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Effects of At-Home Bleaching Gel and Two Beverages on the Microhardness of an Aesthetic Composite Resin

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ABSTRACT

Introduction: The purpose of this study was to investigate the effects of 15% carbamide peroxide, orange juice, and Cola on the microhardness of composite resin restoration material.

Materials and Methods: In this in vitro study, forty disk-shaped composite samples were prepared and randomly classified into four groups (n=10); the artificial saliva (control), bleaching agent (15% carbamide peroxide), orange juice, and Cola. Vickers microhardness was measured on the surface of the samples before and after immersion for 6 and 48 hours.

Results: The microhardness values of the 15 % carbamide peroxide, Orange juice and Cola groups were significantly lower after 48 hours compared to the artificial saliva group (P=0.003, P=0.002, P=0.001, respectively). However, these differences were not statistically significant after 6 hours of immersion (P=0.068). When comparing the microhardness values of these groups over time, as expected, these measures significantly decreased, except for the 15 % carbamide peroxide group in which the mean microhardness value did not significantly decrease from baseline after 6 hours immersion (P=0.106). However, there was a significant difference after 48 hours compared to baseline and 6 hours immersion (P=0.001, P=0.004).

Conclusion: This suggests that 15 % carbamide peroxide gel can be employed as a bleaching agent in cases with composite restorations for a limited amount of time without significant deterioration of the microhardness.

Keywords: Hardness; Carbamide Peroxide; Orange juice; Cola.

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Introduction

Composite resin is the leading choice of restoration in many countries. Due to its possibility of minimally invasive dental treatment, tooth-colored restoration, and high levels of physical, mechanical, and aesthetic properties, the demand for composite resin is high [1]. Despite the continuous progressions in resin composites' structure, a concern remains about their chemical and enzymatic degradation in the oral environment [2,3]. Beverages such as juices, coffee, tea, and wine, smoking, and bleaching procedures can potentially cause softening and increased surface roughness to resin composites, depending on the resin composite and the bleaching agent used [3,4].

The durability and longevity of the esthetic restorative materials are necessary for correctly selecting the material in the oral environment [5]. Ozkanoglu et al. concluded that the hardness of restorative materials such as direct composites, high viscosity glass ionomer cement, and indirect composite resin could be negatively affected by some beverages (distilled water, black tea, coffee, and Cola), especially coffee and Cola [6]. Wongkhantee et al. showed that Cola, Orange juice, and sports drinks significantly reduced the hardness of enamel, dentin, micro-filled composite, and resin-modified glass ionomer. By contrast, immersion in yogurt and tom yam soup did not reduce the hardness of any samples [7]. Bandeira de Andrade et al. demonstrated that the nano-filled resin composite specimens immersed in red wine and coffee provided lower microhardness values than those immersed in distilled water [3].

Tooth bleaching can be used to enhance the esthetics of discolored dental composites. Bleaching products contain peroxides that act as powerful oxidizing agents, generating free radicals that break chromophores into smaller compounds [8]. This might enhance the esthetic outcome of dental composites but also have a detrimental effect on surface roughness, color stability, and translucency, according to the used protocol: either in-office bleaching, home bleaching, or a combination of both [8-12]. Attia et al. affirmed that the bleaching procedures significantly affect surface roughness, not micro-hardness [13], whereas others showed increasing hardness or lack of changes after exposure to carbamide peroxide [14]. Alaghehmand et al. described that 20% fluoridated carbamide peroxide gel increased the microhardness of four restorative materials and that 22% non-fluoridated carbamide peroxide decreased the microhardness [15].

Microhardness is a strong indicator of the clinical deterioration of dental materials. It also correlates to the strength and rigidity of restorative materials [16]. Various factors affect the microhardness of resin composite, the organic matrix's composition, and filler particles' type and shape [17]. The contrasting results of some studies regarding the effects of certain beverages and new bleaching agents on the microhardness of composite resin materials underscore the need for further research on this topic. The present study, which evaluates and compares the effects of 15% carbamide peroxide, orange juice, and Cola on the microhardness of Amaris resin composite, is a step towards addressing this need.

Materials and Methods

Study design

This was an in vitro study conducted at the Zahedan School of Dentistry following approval by the Institutional Review Board (IR.ZAUMS.Rec.1393.6551). Forty disk-shaped Amaris composite samples resin (Translucent natural, Voco Cuxhaven, Brochure Co, Germany) with a diameter of 6.0mm and a thickness of 2.0mm were prepared using a silicone matrix mold (Elite HD, Zhermack BadiaPolesine, Italy). The lower surface of the mold was covered with a glass slab and a polyester strip, after which the resin composite was inserted into the mold in increments. A polyester strip and a glass slab were placed over the specimens to flatten their surfaces and ensure a smooth mirror surface on each specimen. Each side of a specimen was light cured for 40 seconds using a halogen light (Coltolux 75, Coltene Whaledent, Inc., USA) with an intensity of 450mW/cm^2. The intensity of the halogen light was verified with a radiometric device (Coltene Whaledent, Inc., USA). All specimens were stored in distilled water at 37°C for 24 hrs. The specimens were then randomly divided into four groups: Artificial saliva (control), Bleaching agent (15% carbamide peroxide), Orange juice and Cola. The control group was stored in 20mL of artificial saliva at 37°C. Artificial saliva was composed according to a study by Suryakumari et al. [18]. The Bleaching agent group was exposed to 15% carbamide peroxide gel (Opalescence PF, Ultradent Products. Inc, South Jordan, UT, USA) (pH=7). According to the manufacturer's instructions, the bleaching agent was inserted on top of the specimens at a thickness of 1.0mm. The specimens of orange juice and Cola groups were immersed in 20mL of 100% natural noncarbonated orange juice (Sunich; Ali Fard Co., Iran) and 20 mL Cola (Behnoush Co., Iran) at 37°C. The pH of orange

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juice and Cola was measured using a digital pH meter before immersion; the pH readings were around 3.7 and 3.3, respectively. To maintain the initial pH level of the experimental substances, they were refreshed daily.

Variables

After each immersion, samples were rinsed with distilled water for 1 min, brushed with a soft toothbrush and dried. The baseline surface hardness was determined using a Vickers hardness testing machine (Buehler/Mxt-al, USA) with a diamond Vickers indenter. 100 g was applied to the center of the upper surface for a 10-second dwell time. Three microhardness indentations located 1 mm from one another were measured, after which the average indentation was recorded. This measure was repeated at 6 and 48 hours after immersion.

Statistical Analysis

Data were analyzed using SPSS version 28 software. Mean and standard deviation (SD) were used for reporting descriptive summaries. Data were subjected to one-way ANOVA to compare the microhardness between the groups and repeated measure ANOVA to compare the microhardness of each group at different time points, and in cases of significant results, a post-hoc pairwise comparison test was performed to indicate which pair had a significant difference. $P<0.05$ was considered statistically significant.

Results

According to Table 1, the one-way ANOVA revealed no significant differences between the mean microhardness values of the four groups before immersion (P=0.279) and after six hours of immersion (P=0.068). However, these differences were significant after 48 hours (P=0.001). The results of the post-hoc pairwise comparison of the microhardness values of the four groups after 48 hours of immersion are presented in Table 2. Notably, the differences were significant between the microhardness values of the specimens immersed in artificial saliva and 15% carbamide peroxide (P=0.003), artificial saliva and orange juice (P=0.002), and artificial saliva and Cola (P=0.001), but not significant between 15% carbamide peroxide and orange juice (P=0.958), carbamide peroxide and Cola (P=0.252), orange juice and Cola (P=0.274). Therefore, the control group had significantly higher microhardness values after 48 hours compared to the 15% carbamide peroxide, Orange juice and Cola groups. Repeated measures ANOVA was performed to compare the microhardness of intragroup specimens at different time points.

The findings indicated that the differences among the microhardness values of each group at different time points were significant in all the groups except for the artificial saliva (control) group (Table 1). The results of the post-hoc test are presented in Table 3. Accordingly, the microhardness values of the Orange juice and Cola groups were significantly decreased from baseline to 6 hours and from 6 hours to 48 hours after immersion. For the 15 % carbamide peroxide group, there was no significant difference between the microhardness values at baseline (before immersion) and after 6 hours of immersion (P=0.106). However, a significant decrease in the microhardness values was observed after 48 hours of immersion.

Table 1. Mean and standard deviations of microhardness values in the studied groups at different time points.

Groups	*Microhardness before test (Mean±SD)*	*Microhardness after 6 hours (Mean±SD)*	*Microhardness after 48 hours (Mean±SD)*	*P value $^{\beta}$*
Carbamide peroxide (15%)	*56.0±3.6*	*54.8±4.3*	*47.5±5.5*	*P<0.007**
Orange juice	*58.1±2.6*	*52.9±4.1*	*47.4±3.8*	*P<0.0001**
Cola	*57.3±3.7*	*50.3±2.5*	*45.4±3.5*	*P<0.0001**
Control	*55.2±4.0*	*54.3±4.5*	*53.5±3.2*	*P=0.144*
P value $^{\alpha}$	*P=0.279*	*P=0.068*	*P=0.001**	-

* Significant results: α One-way ANOVA test; β Repeated Measure ANOVA.

Table 2. Post-hoc pairwise comparison of the microhardness values of the four groups after 48 hours of immersion.

Groups		P value
Carbamide peroxide (15%)	Orange juice	P=0.958
	Cola	P=0.252
	Control	P=0.003*
Orange juice	Cola	P=0.274
	Control	P=0.002*
Cola	Control	P=0.0001*

* Significant results.

Table 3. Post-hoc pairwise comparison of the microhardness of 15%Carbamide peroxide, Orange juice and Cola groups at different time points.

Time		15% Carbamide peroxide	Orange juice	Cola
Before test	After 6 hours	P=0.106	P=0.004*	P=0.0001*
	After 48 hours	P=0.001*	P=0.0001*	P=0.0001*
After 6 hours	After 48 hours	P=0.004*	P=0.0001*	P=0.0001*

* Significant results.

Discussion

The results indicated that the microhardness values of the 15 % carbamide peroxide, Orange juice and Cola groups were significantly lower after 48 hours compared to the artificial saliva group. However, these differences were not statistically significant after 6 hours of immersion. When comparing the microhardness values of 15 % carbamide peroxide, Orange juice and Cola groups over time, as expected, these measures significantly decreased, except for the 15 % carbamide peroxide group, in which the mean microhardness value did not significantly decrease from baseline after 6 hours of immersion. However, there was a significant difference after 48 hours compared to baseline and 6 hours immersion.

Declining surface microhardness values result in poor wear resistance and a propensity for scratching, which may further compromise the longevity of the restoration [2]. Results showed that the composites' microhardness values decreased after 6 and 48 hours of immersion in the artificial saliva, but the decrease was not significant. These findings agree with Yap et al. and Ratto de Moraes et al. [19,20]. The hardness of the specimens in the current work increased after one day of immersion in distilled water, potentially causing additional crosslink reactions and completing the polymerization process in the resin matrix [21]. The high organic matrix of the micro-hybrid materials may be the reason for their increased susceptibility to water absorption and material disintegration. Conversely, the hydrophobic matrix of the resin composite materials may have prevented water absorption, thus contributing to the microhardness of the materials [21]. A Comparison of the microhardness values of the composites immersed in 15% carbamide peroxide showed a significant decrease from 6 hours to 48 hours of immersion. This result is consistent with those derived by Bristo et al. [22], Prabhakar et al. [23], Hatanaka et al. [24], Malkondu et al. (for some materials) [25], Zuryati et al. [26], and Alqahatani et al. [27]. In the bleaching process, carbamide peroxide is broken down into hydrogen peroxide and urea, which hydrogen peroxide generates per hydroxyl free radical.

These free radicals exhibit oxidizing potential and may affect a composite matrix, filler, or both. However, since the filler is often glass or ceramic, free radicals exert a mild effect on them; by contrast, a resin matrix (Bis-GMA or UDMA) may suffer from chemical degradation and reduce the hardness of composites through solubility [14]. In our study, the mean microhardness value of the 15% carbamide peroxide group did not significantly decrease from baseline after 6 hours of immersion. The presence of 1.1% fluoride and 3% potassium nitrate in the composition of our bleaching agent and its pH level (pH=7) attenuated the deteriorating effects of the bleaching agent on the composite's microhardness. This suggests that 15% carbamide peroxide gel can be utilized as a bleaching agent in cases with composite restorations for a limited amount

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of time without significant deterioration of microhardness. However, further investigation is required under conditions similar to the oral environment. Aparecido Fernandes et al. [11], Taib et al. [14], and Yap et al. [19] found that the hardness of samples did not change when exposed to bleaching agents. Malkondu et al. observed a significant increase in the microhardness of Filtek Supreme XT after Opalescence PF was used; this increase was attributed to continuing polymerization [25]. Studies have generated inconsistent results for the following reasons: the differences in types of restoration materials [15,27], the duration of use of the bleaching agents [20], the types and concentrations of bleaching agents [19], the kind of thickener [12], the pH levels of the bleaching agent [19,21], the types of hardness tests and loading amounts and durations [21,25], the composition of the composite resin [28] and employment of polished or unpolished composite resins [29]. In the present study, the microhardness of the composite samples immersed in orange juice and Cola significantly decreased after 6 and 48 hours of immersion. These results are similar to those of Wongkhantee et al. [7], NarsimhaVanga [30], Yanikoglu et al. [21], Hashemi Kamangar et al. [31], and Tanthanuch et al. [32].

Orange juice contains citric acid, and Cola contains phosphoric acid. The acidic compounds in these beverages influence composite properties, including surface hardness, through the hydrolytic breakdown of filler–silane bond particles or the hydrolytic degradation of filler materials [32]. Organic acids soften the Bis-GMA in a polymer's structure [7]. In addition, the remaining CO_2 bubbles in fresh beverages reduce the microhardness [31]. The effects of these beverages on the properties of composite materials depend on various factors, such as the type and duration of composite polishing technique, the temperature, acidic composition, and pH levels of the beverage [21,32], the duration of immersion and material dependence [6,32]. Clinically, the effects of the substances used in this work are dependent on the conditions of the oral environment, which cannot be replicated in vitro. Dental pellicles and oral hygiene habits can increase or decrease the effects of beverages [5,21]. The confounding effects of these conditions were not investigated in this study.

Conclusion

Despite the limitations of this in vitro study, the results indicated that:

The microhardness values of the 15 % carbamide peroxide, Orange juice and Cola groups were significantly lower after 48 hours compared to the artificial saliva group. However, these differences were not statistically significant after 6 hours of immersion. When comparing the microhardness values of 15 % carbamide peroxide, Orange juice and Cola groups over time, as expected, these measures significantly decreased, except for the 15 % carbamide peroxide group, in which the mean microhardness value did not significantly decrease from baseline after 6 hours of immersion. However, there was a significant difference after 48 hours compared to baseline and 6 hours of immersion. This suggests that 15 % carbamide peroxide gel can be employed as a bleaching agent in cases with composite restorations for a limited amount of time without significant deterioration of the microhardness. However, further investigation is required in this field.

Conflict of Interest

There is no conflict of interest to declare.

References

[1] Irmaleny, Hidayat OT, Khalidja D. The Hardness Differences between Packable Composite and Bulk Fill Composite. Journal of International Dental and Medical Research. 2022; 15(4): 1459-1464.

[2] Vejendla I, Hima Sandeep A, Pradeep S, Sahil Choudhari. In Vitro Evaluation of the Effects of Different Beverages on the Surface Microhardness of a Single-Shade Universal Composite. Cureus. 2023; 15(8): e43669.

[3] Bandeira de Andrade IC, Tarkany Basting R, Rodrigues JA, Flávia Lucisano BA, Turssi CP, Gomes França FM. Microhardness and color monitoring of nanofilled resin composite after bleaching and staining. Eur J Dent. 2014; 8 (2): 160-165.

[4] Hosseini Tabatabaei S, Sabaghi A. The Effect of Three Mouthwashes on Micro-Leakage of a Composite Resin-An in Vitro Study. Journal of American Science. 2013; 9(10s):13-19.

[5] Abuljadayel R, Mushayt A, Al Mutairi T, Sajini SH. Evaluation of Bioactive Restorative Materials' Color Stability: Effect of Immersion Media and Thermocycling. Cureus. 2023; 15(8): e43038.

[6] Ozkanoglu S, Akin E G G. Evaluation of the effect of various beverages on the color stability and microhardness of restorative materials. Niger J Clin Pract. 2020; 23(3): 322-328.

[7] Wongkhantee S, Patanapiradej V, Maneenut C, Tantbiroin D. Effect of acidic food and drinks on surface hardness of enamel, dentine, and tooth-coloured filling materials. J Dent. 2006; 34(3): 214-20.

[8] Redwan HS, Hussein MA, Abdul-Monem MM. Effect of Bleaching on Surface Roughness and Color Parameters of Coffee-Stained Nanohybrid Dental Composites with Different Viscosities. Eur J Gen Dent. 2024-05-13.

[9] Velasco Luque J, Zubizarreta-Macho A, Bartolomé JF, Kois JC, Revilla-LeónIntM. Effect of hydrogen peroxide-based bleaching agents on the color dimensions and surface roughness of different milled restorative dental materials. J Prosthodont. 2023; 5.

[10] Hosseini Tabatabaei S, Hosseini Tabatabaei MR, Naebi M, Sharafi M. The Effect of Bleaching Agents on Micro-Chemical Structure of Human Enamel by FTIR Spectroscopy Method (An in-vitro study). Sch. J. Dent. Sci (SJDS). 2015; 2(7): 416-421.

[11] Aparecido Fernandes R, Badaoui Strazzi-Sahyon H, Umeda Suzuki TY, Fraga Briso AL, dos Santos PH. Effect of dental bleaching on the microhardness and surface roughness of sealed composite resins. Restor Dent Endod. 2020; 45(1): e12.

[12] Nunes Gouveia TH, Juliana do Carmo Públio JD, Bovi Ambrosano GM, Luís Alexandre Maffei Sartini Paulillo LAM, Flávio Henrique Baggio Aguiar FH, Nunes Leite Lima DA. Effect of at-home bleaching with different thickeners and aging on physical properties of a nanocomposite. European Journal of Dentistry. 2016; 10(1): 82-91.

[13] Attia RM, Sobhy EM, El Said Abd El Hameed Essa M. Micro-Hardness and Surface Roughness of Bulk-Fill Composite Resin: Effect of Surface Sealant Application and Two Bleaching Regimens. Eur J Gen Dent. 2023; 12:169–176.

[14] Taib F, Ghani Z, Mohamad D. Effect of home bleaching agents on the hardness and surface roughness of resin composites. Arch Orofac Sci. 2013; 8(1): 1-7.

[15] Alaghehmand H, Esmaeili B, Sheibani SA. Effect of fluoride-free and fluoridated carbamide peroxide gels on the hardness and surface roughness of aesthetic restorative materials. Indian J Dent Res' 2013; 24:478-83.

[16] Salama F, Abdelmegid F, Alhomaidhi L, Alswayyed S, Alfarraj SH. Effect of Whitening Toothpastes and Brushing on Microhardness of Esthetic Restorative Materials. The Journal of Clinical Pediatric Dentistry. 2020; 44(5): 296-301.

[17] Nithya K, Sridevi K, Keerthi V, Ravishankar P. Evaluation of Surface Roughness, Hardness, and Gloss of Composites After Three Different Finishing and Polishing Techniques: An In Vitro Study. Cureus. 2020;12(2): e7037.

[18] Suryakumari NB, Reddy PS, Surender L, Kiran R. In vitro evaluation of influence of salivary contamination on the dentin bond strength of one-bottle adhesive systems. Contemporary clinical dentistry. 2011; 2(3): 160.

[19] Yap AUJ, Wattanapayungkul L. Effects of in-office tooth whiteners on hardness of tooth-colored restoratives. Oper Dent. 2002; 27: 137-41.

[20] Ratto de Moraes R, Marimon JLM, Schneider LFJ. Effects of 6 mounths of aging in water on hardness and surface roughness of two microhybrid dental composites. J of Prosthet. 2008; 17:323- 326.

[21] Yanikoglu N, Duymus ZY, Yilmaz B. Effect of different solution on the surface hardness of composite resin materials. Dental materials journal. 2009; 28(3): 344-351.

[22] Bristo AL, Tuñas IT, de Almeida LC, Rahal V, Ambrosano GM. Effects of five carbamide peroxide bleaching gels on composite resin microhardness. Acta Odontol Latinoam. 2010; 23(1): 27-31.

[23] Prabhakar AR, Sahana S, Mahantesh T. Effects of different concentrations of bleaching agent on the micro hardness and shear bond strength of restorative materials – An in vitro study. Journal of Dentistry and Oral Hygiene. 2010; 2(1): 7-14.

[24] Hatanaka GR, Abi-Rached Fd O, Almeida-Junior AA, Cruz CA. Effect of carbamide peroxide bleaching gel on composite resin flexural strength and microhardness. Braz Dent J. 2013; 24(3): 263-6.

[25] Malkondu O, Yurdaguven H, Say EC, Kazazoglu E, Soyman M. Effect of bleaching on microhardness of esthetic restorative materials. Oper Dent. 2011; 36:177-186.

[26] Zuryati AG, Qian OQ, Dasmawati M. Effects of

 DOI:

home bleaching on surface hardness and surface roughness of an experimental nanocomposite. J Conserv Dent. 2013; 16(4): 356-61.

[27] Alqahatani MQ. The effect of a 10% carbamide peroxide bleaching agent on the microhardness of four types of direct resin-based restorative materials. Oper Dent. 2013; 38(3): 316-23.

[28] Isabele Vieira, Laura Nobre Ferraz, Waldemir Francisco Vieira Junior, Carlos Tadeu Dos Santos Dias, Débora Alves Nunes Leite Lima. Effect of at-home bleaching gels with different thickeners on the physical properties of a composite resin without bisphenol A. J Esthet Restor Dent. 2022; 34(6): 969-977.

[29] Ramírez-Vargas GG, Medina Y Mendoza JE, Aliaga-Mariñas AS, Ladera-Castañeda MI, Cervantes-Ganoza LA, Cayo-Rojas CF. Effect of Polishing on the Surface Microhardness of Nanohybrid Composite Resins Subjected to 35% Hydrogen Peroxide: An In vitro Study. J Int Soc Prev Community Dent. 2021; 11(2): 216-221.

[30] Narsimha, Vanga V. Effect of Cola on Surface Microhardness and Marginal Integrity of Resin Modified Glass Ionomer and Compomer Restoration -- An in vitro Study. People's Journal of Scientific Research. 2011; 4 (2): p34.

[31] Hashemi Kamangar SS, Ghavam M, Mirkhezri Z, Karazifard MJ. Comparison of the Effects of Two Different Drinks on Microhardness of a Silorane-based Composite Resin. J Dent Shiraz, 2015; 16(3): 260-266.

[32] Tanthanuch S, Kukiattrakoon B, Siriporananon C, Ornprasert N, Mettasitthikorn W, Likhitpreeda S, and Waewsanga S. The effect of different beverages on surface hardness of nanohybrid resin composite and giomer. J Conserv Dent. 2014; 17(3): 261–265.