixed group effect may also be explained by the combined action of the erosive ingredients in cola and Marlboro cigarettes.

Additionally, there was no discernible difference in the surface roughness values across the various subgroups when compared, with the mixed subgroup in Omnichroma and the cigarette subgroup in Vittra APS Unique resin composite having the highest mean value. This is in accordance with Alandia-Roman et al.'s [30] findings in 2013, which indicated that the lack of polishing raises the staining capability of cigarettes on composite materials as well as their surface roughness. These findings go against the literature's claims that cigarette smoke does not influence roughness; nonetheless, brushing after smoking may have contributed to this shift because cigarettes' erosive properties weaken enamel [37, 38].

In the meantime, there was a notable difference in the mean ΔE between the two tested resin composites in this study's results for color stability, with greater values for Vittra APS Unique. This result is consistent with the results of the current study for surface roughness. It was found that there was a moderately significant correlation between surface roughness and color changes in both Omnichroma and Vittra APS unique, as demonstrated statistically in "Table 7". This result was consistent with that of Rohym et al.'s 2023 study [39], which examined the impact of coffee on the surface roughness and color stability of recently released single-shade composite materials. In the meantime, the current study was in opposition to Yikilgan et al.'s 2019 study [40]. This discrepancy can result from the various beverages that were tested.

In resin composite materials, adding more resin causes hydrolytic breakdown and improves the material's capacity to absorb water. It has been shown that water absorbed by the polymer matrix can boost coloration by breaking the link between the matrix and the filler or by hydrolyzing the filler's breakdown. [41]. The single-shade composite resin structures (Omnichroma and Vittra APS Unique) that exhibited the greatest color change in our investigation both contained TEGDMA monomer. Compared to nano-filled composite (Omnichroma), nanohybrid (Vittra APS Unique) composite exhibited more color instability. This could be explained by the fact that Omnichroma uses 260 nm spherical fillers that are regularly sized. This allows for the use of "Smart Chromatic Technology," which lessens the ability to distinguish between composite and tooth using specific light wavelengths.

Additionally, there was a substantial variation in the color change ΔE values amongst the various subgroups, with the Cola subgroup in both resin composites having the highest mean value. This outcome was consistent with the findings of Al Kheraif et al. (2013) [42], who discovered that the Cola (acidic pH) subgroup recorded the highest color change, followed by the Licorice (alkaline pH) subgroup, while the Distilled Walter (neutral pH) subgroup recorded the lowest color change. These findings were caused by the erosive effect of carbonated drink on the resin surface, which was followed by the adsorption of the caramel pigment found in the cola.

Since it indicates the brightness of the samples, the coordinate L* is crucial to the processing of the data. Because there are far more rods (the cells responsible for seeing black and white) than cones (the cells responsible for seeing color), the human eye can distinguish differences in this axis more clearly than in the a* and b* axes. For color stability and therapeutic success, any loss of brightness is crucial [43]. The current finding contradicts that of Dos Santos Bertoldo et al who stated that Cola did not cause as much discoloration as tea or coffee, despite having the lowest pH and perhaps damaging the materials' surface integrity. This could be because, contrary to what has been reported in the literature, cola does not include a yellow colorant [44]. When the test fluids were compared, Coke showed more surface alterations than tea or coffee, and coffee also demonstrated a greater propensity to induce color changes. Coffee comes first, followed by Tea, Coke, and finally, Water [15].

Excessive deposits of smoke components stuck to the test specimen surface with each cigarette's exposure. The tar, sugars, and cocoa found in cigarettes contribute to the formation of these sediments. The tar is a viscous, black residue that can become impregnated in the sample surface and produce high color change values. This is incompatible with clinical reality, where saliva and tongue movements help to clean teeth and restorations. In this investigation, the specimen was just cleaned with distilled water after each exposure to cigarettes. Furthermore, the current study's high exposure to cigarette smoking (20 cigarettes per day) may have inflated the impact on color measurements.

The findings of this investigation were consistent with a review article [32] which discovered that the color changes caused by traditional cigarettes were more pronounced than those caused by electronic cigarettes. Although single-shade composite restorations may become more discolored due to exposure to staining agents and smoking, their combined effect showed lower ΔE Values than the separate exposure to cola or cigarettes. This may be explained by the cola first has a softening effect on the composite that facilitates adsorption of the coloring component, but this effect was counteracted by smoking cigarettes that contain ammonium hydroxide and licorice that could overcome the previous effect of cola.

All the current findings which stated that exposure to carbonated beverages and/or cigarette smoke can influence the surface roughness and change the color of Vittra APS Unique single-shade composites with significant differences and higher values than Omnichroma single-shade composite, so the null hypothesis was partially rejected.

CONCLUSION

Within the confines of this investigation, it can be concluded that Vittra APS Unique surface roughness and color stability are more negatively impacted by cigarette smoking and Cola consumption than Omnichroma single-shade composite. Although the combined use of cola and cigarette didn't affect the surface roughness, it positively affected the color change values of both composites. Each tested resin composite showed color changes that were above the acceptable limit.

Limitations and recommendations

Due to the in vitro design's inability to accurately replicate oral circumstances, this study has certain drawbacks. Furthermore, it did not investigate other nicotine brands, doses, and Flavors to assess additional effects on tooth restorative materials. Moreover, there was no brushing simulation when the specimens were exposed to smoke. It is advised that future research employ bigger sample numbers, a range of nicotine brands and concentrations, and a comparison of locally manufactured versus foreign-produced franchises. This will help overcome some of the current study's shortcomings and further validate the results.

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