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Original article

Effect of Different Solutions on Two Milled Esthetic Restorative Materials

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Abstract

Introduction: Today, ceramic plays a vital role in restorative dentistry. Common uses include full-coverage crown, inlays, onlays, and ceramic bridges. The demands for esthetics in dental restoration continue, new technologies tend to improve the material properties and develop new methods for application. ***Objective:*** This study aimed to evaluate the effect of different solutions on two milled esthetic restorative materials. ***Material and methods:*** In this study, a total of thirty blocks samples were machine milled by the aid of computer-aided design & computer-aided manufacturing (CAD/CAM) system. The samples were divided according to the material of construction into two main groups. Each group was composed of 15 samples as follows: Group I: constructed from milled composite resin blocks. Group II: constructed from milled feldspathic porcelain blocks. All sample groups were then immersed in 20ml of artificial saliva for 24 hours to be a baseline assessment. ***Results:*** Spectrophotometer measurements of all the groups and subgroups revealed statically significant higher mean ΔE values for ceramic groups than the composite resin groups. All changes in the colour were clinically acceptable except for ceramic samples immersed in acid media. ***Conclusion:*** By reducing the pH value, increasing the acidity of the immersion media that led to an increase in the surface roughness of the tested restorative materials (composite resin and ceramic).

Keywords: ***ceramic crowns, composite inlays, milled esthetic restoration***

Introduction

Esthetic dentistry is intimately associated to all-ceramic dental restoration. All-ceramic materials are the preferred materials when it comes to prosthetic dentistry to satisfy the criteria associated with the esthetic and cosmetic needs of patients and dentists. All-ceramic restorations allow superior translucency, with no metal substructure, and can be used where esthetics are essential. Despite all the advantages of all-ceramic restorations, including esthetic appearance, biocompatibility, and longevity, there are several drawbacks to such materials. Among these drawbacks, the potential of brittle catastrophic fracturing and abrasive wear of the opposing natural teeth are considered. Also, from the practical point of view, fragility during trial insertion and cementation, and toxicity of hydrofluoric acid are also considered as disadvantages. So, there was a need to look for other materials with properties better than the ceramic. Recently composite inlays, onlays, veneers, and crowns can be constructed by CAD/CAM techniques using prefabricated composite resin blocks manufactured under controlled conditions [1]. There is increasing interest in the use of composite resin blocks, due to their optimal stiffness and wear characteristics and because they offer some advantages over feldspathic ceramics. Composite resin restorations are near to the fracture-resistant of feldspathic ceramics. In addition, they can be modified for esthetic or functional reasons with the simple in-office procedure, in contrast to ceramics, which usually require laboratory firing to add ceramic and to accomplish the definitive surface glazing. Furthermore, the adhesive treatment of a composite resin restoration is safer because it does not require the use of hydrofluoric acid, which is indicated for surface treatment of "etchable" feldspathic and glass-ceramics. This is important when the clinician must manage repairs of a restoration intraorally [2]. In the last few years, multiple studies are concerned with the ability of esthetic restorative materials to withstand the variable changes in the oral environment, especially changes in pH values. It was believed that surface roughness may affect esthetic by changing the surface textures of esthetic restoration, increasing the scattering of the incident light, and consequently affecting the colour stability [3]. Thereby, this study was carried out aiming to shed the light on the effects of different oral media on the surface roughness and colour changes of two esthetic restorations.

Oral environment and different pH media:

The oral environment is an aggressive and fluctuating environment due to different pH fluctuating and temperature. Materials may dissolve in the water that is present in saliva to release soluble components; they may erode due to the presence of acids; they may discolour or break down due to absorption of substances from saliva, or they may tarnish and corrode. All these possibilities can adversely affect the chemical stability of the materials and limit their durability [4]. Dental ceramics are mostly compounding of oxygen, such as silica (SiO2) and alumina (Al2O3). These are chemically stable under most circumstances and immune from the oxidation process associated with electrochemical corrosion. Degradation of ceramics generally involves a process of chemical dissolution [4]. Polymers are not stable either, as many will burn once ignited, showing that the polymer oxidizes readily. However, polymer degradation is generally physiochemical in nature, such as swelling, dissolution or covalent bond rupture. The latter may be due to heat or radiation ad invariably results in a reduction in mechanical properties such as strength and toughness. In general, it could be said that ceramics may be subjected to chemical dissolution and polymers tend to suffer from absorption and loss of soluble components. Excessive water sorption can lead to discolouration and degradation of dental restorative materials [4]. Consumption behaviour plays a major role in oral health. Campaigns have been waged concerning sugar products and dental caries. However, public awareness on dental erosion, another form of tooth surface destruction, is not high. Dental erosion is a result of mineral loss from the tooth surface due to a chemical process of acidic dissolution not involving acids of bacterial plaque origin. Sources of acids can be endogenous or exogenous, and erosive intensity is modified by quality and quantity of saliva. Acidic food and beverages are the most common extrinsic factors that cause dental erosion.

Several studies [5-7] had reported the relationship between dental erosion and acidic foodstuffs such as soft drinks, fruit juices, and sour food. Dietary awareness is an important issue in modern society. The consumption of carbonated drinks is popular with the youth of today and the habit is carried over into adulthood. The popularity of sports drinks has raised questions about their erosive potential. Healthy diets, such as fruits, fruit juices, and yogurt, may as well cause erosion by their acidity. Furthermore, acidity can be an essential element in certain sour dishes. The erosion dose not only affects the enamel, but the restorative materials are also affected by erosion [8]. The physical properties of resin-based materials might be deteriorated by various chemical influences, such as contact with alcoholic or acidic solutions [9-11]. Even mouth rinses may exert a material-dependent effect on physical properties of composites [12]. Also, acidic fluoride regimes, such as acidulated phosphate fluoride gels lead to an increased surface roughness of resin composite materials [13]. Acidic fluoride regimes might damage the surface of composite materials [14,15].

Effect of different oral media on ceramic restorations:

Compared the surface roughness of 3 different porcelains (feldspathic porcelain) (Ceramco II), low-fusing porcelain (Finesse), and aluminous porcelain (All- Ceram) [16]. The discs were immersed in 1.23% APF, 0.4% stannous fluoride for 50 minutes, 10% carbamide peroxide for 48 hours, and distilled water for 50 seconds (control). They found that the acidulated phosphate fluoride etched the auto-glazed surface of all 3 porcelains. Ceramco II samples were affected by all 3 solutions, with the auto-glazed surface having higher Ra values (1.23% APF, 0.4% stannous fluoride, and 10% carbamide peroxide, with mean Ra values of 0.35µm, 0.26µm, and 0.24µm, respectively). Immersion in the 3 solutions did not affect the polished surfaces of all-ceramic specimens tested. They concluded that before the use of fluoride and 10% carbamide peroxide; dentists should ascertain the type of porcelain restoration present to prevent a roughened surface from occurring [17]. Evaluated the effect of tea, cola, orange juice, and distilled water on the colour stability of porcelain (VITA VMK 95) and reinforced composite rein (GC Giardia). VITA VMK 95 after immersion in the test solutions showed a small amount of colour change after one month that was clinically non-perceptible in all the solutions, including distilled water. The colour change ranged from 0.21 ΔE units in water to 0.51 ΔE units in orange juice after one month. GC Gradia showed increased discolouration over the observation period of one month. The colour change ranged from 3.12 ΔE units in water to 6.09 ΔE units in tea after one month. They found that tea caused the most significant colour change. ΔE of all of the materials was changed after the immersion in all of the staining solutions during the experimental process [18]. Assessed the colour stability of five esthetic restorative materials when immersed in a coffee solution. Samples were divided into five groups, were made using one direct composite resin (Tetric Ceram, G1), three indirect composite resins (Targis, G2; Resilab Master, G3; belly glass HP, G4) and one porcelain (IPS Empress 2, G5). It was reported that G1 and G3 showed significantly higher discolouration than the other groups. G2 and G4 showed intermediary pigmentation, while G5 showed the smallest changes in colour [19]. evaluated the ion leaching of porcelains immersed in acidic agents. They used 4 types of porcelain (VITA VMK 95, Vitadur Alpha, IPS Empress Esthetic, and IPS e.max Ceram). Four groups of discs were then immersed in acidic agents (Acetic acid, citrate buffer solution, pineapple juice, and green mango juice) and deionized water (control) at 37°C for 168 hours. Surface characteristics of specimens were examined using scanning electron microscopy (SEM). SEM photomicrographs showed surface destruction of all porcelains after being immersed in acidic agents. Acetic acid showed surface destruction more than the other acidic agents tested. They concluded that all acidic agents used in this study affected the surface of the 4 types of porcelains evaluated. Vitadur Alpha is the most affected type of porcelain in this study and the IPS e.max Ceram was the least one [20]. Compared the staining effects of 2 fluoride treatments (0.4% SnF2 or 1.1% NaF) on ceramic disks (glazed and polished) by simulating 1 year of clinical exposure at 10 minutes per day. After both fluoride treatments, ceramic disks exhibited significantly higher surface roughness values when polished. The glazed specimens presented significantly higher surface roughness when treated with 0.4% SnF2 as compared to NaF. For the polished specimens, there was no significant difference in surface roughness and surface gloss values between the 2 fluoride treatments. They concluded, use of 0.4% SnF2 and 1.1% NaF gels, in vitro, caused a significant colour change in the polished disks [21]. determined the stainability of ceramics exposed to the coffee after different surface treatments and to correlate the surface roughness with the colour differences. Surface roughness was evaluated by profilometer and scanning electron microscopy (SEM). Colour difference was measured by a spectrophotometer before and after 12 days of immersion in a coffee solution. Rough surfaces stained more after coffee immersion than did smooth surfaces. They concluded that, the surface treatments affected surface roughness and colour stability. Smooth surfaces showed better colour stability after discolouration. Ceramic staining may be related to surface texture changes after different surface treatments. There was an 83% positively significant relationship between Ra and ΔE values [22]. Investigated the colour stability of feldspathic porcelain (Ceramco II) compared with two indirect composite resins restoration materials (ICRs) (Gradia and SR-Adoro) following immersion in different beverages (coffee, tea, and cola) for 2 weeks and subjected to accelerated aging UV-aging for 300 hours. The colour coordinates and their corresponding colour changes (ΔE) were measured. They found that the beverages used in this study caused significant colour changes to composite resins and dental porcelains. The greatest colour changes were seen in the coffee solution (ΔE=13.34 for SR-Adoro and ΔE = 16.01 for Gradia), while tea was responsible for the greatest colour change in porcelain (ΔE = 4.21). The UV aging test caused the lowest discolouration effects on all three samples (ΔE =3.42 for SR-Adoro, ΔE = 3.01 for Gradia, and ΔE = 1.29 for Ceramco II).

Effect of different oral media on composite resin restorations:

Evaluated the clinical performance of a resin- based composite (Paradigm) and porcelain (Vita Mark II) for computer-aided design /computer-aided manufacturing (CAD/CAM)–generated adhesive inlays [23]. They concluded that, the resin-based composite inlays had a significantly better colour match at three years than did the porcelain inlays. Resin-based composite CAD/CAM inlays performed as well as porcelain CAD/CAM inlays after three years of clinical service [24]. Investigated the effect of 2 staining solutions and 3 bleaching systems on the colour changes of 2 dental composite resins. The disk- shaped specimens of each of 2 composite resins, Filtek Supreme (FS) and Esthet X (EX), were prepared. The specimens were then immersed in 2 staining solutions (coffee or red wine) or distilled water (control) for 3 hours daily over a 40-day test period. Then 3 bleaching agents (Crest Night Effects, Colgate Simply White Night, or Opalescence Quick) were applied to the surface of the specimens over a 14-day period. Colour of the specimens was measured with a spectrophotometer after staining, and after bleaching. The colour differences (ΔEab*) between the 3 measurements were calculated. The value ΔEab*=3.3 was used as an acceptable value in subjective visual evaluations. They found that after staining, FS had more colour change than EX and was more affected by the wine solution. After bleaching, the colour of both EX and FS specimens returned to the baseline. The colour differences between bleaching and baseline were less than value ΔEab*=3.3 for all groups. They concluded that the nanocomposite (FS) changed colour more than the microhybrid composite (EX) as a result of staining in coffee or red wine solutions. After bleaching, discolouration was removed completely from the composite resins tested [25]. Investigated the effect of five commercially available mouth rinses in Egypt (namely; Antiseptol, Citrolen-F, Flucal, Ezaflour, Listerine mouth rinses and distilled water was used as a control) on the colour stability of two resin composite restorative materials (Tetric ceram and Te- econom; non fluoride-containing). Each group of specimens was immersed after curing in distilled water for 24h, then subjected to colour measurement using spectrophotometer for the base line readings determination. Following that, each group was immersed in 20ml of the assigned treatment solution and incubated at 37°C for 24 hours. The specimens were then resubjected to colour measurement. All tested mouth rinses produced a colour change in both tested resin composite. However, the greatest perceptible colour change was observed on using sodium fluoride containing mouth rinses with both resin-composites. It could be concluded that all mouth rinses tested in this study negatively affected the hardness and the colour of the tested resin-composite, but the effect is both mouth rinse and material dependent. Mouth rinses with low pH are more detrimental to the hardness rather than to colour stability. The combination between the active ingredients in a one mouth rinse might increase their adverse effect on the restorative materials [26]. Evaluated the effects of 3 commercially available mouth rinses on the colour stability of 4 different resin-based composite restorative materials. Disc-shaped specimens were prepared from each of the following materials: A nanofill composite (Filtek Supreme XT), a packable low shrinkage composite (AeliteLS Packable), nanoceramic composite resin (Ceram-X) and a microhybrid composite (Aelite All-Purpose Body). The specimens were then incubated in distilled water at 37°C for 24 hours. The baseline colour values (L*, a*, b*) of each specimen were measured with a colourimeter. Then the specimens were stored in 20 mL of each mouth rinse (Oral B, Listerine and Klorhex) for 12 hours. After immersion, the colour values of all specimens were remeasured, and the colour change value ΔE*ab was calculated. They found all specimens displayed colour changes after immersion, and there was a statistically significant difference among restorative materials and mouth rinses. However, the change was not visually perceptible (ΔE*ab<3.3). The interaction between the effect of mouth rinses and type of restorative materials was not statistically significant. They concluded that although visually nonperceptible, all resin restorative materials tested showed a colour difference after immersion in different mouth rinses [27]. Assessed the influence of commonly used types of coffee, in Saudi Arabia, on surface colour stability of microhybrid resin-based composite (Filtek Z250), nanofilled resin-based composite (Filtek Supreme) and organic modified ceramic composite (Ormocer). All the three resin-based composite materials showed significant colour change after immersion in three types of coffee (Espresso, Turkish and American) ΔE*> 3.3. Z250 resin-based composite showed the least colour change followed by Ormocer [28]. Assessed the effects of three sports drinks on the colour stability of two nano-filled and two micro-hybrid composite materials after 1-month and 6-month periods. Specimens were made from four resin composites (Clearfil Majesty Posterior, Filtek Supreme, Clearfil APX, and Filtek Z250). All the specimens were stored in distilled water for 24 h at 37°C and then immersed in one of the three sports drinks (Powerade, Red Bull, and Burn) or distilled water (control) for 1 and 6 months. They founded that; the tested resin composites showed colour changes over the 6-month evaluation periods. At 1-month, highest level of colour changes was observed in the Clearfil APX specimens immersed in Burn (3.83). Clearfil Majesty Posterior showed less discolouration in all the composite materials tested after 6 months with all three sports drinks. Independent of the composite materials tested, Burn resulted in the highest level of discolouration after both immersion periods. They concluded that, all the test solutions used in the present study caused greater discolouration than the clinically acceptable level of threshold (ΔE < 3.3) over the 6-month evaluation period except for Clearfil Majesty Posterior immersed in distilled water (2.91). Due to the wide use of tooth-coloured restorative materials, it is important to determine which ones are susceptible to surface and colour changes. To ensure excellent aesthetics it is necessary for tooth-coloured materials to maintain extrinsic colour stability and a resistance to surface changes. An extensive search of the review of literature showed that, there is not much of documentary evidence available regarding the effect of different oral media on the milled

CAD/CAM feldspathic ceramics and composite restorations. The purpose of this study was to determine the effect of different oral media on colour stability and surface roughness of milled composite resin restorations and milled feldspathic porcelain restorations.

Materials and Method

This study was carried out aiming to shed the light on the effects of different oral media on the surface roughness and colour changes of two esthetic restorations. In this study a total of thirty blocks samples were machine milled by the aid of computer-aided design & computer-aided manufacturing CAD/CAM system. The samples were divided according to the material of construction into two main groups. Each group was composed of 15 samples as follows:

Group I: constructed from milled composite resin blocks.

Group II: constructed from milled feldspathic porcelain blocks.

All sample groups were then immersed in 20ml of artificial saliva for 24 hours to be baseline assessment. Each group was further subdivided into three subgroups each of five samples according to the type of immersion media. The samples of subgroup [1] were immersed in the acid media for 12 days. For subgroup [2] the samples were immersed in topical fluoride agent for 6 hours. While for subgroup [3] the samples were immersed in the mouth wash for 12 hours. All immersion times were equivalent to consumption of the materials of immersion media for one year by the patient. For quantitative evaluation of surface roughness, all samples were subjected to profilometric measurements. Colour measurement tests were also conducted for all the samples by spectrophotometer. These measurements were made twice, once after artificial saliva immersion and again after storage in different immersion media for the specific time.

Each milled disc was inspected then the attachment screw was removed by diamond finishing stone. All disc samples were finished by ten strokes on wet sandpaper grit 900 followed by 1200. The ceramic samples were polished by Optra Fine Ceramic Polishing System. The Optra Fine P polisher (dark blue) was used with water to polish the surface of the ceramic disc samples. Then the Optra Fine HP high polishing brushes and paste were used according to manufacture without water to obtain a high luster gloss on the surface of the ceramic disc samples. The composite resin samples were polished by SofLex discs** (aluminium oxide-coated discs). The fine SofLex disc was used and followed by super-fine one according to manufacture. Then a diamond polishing paste was applied with a soft bristle brush to produce a high shine surface. All milled samples were carefully checked and examined after finishing and polishing for any surface defects. To distinguish the disc surface subjected to roughness measurement, guiding grooves were made in specific pattern by diamond finishing stone. All samples were stored in 20ml artificial saliva for 24 hours for baseline measurement prior to immersion procedures.

All milled disc samples were removed from the artificial saliva and blotted dry using a filter paper to be immersed in different media. With the aid of a pH meter, the pH value of all media was measured before use. The pH of acid media (Marinda) was 2.85 while the pH of topical fluoride was 4, and the pH of the mouth wash was 6. Ten samples (five composite resin and five feldspathic porcelain discs) were chosen for immersion in each media, and the following procedures were adopted:

For Acid media (a): each sample was immersed separately in a closed individual container containing beverage Marinda for 12 days. The storage for 12 days was selected as a standard time. However, the average time for consumption of 1 cup of a drink is 15 minutes, and among beverage drinkers, the average consumption of beverage is 3.2 can per day. Therefore, 24 hours' storage time was simulated consumption of the beverage over 1 month. So, 12 days period was equivalent to consumption of the beverage for one year [29]. The beverage solution was changed every 24 hours from a newly opened can. For Topical Fluoride (f): application of topical fluoride for 6 hours was reported to be equivalent to a single application for one minute per day for one year as reported by the manufacture. For Mouth Wash (m): each sample was immersed in 5 ml mouth wash for 12 hours, which was reported as the equivalent to 2 mouth rinses per day for 1 year [30]. The immersion solutions were shaken every 3 hours to provide homogeneity. At the end of all the test periods, the samples were removed by a tweezer and submerged in distilled water. Then the specimens were blotted dry using a filter paper.

For quantitative evaluation of surface roughness, all samples were subjected to profilometric measurements. While for qualitative assessment of the surface topography, scanning electron microscope (SEM) evaluation was carried out for selected samples from the different groups and subgroups. Colour measurement tests were also conducted for all the samples. The previously mentioned measurements were made twice, first after artificial saliva storage and again after storage in different immersion media for the specific time.

Surface roughness measurements were performed using profilometer. The large LCD display shows roughness parameter Ra. The diamond tracer tip (radius 10 µm ± 10 µm) has a tracing length of 6 mm and tracing speed 1.0 mm/second. The flat surface of the discs was adjusted in the horizontal plane parallel to the horizontal machine base. Three readings were recorded for each sample and their mean was calculated. The Mean Roughness (Roughness Average Ra) is the arithmetic average of the absolute values of the roughness profile ordinates. Mean surface roughness of all samples were obtained after immersion in artificial saliva and were considered as control and after immersion in different media (acid media, topical fluoride application, and mouth wash). Acrylic resin base holder was constructed with depression with the same size and shape of the disc samples to fix them during surface roughness measurement. All data were recorded and saved. All data were recorded from different test measurements, collected and statistically analysed using IBM*SPSS* Statistics Version 20 for Windows.

Results

Data were presented as mean and standard deviation (SD) values. Student's t-test was used to compare between mean Ra and (ΔE) of the two groups. One - way Analysis of Variance (ANOVA) was used to compare between Ra and (ΔE) of different media and different interactions. Tukey's post-hoc test was used for pair-wise comparison between the mean values when ANOVA test is significant. Pearson's correlation coefficient was used to determine significant correlation between surface roughness and colour changes. The significance level was set at $P \leq 0.05$. Statistical analysis was performed with IBM® SPSS® Statistics Version 20 for Windows.

I- Results of the surface roughness measurements:

A. Results of the effect of material type on the surface roughness:

In artificial saliva, there was no statistically significant difference between samples in the ceramic group (0.95 µm ± 0.21) and composite group (0.69 µm ± 0.20) at P ≤ 0.05. For acid media, there was no statistically significant difference between the ceramic group (1.18 µm ± 0.41)) and composite group (1.23 µm ± 0.19) at P ≤ 0.05. Also, for topical fluoride, there was no statistically significant difference between the ceramic group (1.15 µm ± 0.26) and composite group (1.21 µm ± 0.29) at P ≤ 0.05. In case of mouth wash, the composite group showed statistically significant higher means Ra value (1.05 µm ± 0.20) than ceramic group (0.51µm ± 0.06) at P ≤ 0.05. All values for the tested materials and media are presented numerically in table [1].

Table 1: The mean, standard deviation (SD) of Ra values of tested materials as affected by the different immersion media

Materials / Media	Composite		Ceramic		P-value
	Mean	SD	Mean	SD	
Saliva	0.69	0.20	0.95	0.21	0.087
Acid	1.23	0.19	1.18	0.41	0.829
Fluoride	1.21	0.29	1.15	0.26	0.767
Mouth wash	1.05	0.20	0.51	0.06	<0.001*

**: Significant at P ≤ 0.05*

B. Results of the effect of different media on the surface roughness of tested materials:

For group I (composite resin): There was no statistically significant difference between Ra values after immersion in acid (1.23 µm ± 0.19), fluoride (1.21 µm ± 0.29) both showed the statistically significantly highest mean Ra values. Mouth wash showed significantly lower mean value. (1.05 µm ± 0.20) and saliva showed the statistically significantly lowest mean Ra value (0.69 µm ± 0.20) at P ≤ 0.05. For group II (ceramic): There was no statistically significant difference between acid media (1.18µm ± 0.21) and Fluoride (1.15 µm ± 0.26); both showed the statistically significant highest mean Ra values. Saliva showed significantly lower mean Ra value (0.95 µm ± 0.26). Mouth wash showed the statistically significant lowest mean Ra value (0.51 µm ± 0.06) at P ≤ 0.05. All values for the tested materials and media are presented numerically in table [2].

Table 2: The mean, standard deviation (SD) of Ra values as affected by the material types

Material / Media	Composite		Ceramic	
	Mean	SD	Mean	SD
Saliva	0.69 [c]	0.20	0.95 [b]	0.21
Acid	1.23 [a]	0.19	1.18 [a]	0.41
Fluoride	1.21 [a]	0.29	1.15 [a]	0.26
Mouth wash	1.05 [b]	0.20	0.51 [c]	0.06
P-value	**0.001***		**0.004***	

**: Significant at P ≤ 0.05, Different letters are statistically significantly different according to Tukey's test*

C. Comparison between different interactions

There was no statistically significant difference in Ra values between the composite resin samples immersed in acid (1.23 µm ± 0.19), composite resin samples with fluoride application (1.21 µm ± 0.29), ceramic samples immersed in acid (1.18µm ± 0.21) and ceramic with Fluoride application (1.15 µm ± 0.26); all showed the statistically significantly highest mean Ra values at P ≤ 0.05. There was no statistically significant difference between composite resin samples immersed in mouth wash (1.05µm ± 0.26) and ceramic samples immersed in saliva (0.95µm ± 0.21); both showed lower mean Ra values at P ≤ 0.05. This was followed by composite samples immersed saliva (0.69µm ± 0.20) which showed significantly lower mean value at P ≤ 0.05. Ceramic samples immersed in mouth wash showed the statistically significantly lowest mean Ra value (0.51 µm ± 0.06) at P ≤ 0.05. All values for the tested materials and media are presented numerically in table [3].

Table 3: The mean and standard deviation (SD) of Ra values for the interactions between tested materials and different immersion media

Material x Media	Mean	SD	P-value
Composite x Saliva	0.69 c	0.20	<0.001*
Composite x Acid	1.23 a	0.19	
Composite x Fluoride	1.21 a	0.29	
Composite x Mouth wash	1.05 b	0.20	
Ceramic x Saliva	0.95 b	0.21	
Ceramic x Acid	1.18 a	0.41	
Ceramic x Fluoride	1.15 a	0.26	
Ceramic x Mouth wash	0.51 d	0.06	

**: Significant at P ≤ 0.05, Different letters are statistically significantly different according to Tukey's test*

II- Results of the effect of different media on the colour change (ΔE) of the tested materials:

A. Results of the effect of material type on the colour change (ΔE):

For acid media, the ceramic group showed statistically significant higher mean ΔE value (4.77± 0.34) than composite group (3.02 ± 0.35) at P ≤ 0.05. While for topical fluoride media, the ceramic group showed statistically significant higher mean ΔE value (2.58 ± 0.35) than composite group (1.71 ± 0.25) at P ≤ 0.05. In case of mouth wash media, the ceramic showed statistically significant higher mean ΔE value (0.97 ± 0.09) than composite group (0.62 ±

0.05) at P ≤ 0.05. All values for the tested materials and media are presented numerically in table [4].

Table 4: The mean, standard deviation (SD) of ΔE values of tested materials as affected by the different immersion media

Media \ Material	Composite		Ceramic		P-value
	Mean	SD	Mean	SD	
Acid	3.02	0.35	4.77	0.34	<0.001*
Fluoride	1.71	0.25	2.58	0.35	0.002*
Mouth wash	0.62	0.05	0.97	0.09	<0.001*

**: Significant at P ≤ 0.05*

B. Results of the effect of different media on the colour change (ΔE) of tested materials:

For group I (composite resin): Acid media showed the statistically significantly highest mean ΔE value (3.02 ± 0.35) followed by Fluoride (1.71 ± 0.25). Mouth wash showed the statistically significantly lowest mean ΔE value (0.62 ± 0.05) at P ≤ 0.05.

For group II (ceramic): Acid showed the statistically significantly highest mean ΔE value (4.77± 0.34) followed by Fluoride (2.58 ± 0.35). Mouth wash showed the statistically significantly lowest mean ΔE value (0.97 ± 0.09) at P ≤ 0.05. All values for the tested materials and media are presented numerically in table [5].

Table 5: The mean, standard deviation (SD) of ΔE values as affected by the material types

Media \ Material	Composite		Ceramic	
	Mean	SD	Mean	SD
Acid	3.02 a	0.35	4.77 a	0.34
Fluoride	1.71 b	0.25	2.58 b	0.35
Mouth wash	0.62 c	0.05	0.97 c	0.09
P-value	<0.001*		<0.001*	

**: Significant at P ≤ 0.05, Different letters are statistically significantly different according to Tukey's test*

C. Comparison between different interactions

There was a statistically significant difference between all interactions. Ceramic samples immersed in acid showed the statistically significantly highest mean ΔE value (4.77± 0.34) at P ≤ 0.05. This was followed by composite samples immersed in acid (3.02 ± 0.35), ceramic samples with fluoride application (2.58 ± 0.35), composite samples with fluoride application (1.71 ± 0.25) and ceramic samples immersed in mouth wash (0.97 ± 0.09) with a statistically significant difference between all groups at P ≤ 0.05. Composite samples immersed in mouth wash showed the statistically significantly lowest mean ΔE value (0.62 ± 0.05) at P ≤ 0.05.

All values for the tested materials and media are presented numerically in table [6].

Table 6: The mean and standard deviation (SD) of ΔE values for the interactions between tested materials and different immersion media

Material x Media	Mean	SD	P-value
Composite x Acid	3.02 b	0.35	<0.001*
Composite x Fluoride	1.71 d	0.25	
Composite x Mouth wash	0.62 f	0.05	
Ceramic x Acid	4.77 a	0.34	
Ceramic x Fluoride	2.58 c	0.35	
Ceramic x Mouth wash	0.97 e	0.09	

**: Significant at P ≤ 0.05, Different letters are statistically significantly different according to Tukey's test*

Discussion

Increasing the demands for dental esthetics is coupled with outstanding development of esthetic restorative materials. Despite the development in the composition and characteristics of these restorative materials, restorations in the oral cavity are subjected to several conditions that may cause changes in the physical and mechanical properties of these restorations, such as surface roughness and colour. Thereby, undermining the quality of the restoration and eventually necessitating replacement [31]. Any esthetic restorative material must simulate the natural tooth in colour, translucency and texture. These materials must also maintain colour stability for long periods of time. Discolouration of restorations can be due to extrinsic or intrinsic causes. Extrinsic causes include accumulation of plaque and surface stains, alterations of surface or subsurface colour, implying a superficial degradation or a slight penetration and reaction of staining agents within the superficial layer of resin composites. The degree of colour change can be influenced by several factors like chemical reactivity, diet, oral hygiene and surface smoothness of the restoration. Accordingly, the present study was carried out to evaluate the effect of different oral media such as acid media, topical fluoride and mouth wash on the surface roughness and colour stability of milled composite resin restorations (paradigm MZ100 composite resin blocks) and milled feldspathic porcelain restorations (sirona cerec blocks). Milled composite resin blocks were selected for testing in the current study due to some advantages as easier finishing and polishing, kindness to the natural dentition regarding wear and easier to make add-on adjustment compared to feldspathic ceramic as claimed by the manufacturer. In the present study feldspathic ceramic blocks were used due to the approximation of some of its properties to the milled composite resin as assumed by the manufacture. The CEREC CAD/CAM system was selected to construct the samples of this study as it offers the opportunity to prepare, design, and fabricate the ceramic and composite resin restoration in a single appointment, without the need for making impressions, provisional restorations, or dental laboratory support. Moreover, the CAD/CAM milling of ceramic and composite resin blocks, fabricated under controlled and optimum manufacturer conditions, enables the production of a restoration with a higher intrinsic strength without the material variations inevitable in laboratory produced restorations [1]. Prior to any immersion procedure, all the samples were immersed in artificial saliva for 24 hours to be marked as baseline samples. Artificial saliva was chosen instead of human whole saliva in order to minimize the influence of inter individual variations in salivary protein content and composition and was accurately prepared according to *Wongkhantee et al.* [18]. The selected immersion media were of the commonly consumed beverages such as Marinda orange due to its low pH value as in accordance with *Hamouda* [32] who found that the pH measured for Marinda orange was 2.85, Pepsi cola was 2.90, Sprite was 3.13, and Fayrouz was 3.00. While the 0.4% stannous fluoride SnF_2 was selected due to its usage in daily preventive measures and its pH was 4 when compared to the neutral sodium fluoride NaF (pH=7) [30]. Mouth wash was selected also due to the increased frequency of its use, not only as a result of their effectiveness in caries and gingivitis control but also because people tend to use mouth rinses for social and cosmetic reasons. Especially the selected mouth rinse is from the commonly used mouth rinses in the Egyptian market. The pH of mouth wash was 6. This study was designed to simulate consumption of the previous agents for one year by the patient. The immersion time for Miranda was 12 days. This simulated consumption of material over one year [29]. The fluoride agent applied for 6 hours, which was reported as the equivalent of 1 time of application for. The samples were immersed in the mouth wash solution for 12 hours which is equivalent to a minimum of one year of two minutes use per day as described by *El Badrawy et al.* [30] In the present study, the change in the surface roughness was tested as it has been reported [3] that, the surface roughness may affect esthetic by changing the texture of esthetic restoration, increasing scattering of incident light and consequently affecting the colour stability. Surface roughness of all baseline samples after immersion in saliva were measured with Profilometer. Colour changes can be assessed by visual and instrumental mechanisms. Instrumental techniques eliminate the subjective interpretation of visual colour comparison; thus, even slight colour changes in dental materials can be detected using spectrophotometers. *Um and Ruyter* [33] reported that colour difference values (ΔE^*) of esthetic restorations higher than 1.0 are perceptible while those up to 3.3 are considered acceptable. With regard to the effect of immersion media on the surface roughness of the tested materials, results of the present study demonstrated a statistically significant increase in surface roughness of composite resin samples after immersion in all tested media, compared to the roughness recorded after immersion in artificial saliva. The Ra value of composite resin samples subjected to topical fluoride application (If) was also significantly higher (1.21µm) than control group (0.69µm). The data also indicated that 0.4% SnF_2 (pH= 4), caused increase in Ra values due to erosive action of its acidity. This finding agreed with the study of *Yeh et al*, [34] who reported the dissolution effect of acidulated phosphate fluoride (APF) on composite filler particles. This was also observed on SEM micrographs as grainy surface with less rough aspect than group Ia . The Ra value of composite resin samples immersed in mouth wash media (Im) was the lowest (1.05µm) among the composite groups. This may be due to the lower acidity of mouth wash in comparison to other media, thus it had a mild erosive effect on the surface of the restoration. This was also observed on SEM micrographs as small areas of degradation with few alterations on the surface and less extensive loss of the matrix. Multiple filler particles were evident scattered over the surface. No similar study was found to compare the results with our finding and such finding needs further investigations. Regarding the effect of the immersion media on the colour change of the tested materials, results of the current study revealed statistically significant colour changes in composite resin samples after immersion in the tested media but still clinically acceptable according to *Um and Ruyter* [33]. Composite resin samples immersed in acid media recorded the highest ΔE value (3.02) followed by composite resin samples with topical fluoride application (1.71) and mouth wash (0.62) respectively. Results of the present study also revealed a statically significant colour changes (ΔE) in ceramic samples after immersion in the tested media. According to *Um and Ruyter* [33] this colour change was clinically unacceptable for ceramic samples immersed in acid media (4.77) but the colour change for ceramic samples subjected to topical fluoride and immersed in mouth wash was clinically acceptable (2.58 and 0.97 respectively) By comparing the results of ΔE values of the ceramic groups with the composite resin groups, all ceramic groups showed statically significant higher ΔE values than composite resin groups after the immersion in different media. This finding agreed with the study of *Shillingburg* [35], who found the resin based composite inlays had a significantly better colour match than did the ceramic inlays at three years. The pattern of the surface roughness seemed to influence the colour change of the tested materials. This is evidenced by the increase in colour change (ΔE) of ceramic material compared to composite resin material. In this in vitro study, the most significant finding was that both types of restorative materials are susceptible to roughness and colour change with acid media. However, it must be noted that there were some limitations to this study. This study did not account for the role of saliva. The effect of acidic food or drinks will be reduced because of its dilution effects and through the action of buffering systems. Furthermore, the oral cavity presents a more complex testing environment. For example, the presence of water, temperature change, and pH level in the oral cavity may also considerably affect the properties of restorations. Therefore, further studies are required to elucidate the effect of acidic agents on esthetic restorative materials in vivo. Finally, the consumption of acidic food and beverage can increase surface roughness of resin composites and ceramic which facilitate dental plaque accumulation and bacterial adhesion on their surface, resulting in discolouration and recurrent dental caries.

Conclusions

Within the limitations of this study the following conclusions were derived: By reducing the pH value, increasing the acidity of the immersion media that led to an increase in the surface roughness of the tested restorative materials (composite resin and ceramic). The highest surface roughness was recorded for acid media (Marinda) followed by topical fluoride application. While the lowest surface roughness was recorded for mouth wash media (antiseptol) with both materials. Clinically unacceptable colour change (ΔE) was encountered with ceramic samples immersed in acid media while the colour change (ΔE) of the remaining groups was acceptable for both materials. Milled composite resin materials provided comparable results to milled feldspathic ceramics regarding roughness and colour change after immersion in media with different pH.

List of Abbreviations

(CAD/CAM): Computer-aided Design & Computer-aided Manufacturing
(SEM): Scanning Electron Microscope
(APF): Acidulated phosphate fluoride
(NaF): Sodium fluoride
(SnF2): Stannous fluoride
(ICRs): Indirect composite resins restoration materials

Conflict of interest

The authors declare that there is no conflict of interest regarding the publication of this article.

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Ethical approval

The study was approved by the Human research ethical Committee, of Alfarabi college in Jeddah at 31/8/2020, letter number 20-08/1.

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