Journal of International Dental Sciences
Uluslararası Diş Hekimliği Bilimleri Dergisi

Research | Araştırma

The Effect Of Povidone Iodine As An Oral Antiseptic On Color Stability Of Different Restorative Materials

Oral Antiseptik Olarak Povidon İyot Kullaniminin Farklı Restoratif Materyallerin Renk Stabilitesine Etkisi

ABSTRACT

Objective: The aim of this study is to examine the effect of povidone iodine on the color stability of different restorative materials.

Materials and Method: In this study, ten discs (30 in total) of 8 mm diameter and 2 mm thickness were prepared with compomer, composite and glass ionomer cement materials. One surface of all samples was standardized under water with 800, 1000 and 1200 grid sandpapers, respectively. After the samples were kept in distilled water color measurements were performed using a spectrophotometer. 10 samples in each group were kept in 0.23% povidone iodine for 1 minute. The surfaces of the samples were washed with distilled water to remove povidone iodine and dried with tissue paper. Color measurements of the samples were carried out with the spectrophotometer. Color change amounts were calculated in ΔE. The data were analyzed statistically with the Shapiro Wilk test, Anova and Post Hoc Tamhane test.

Results: A statistically significant difference was found between the ΔE measurement averages of the samples kept in povidone iodine according to the materials used ($p<0.05$). The ΔE average of the glass ionomer samples was found to be statistically significantly higher than the ΔE average of the compomer and composite samples, and the ΔE average of the compomer samples was statistically significantly higher than the ΔE average of the composite samples**.**

Conclusion: The color stability of the composite material was higher than the compomer and the compomer material compared to the glass ionomer cement.

Key Words: Povidone Iodine, Color Change, Restorative Material.

ÖZ

Amaç: Bu çalışmada amacımız, povidon iyotun farklı restoratif materyallerin renk stabilitesine etkisinin değerlendirilmesidir.

Gereç ve Yöntemler: Bu çalışmada kompozit ve cam iyonomer siman materyalleri ile 2 mm kalınlığında olan ve 8 mm çaplı 10'ar adet (toplam 30 adet) disk örneği hazırlandı. Örneklerin bir yüzeyi sırayla farklı büyüklükteki grid zımparalar ile standard hale getirildi. Örnekler distile suda bekletillip, renk ölçümleri bir spektrofotometre ile gerçekleştirildi. Her gruptaki 10'ar adet örnek 1 dk % 0,23'lük povidon iyot içerisinde bekletildi. Tamamlanan süre sonunda her gruptaki örneklerin yüzeyleri povidon iyotun uzaklaştırılması amacıyla distile suyla yıkanarak kağıt mendille kurutuldu. Örneklerin renk ölçümleri spektrofotometre yardımıyla gerçekleştirildi. Povidin iyot uygulama öncesi ve sonrası örneklerde meydana gelen renk renk değişim miktarları ΔE cinsinden hesaplandı. Veriler Shapiro Wilk testi, Anova ve Post Hoc Tamhane testi ile analiz edilerek istatistiksel olarak değerlendirildi.

Bulgular: Povidon iyotta bekletilen örneklerin kullanılan materyallere göre ΔE ölçüm ortalamaların arasında istatistiksel olarak anlamlı bir fark bulundu ($p<0,05$). Cam iyonomer numunelerinin ΔE ortalaması, kompomer ve kompozit numunelerin ΔE ortalamasından, kompomer numunelerinin ΔE ortalaması, kompozit numunelerin ΔE ortalamasından istatistiksel olarak anlamlı derecede yüksek bulundu.

Sonuç: Kompozit materyalin kompomere, kompomer materyalin cam iyonomer simana göre renk stabilitesi daha yüksek bulundu. Oral antiseptikler veya gargaralar kullanılırken hastanın ağzındaki mevcut restorasyonlarının türü ve renklenme ihtimalleri göz önünde bulundurulmalıdır.

Anahtar Kelimeler: Povidon İyot, Renk Değişimi, Restoratif Materyal.

Melek BELEVCİKLİ[1]
ORCID: 0000-0002-9745-0360

Edanur ÇAKIR[1]
ORCID: 0000-0001-9109-613X

Gamze KILIÇ[1]
ORCID: 0000-0001-5624-298X

[1]Zonguldak Bülent Ecevit University,
Faculty of Dentistry,
Department of Pedodontics,
Zonguldak, Turkey

Geliş tarihi / *Received: 21.06.2023*
Kabul tarihi / *Accepted: 17.08.2023*

İletişim Adresi/*Corresponding Adress:*
Edanur ÇAKIR,
Zonguldak Bülent Ecevit University,
Faculty of Dentistry,
Department of Pedodontics,
Zonguldak, Turkey
E-posta/e-mail: ckredanur@gmail.com

INTRODUCTION

Due to the increasing interest in aesthetic restorations in recent years, new materials that can imitate the properties of natural teeth were produced with the developing technology. The usage of materials compatible with tooth color in dental practice is becoming increasingly widespread and many researches are carried out to determine the aesthetic properties of restorative materials used in dentistry. The selection of restorative materials in dentistry is important to meet the functional and aesthetic needs of patients. Composite, compomer and glass ionomer materials are the three main materials commonly used in dental restorations (1). Composites are preferred in procedures such as posterior and anterior caries treatment, diastema closure, composite laminate and fracture treatment, thanks to their color compatibility with dental tissues and their durability (2,3,4). Compomers are a polyacrylic acid modified composite (1,5). These materials are a blend of composite materials and glass ionomer and combine the advantages of both ionomers and composites. They have fluoride release and ease of usage like glass ionomers and superior material qualities and aesthetics like composite resins. Glass ionomer cements (GIC) are defined as a hybrid of silicate cement and polycarboxylate cement, obtained by mixing powder and liquid forms, in which all or most of the setting reaction is an acid-base reaction. GIC can be used as adhesive, base material, restorative and canal filling paste (5).

What is expected from aesthetic restorative materials is that they maintain their color stability against various factors for a long time. However, color changes may occur in restorations due to internal and external effects. If the restorations are exposed to factors that cause discoloration in the mouth, such as different foods, beverages and drugs, etc., color stability, long-term success and patient satisfaction are affected (6). Extrinsic coloration can be affected by coloring pigment exposure and the characteristics of the restorative material (7). Moreover, the properties of the materials used, the characteristics of the photoinitiators and inorganic fillers play a role in the color change as they affect the surface properties of the restorations (6,7). The usage of instruments used in color measurement in dentistry started with the production of instruments that imitate human vision and mathematically specify the different dimensions of color for usage in quality control processes in the industrial field. There are four main types of devices that can be used for color measurements. These are colorimeters, spectroradiometers, spectrophotometers and digital cameras. Measurements made with the help of the device are more reliable and repeatable. Color evaluations made with the "CIELAB" color analysis method, which is a suitable analysis method in this respect, are highly accepted in dental research (8,9).

It is stated in the literature that antiseptics and mouthwashes used for oral infection control and for providing antimicrobial activity can cause external discoloration of dental tissues and dental restorations. Mouthwashes and antiseptics containing chlorhexidine gluconate, benzydamine hydrochloride, povidone iodine, hyaluronic acid and alcohol are frequently used in dentistry. PVP-I (Povidone iodine) is an antiseptic agent and is used in dentistry for the prevention and treatment of infections. This antiseptic is a water solution of iodine and helps prevent the growth and spread of bacteria, viruses and fungi. In dentistry, the usage of povidone iodine is common and has a variety of applications (10,11). Povidone iodine is used as an effective antiseptic in dentistry to ensure oral hygiene. It is recommended as a mouthwash by dentists as a preventive measure against infections of the teeth and gingival tissue (12). After some procedures in dentistry, wounds are at risk of infection. In these cases, povidone iodine is an antiseptic solution used for wound care (13). Povidone iodine can also be used in the treatment of gingival diseases caused by inflammation of the gingival tissue around the teeth. It is also reported that povidone iodine is used for cleaning and disinfecting root canals during root canal treatment (14).

In pediatric dentistry, where protective applications are important, povidine iodine is used for chemical control plaque. Povidone iodine is effective against both Streptococci and Lactobacilli in children (15). Studies have suggested that in order to reduce the risk of caries in children younger than six years of age, in the middle and high caries risk group, 10% povidone iodine cotton swabs should be used and children older than six years old or with spitting ability should rinse their mouth with 10 ml of povidone iodine and spit it out. In addition, periodic administration of povidone iodine is recommended in high-risk children (16).

The aim of this study is to evaluate the effect of povidone iodine mouthwash applications on the color stability of compomer, composite and glass ionomer cement fillers routinely used in pediatric dentistry practice with the help of a spectrophotometer.

MATERIAL AND METHODS

This study was carried out in vitro at Zonguldak Bülent Ecevit University, Faculty of Dentistry, Department of Pedodontics. Composite (Palfique estelite paste, Tokuyama, Japan), compomer (Dyract Extra, Dentsply,

Germany) and glass ionomer cement (R&D Series Nova Glass-L, Imicryl, Konya, Turkey) materials were used in the study (Table 1).

Restorative Material	Brand	Manufacturer	Ingredient
Composite	Palfique estelite paste	Tokuyama Dental Corporation, Tokyo, Japan	Silica-zirconia spherical particles Bis-GMA Triethylene glycoldimethacrylate (contains 71% fillers by volume)
Compomer	Dyract XP	Dentsply Sirona, Konstanz, Germany	UDMA, TCB Resin, TEGDMA, Dimethacrylate and Trimethacrylate Resin, Camphorquinone, Ethyl4(dimethylamino) Benzoate, BHT, UV Stabilizer, Strontium-Alumino-SodiumFluoro-Phosphor-Silicate Glass, Silicon Dioxide, Strontium Fluorine, Iron Oxide and Titanium Oxide (47% filler by volume)
Glass ionomer cement	R&D Series Nova Glass-L	Imicryl, Konya, Turkey	Silica, Alumina Fluoride, Polyacrylic acid,

Table 1. Restorative materials, manufacturers and ingredients used in the study.

First of all, 10 disc-shaped specimens (30 in total) were prepared for each restorative material with the help of 2 mm thick and 8 mm diameter silicone molds, on which transparent tape was placed and both sides were closed with microscope glass. In accordance with the manufacturer's recommendations, the restorative materials were polymerized for 20 seconds with an LED light source (Espe Elipar S10, 3M, St.Paul USA) (1200 mW/cm2). One surface of all samples was standardized under water with 800, 1000 and 1200 grid sandpapers, respectively. Three working groups were formed, consisting of 10 composite discs, 10 compomer discs, and 10 glass ionomer discs. After the samples were kept in distilled water in closed containers for 24 hours, the first color measurements were performed using a spectrophotometer (VitaEasyshade, Vita Zahnfabrik, Bad Sackingen, Germany). Color measurement was completed in the instrument's L, a, b modes after the samples were dried with blotter and three consecutive measurements were taken from each sample. Ten samples in each group were soaked in 0.23% povidone iodine (Konix, Turkuaz health services, Istanbul, Turkey) for 1 minute.

At the end of the completed time, the surfaces of the samples in each group were washed with distilled water to remove povidone iodine and dried with a tissue paper.

Color measurements of the samples were carried out with the help of spectrophotometer. L, a and b values obtained during the first measurement from the device and at the end of the povidone iodine application were placed in the formula below and the color differences between the two measurements in the sample were calculated.

$$\Delta E^* = [(L2^*-L1^*)2+(a2^*-a1^*)2+(b2^*-b1^*)2]1/2$$

L, a, b values numbered 1 in the formula represent the values obtained in the first measurement, and L, a, b values numbered 2 represent the values obtained in the second measurement.

Analyzes were performed in IBM SPSS 25 program and the significance level was evaluated as $p<0.05$. The obtained data were checked with the Shapiro Wilk test for the assumption of normality as the first step of the statistical analysis and the homogeneity of variance with the Levene test. Anova (Welch statistic) test was used to compare three independent groups with normal

distribution but not homogeneous variance. Post Hoc Tamhane tests were conducted to identify the group or groups that made the difference.

RESULTS

Assumptions were checked and Anova test was applied to compare the ΔE measurement averages according to the materials. As a result of the analysis, a statistically significant difference was found between the ΔE measurement averages according to the materials used ($p<0.05$) **(**Table 2).

Material	n	Min.	Max.	mean ± sd	p
Compomer	10	1.22	7,55	3,35 ± 2,21	0,000*
Composite	10	0,55	2,20	1,08 ± 0,57	*
Glass ionomer	10	3,05	13,61	7,51 ± 3,35	*

*p<0.05

Table 2. ΔE measurements by materials.

Statistically significant differences were obtained between compomer and composite and glass ionomer, and between composite and glass ionomer (p=0.030, p=0.014 and 0=0.000) (Table 3). The ΔE mean of the glass ionomer samples was statistically significantly higher than the ΔE mean of the compomer and composite samples. The ΔE mean of the compomer samples was also statistically significantly higher than the ΔE mean of the composite samples.

Material	mean ± sd	p
Compomer-Composite	2.26 ± 0.72	0.030
Compomer Glass ionomer	-4.16 ± 1.26	0.14
Composite-Glass ionomer	-6.43 ± 1.07	0.00*

*p<0.05

Table 3. Comparison of ΔE measurements by materials.

DISCUSSION

Today, where aesthetics comes to the fore, the number of researches on aesthetic fillers is increasing day by day. Compomer, composite and glass ionomer cement are frequently preferred tooth-colored restorative materials in pediatric dentistry practice (17). The material used in the restorations, the experience of the physician, the oral hygiene habits of the patient, the location and size of the restoration are the factors that affect the success and longevity of the restorations. The compilation of studies conducted by using various parameters and the results of many accepted studies show us how important the selection of restorative materials and restorative procedures are for the longevity of restorations (18). The bonding capacity of dental tissues, polymerization shrinkage, resistance of the roughness to surface and stresses, and color stability of the selected restorative material affect the success of restorations. Restorative materials should be able to imitate the appearance of natural teeth by providing color harmony with the tooth tissue and maintain this feature during their stay in mouth. Restorations need to be changed in order to eliminate the bad aesthetic appearance caused by the discoloration of the material, which causes both time and financial loss for the patient and the physician (19). Color stability is one of the important features for restorations to be long-lasting (17). It is known that mouthwash and mouth rinse solutions used for various purposes can cause discoloration of teeth and restorations.

To prevent the risk of cross infection before dental procedures, gargling with antiseptics such as 0.2% povidone iodine is a practice recommended by the American Dental Association all over the world.

A concentration of 0.23% PVP-I was found to inactivate SARS-CoV, MERS-CoV, influenza A virus and rota virus in vitro. Another study showed that the effect of PVP-I (0.23%) on SARS-CoV was equivalent to 70% ethanol (20). Studies showed that povidone iodine is useful in preoperative antisepsis of gingival or mucosal surfaces (20). In Turkey, mouth rinse solutions recommended by physicians can be used once/twice a day in addition to tooth brushing in children older than 6 years, considering the manufacturer's recommendations (21).

Kuzu et al. (22) investigated the effect of different antiseptics and mouthwashes on color stability of different composite resins, and the highest average ΔE values were observed in the samples kept in povidone-iodine solution.

It was stated that the povidone-iodine-containing antiseptic solution used in the study caused a statistically significantly higher ΔE value in both composites with its dense consistency and high coloring pigment content (22).

Therefore, in this study, the coloring effect of PVP-I, which is frequently used as an antiseptic mouthwash in clinical practice, on existing restorations in the mouth was evaluated. It is recommended to use 0.23% PVP-I mouthwash for at least 15 seconds before the procedure (20,23). Considering similar studies in the literature and thinking that the individual should rinse the mouth for at least 15 seconds in a single usage, color changes on the discs were measured by keeping the samples in PVP-I solution for 1 minute.

In this study, in order to evaluate the color stability of glass ionomer cement, composite and compomer materials used in the restorative treatments of primary teeth in povidone iodine solution as an oral antiseptic, color measurements of the samples were made with spectrophotometer device. In their review on color measurement in dentistry, Kurt et al. (24) reported that the visual method is subjective and more detailed and reliable results can be obtained with spectrophotometers.

Studies on the coloring effect of oral antiseptics and mouthwashes are rare in the literature, and in these studies, generally the color changes of mouthwashes in composites, conventional and resin modified glass ionomer cements and were investigated (25). Öngöl et al., in their study, kept the samples prepared from the composites in 6 different mouthwashes. As a result of the study, they determined a significant color difference in all samples (21). In a study investigating the effects of 3 different mouthwashes on the color stability of 4 different composite materials, they stated that color change was observed in all composite types (26).

In this study, it was observed that glass ionomer samples had more color change than compomer samples, and compomer samples had more color change than composite samples. Similar to this study, Abu-Bakr et al. (27) used four different compomer, composite and resin-modified glass ionomer cements in their study, kept the samples in whiskey, orange juice, cola, deionized water and measured the color changes on different days. composite showed minimal color change. Ozmen B. et al. (9), in their study where they measured the color changes of compomer with different beverages, mouthwash solutions and toothpaste applications, mouthwash solutions caused a color change below the clinically acceptable value and these solutions can be used safely in terms of color change in children with compomer restoration.

In a study comparing the color changes of composite and compomer in different beverages, it was found that compomer had higher ΔE values than composite resins (28). Similarly, Janda et al., in their study using 3 different composites and compomers, stated that compomer is the most unstable material in terms of color and that acid-base reaction, monomer structure and relatively low filler content may be responsible excessive color change rather than incomplete radical polymerization in superficial layer (29). High filler content composites can increase color stability as it can reduce monomer content (30). Almutairi et al. (31) stated that glass ionomer cement showed significantly more color change compared the other two material types, as a result of their study by soaking composite, glass ionomer cement and compomer in different drugs. It was reported that low color stability of glass ionomer cement may be due to the material's polyacid content, porous structure, and microcracks that allow dehydration and discoloration after the setting reaction (32). Fluoride-releasing materials exhibit a high ionic exchange, releasing a significant number of ions when exposed to pH changes, resulting in color change (33-35).

CONCLUSION

As a result of in this study, it was seen that glass ionomer cement had more color change than compomer and compomer had more color change than composite material. Dentists should consider this situation in the selection of antiseptic mouthwash and restorative materials, examine the color compatibility of the existing restorations with the dental tissues, and replace the old and colored restorations when necessary. Additional clinical studies are needed to evaluate the discoloration effect of povidone iodine, which is recommended for usage before dental applications, on dental materials.

REFERENCES

1. Mutluay MS. Süt dişlerinde restoratif materyal seçimi ve etkileyen faktörler. Selcuk Dent J. 2016; 3(3):151-58.

2. da Veiga AM, Cunha AC, Ferreira DM, da Silva Fidalgo TK, Chianca TK, Reis KR, Maia LC, Longevity of direct and indirect resin composite restorations in permanent posterior teeth: A systematic review and meta-analysis. J Dent. 2016; 54:1-12.

3. Yapar Mİ, Celik N, Sagsoz O, Karalar B, Seven N, Bayındır Y., Farklı polimerizasyon tekniklerinin kompozit rezinlerin mekanik ve fiziksel özelliklerine etkisi. Atatürk Üniv Diş Hek Fak Derg. 2020; 30:26-32.

4. Mahajan RP, Shenoy VU, Sumanthini MV, Mahajan HP, Walzade PS, Mangrolia R, Comparative evaluation of the discoloration of microhybrid and nanohybrid composite resins by different beverages: a spectrophotometric analysis. J Contemp Dent Pract. 2019; 20:226-30.

5. Zimmerli B, Strub M, Jeger F, Stadler O, Lussi A. Composite materials: composition, properties and clinical applications. A literature review. Schweiz Monatsschr Zahnmed. 2010;120(11):972-86.

6. Malekipour MR, Sharafi A, Kazemi S, Khazaei S, Shirani F, Comparison of color stability of a composite resin in different color media. Dent Res J. 2012; 9:441-46.

7. Wang LK, Liu YN, Hui H, Li PP. [Color stability of computer aided design and computer aided manufacture composite ceramic/resin cements after accelerated ageing]. Zhonghua Kou Qiang Yi Xue Za Zhi. 2019; 54(11):765-69.

8. Mohammadi Z, Abbott PV. The properties and applications of chlorhexidine in endodontics. Int Endod J. 2009; 42(4):288-302.

9. Özmen B, Yasemin N. The effect of beverages, mouthrınse solutıons and toothpastes on color stabılıty of the compomer resin. Cumhuriyet Dent J. 2018; 21(1):40-8.

10. Haapasalo M, Shen Y. Evolution of nickel-titanium instruments: from past to future. Endodontic Topics. 2013; 25(1):3-17.

11. Gunsolley JC. Clinical efficacy of antimicrobial mouthrinses. J Dent. 2010;38 Suppl 1:6-10.

12. Ricucci D, Siqueira JF Jr. Biofilms and apical periodontitis: study of prevalence and association with clinical and histopathologic findings. J Endod. 2010; 36(8):1277-88.

13. Vianna ME, Gomes BP, Berber VB, Zaia AA, Ferraz CC, de Souza-Filho FJ. In vitro evaluation of the antimicrobial activity of chlorhexidine and sodium hypochlorite. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2004; 97(1):79-84.

14. Mohammadi Z, Abbott PV. The properties and applications of chlorhexidine in endodontics. Int Endod J. 2009; 42(4):288-302.

15. Lopez L, Berkowitz R, Zlotnik H, Moss M, Weinstein P. Topical antimicrobial therapy in the prevention of early childhood caries. Pediatr Dent. 1999; 21(1):9-11.

16. Özdaş D. Güncelleme; Çocuk diş hekimliğinde koruyucu uygulamalar. Selcuk Dent J. 2014; 1(2): 84-91.

17. Nasim I, Neelakantan P, Sujeer R, Subbarao CV. Colorstability of microfilled, microhybrid and nanocomposite resins-an in vitrostudy. J Dent. 2010; 38:137-142.

18. Bölükbaşı B, Kara S, Çoğulu D, Farklı içeceklerin rezin esaslı restoratif materyallerin renkleşmesi üzerine etkisi, Atatürk Üniv Diş Hek Fak.Derg. 2015; 25(1):72-776 .

19. Akgül S, Gündoğdu C, Çalışkan Z, Çelik A, Bala O, Farklı içeceklerin üniversal rezin kompozitlerin renk stabilitesi ve yüzey özelliklerine etkisinin incelenmesi. Selcuk Dent J. 2022; 9(2): 445-50.

20. Addy M, Wright R. Comparison of the in vivo and in vitro antibacterial properties of providone iodine and chlorhexidine gluconate mouthrinses. J Clin Periodontol. 1978; 5(3):198-205.

21. Öngül D, Mim A, Şahin H, Değer S. Ağız gargaralarının restoratif materyallerin renk stabilitesine olan etkisi. İstanbul Üni Diş Hek Fak Derg. 2012; 46(2):13-20.

22. Kuzu Turan Emre, Özcan Karataş, Ağız gargaraları ve antiseptiklerinin farklı kompozit rezinlerin renk stabilitesine etkisi. Atatürk Üniv Diş Hek Fak Derg. 2021; 31(1):6-71.

23. Gürkan Mustafa, Serter Mert Selamet, Övül Kümbüloğlu. Covid-19 Sonrası Dental Tedavi Uygulamalarında Ağız Gargaralarının Yeri Ve Önemi. EÜ Dişhek Fak Derg.2020; 41(1):59-66.

24. Kurt M, Bal BT, Bal C. Actual Methods of Color Measurement: A Systematic Review. Turkiye Klinikleri J Dental Sci. 2016; 22:130-46.

25. Goiato MC, Nóbrega AS, dos Santos DM, Andreotti AM, Moreno A. Effect of different solutions on color stability of acrylic resin-based dentures. Braz Oral Res. 2014; 28:1806.

26. Celik C, Yuzugullu B, Erkut S, Yamanel K. Effects of mouth rinses on color stability of resin composites. Eur J Dent. 2008; 2(4):247-53.

27. Abu-Bakr N, Han L, Okamoto A, Iwaku M. Color stability of compomer after immersion in various media. J Esthet Dent. 2000; 12(5):258-63.

28. Tekçe N, Tuncer S, Demirci M, Serim ME, Baydemir C. The effect of different drinks on the color stability of different restorative materials after one month, Restor Dent Endod. 2015; 40(4):255-61.

29. Janda R, Roulet JF, Latta M, Steffin G, Rüttermann S. Color stability of resin-based filling materials after aging when cured with plasma or halogen light. Eur J Oral Sci. 2005; 113:251-57.

30. Reis AF, Giannini M, Lovadino JR, Ambrosano GM, Effects of various finishing systems on the surface roughness and staining susceptibility of packable composite resins. Dent Mater. 2003; 19:12-8.

31. Almutairi M, Moussa I, Alsaeri N, Alqahtani A, Alsulaiman S, Alhajri M. The Effects of Different Pediatric Drugs and Brushing on the Color Stability of Esthetic Restorative Materials Used in Pediatric Dentistry: An In Vitro Study. Children (Basel). 2022; 9(7):1026.

32. Kalampalikis E, Koulaouzidou EA, Koliniotou-Koumpia E, Helvatjoglu-Antoniades M, The influence of topical fluoride application on colour stability of aesthetic fluoride-releasing restorative materials, Balkan J Dent Med. 2014; 8:24–8.

33. Shalan HM, Alagami RA, Hasan MA, Effect of Coloring Beverages on Different Esthetic Restorative Materials in Primary Teeth. Acta Sci Dent Sci. 2019; 3:64–8.

34. Forss H, Release of fluoride and other elements from light-cured glass ionomers in neutral and acidic conditions. J Dent Res. 1993; 72:1257–62.

35. Hotwani K, Thosar N, Baliga S, Comparative in vitro assessment of color stability of hybrid esthetic restorative materials against various children's beverages. J Conserv Dent. 2014; 17:70-4.