ORIGINAL ARTICLE

Composite resin in the last 10 years – literature review. Part 5: pigmentation and aging

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ABSTRACT: Introduction: This is the fifty of six articles which present a general view about composite resins in the last 10 years. Composite resins were created with the aim of restoring damaged tooth structures, improving function and esthetic of a smile. Despite of their excellent mechanical properties, composites are exposed to different processes of aging in the oral cavity, which can decrease the longevity of the restorations. The aim of this study was to synthesize and describe the main factors related with pigmentation and aging of composite resins and how these factor can influence the material longevity. **Methods:** After an extensive search in Medline/PubMed using specific terms for each evaluated factor, 32 articles were included in this review. Then, the data extraction and the results evaluation were performed. **Results:** All evaluated composite resins presented color alteration after pigmentation procedures. The red wine and the coffee were the substances that showed the higher power of pigmentation. On the other hand, for both methods (immersion and photoaging), all composite resins aged with time. **Conclusion:** The longevity of composite resins is influenced by aging and color alteration caused by pigmentation. These factors must be properly considered and managed by the dentist in order to avoid long-term failure of composite resin restorations.**Keywords:** Composite Resin. Color stability. Staining. Aging.

INTRODUCTION

Composite resins have been in the dental market for over 50 years. This material can be used to restore anterior and posterior teeth, functionally and aesthetically.[1] However, in recent years, the aesthetic demand of patients has increased, so the development of restorative materials with high esthetic and good longevity was necessary.[2]

The clinical success of direct aesthetic restoration is dependent of two main factors: correct reproduction of the shape and color stability of the material.[2,3] Nowadays, it is possible to reproduce dental structures with composite resins by managing color, translucency, opacity, surface texture, reflectance and transmittance of light. These properties and characteristics can be applied in anterior restorations to create a natural looking smile.[4,5]

However, some situations influence the quality and the longevity of composite resin restoration, such as the material color alteration. The color alteration may occur due to the action of intrinsic and/or extrinsic factors.[6,7] Intrinsic factors are associated with composite composition, physical-chemical reactions, water sorption and quality of polymerization. On the other hand, the extrinsic factors are related with absorption of pigments from drinks and foods, mouth rinses with chlorhexidine, smoking, oral hygiene and inadequate finishing and polishing of restorations.[6,7] The surface and adhesive interface degradation are associated with these factors and can also cause color alterations.[8]

In most cases, the color alteration can be identified clinically, but it cannot be quantified. For this reason, the researchers used a color system analysis to evaluate numerically the effect of aging and pigmentation from foods and drinks in the color alteration of the material.[3]

Thus, this literature review aimed to synthesize and describe the main factors related with pigmentation and aging of composite resins and how these factor can influence the material longevity. Moreover, the information about color alteration will be available and more accessible to the dentist.

MATERIALS AND METHODS

An extensive search on the database Medline/PubMed was performed using the association of mesh terms and specific keywords for each factor evaluated. The used words were “composite resins”,

"shade", "color", "colour", "pigmentation", "pigmentations", "discoloration", "pigments", "stain", "colorimetric analysis", "spectrophotometric", "dental aging" and "resin aging". The studies included were only laboratorial researches in English language published between 2007 and 2018. In the initial search, 1040 articles were found. After reading the titles and abstracts, 150 were selected to read the full text. Then, the texts were analyzed and 32 articles were included for this literature review. The data were extracted and organized in tables, in order to show the results obtained in each study according with the factors: pigmentation and aging. The results of color alteration were expressed in ΔE, following the CIELab color system that calculate color variation in the axes L (luminosity), a (green-red) and B (blue-yellow).

RESULTS

Table 1 describes the results of aging factors of composite resins. The studies used immersion protocols in different substances and photoaging to age the samples. There was no difference in the results for both methodologies. The composite resin Filtek Z350 was the most evaluated, showing ΔE values between 1.78 and 26.7. The composite resins for bleached teeth (vitta shade color A1 and B1) presented the highest color alteration. So, the initial color of the composite influence in the color variation after aging procedures.

Table 2 shows the results of pigmentation of composite resins after immersion in different substances. More than 30 immersion solutions were used and all caused some pigmentation on the composite resins tested. The substances that caused the greatest pigmentation were, respectively, red wine, coffee and tea. The time of immersion was between 24 hours and 6 months. The composite Filtek Z350 (or Filtek Supreme) was again that most evaluated and showed an extensive variation on the ΔE (1.63 to 31.3) when immersed in coffee.

Table 1: Characteristics of studies in relation to the aging factor.

AUTHOR	YEAR	COMPOSITE RESINS	AGING METHODOLY	ΔE (STANDARD DEVIATION)	CONCLUSION
Paravina et al.[9]	2004	Synergy Super White O Synergy Super White P Renamel Universal SB1 Renamel Universal SB2 Vitalescence PF Renamel Universal SB3 Synergy Super White N Renew B0 Tetric Ceram Bleach XL TPH Spectrum BW Vitalescence PA Charisma SLO Esthet X White Vitalescence PN Charisma SL Tetric Ceram Bleach L Charisma SLT 3-D Direct 0M2 Esthet X XL 3-D Direct EN2 Durafill VS SL Filtek Z250 Point 4 XL3 Point 4 XL1 Filtek A110 Herculite XRV B1 Durafill VS SLO Renamel Microfill SB2 Durafill VS SSL Renamel Microfill SB1 Renamel Microfill SB3 3-D Direct 1M2 3-D Direct OP0M2 Point 4 XL2 TPH Spectrum XL	180 cycles in accelerated aging chamber	8,6 (0,6) 7,9 (0,6) 7,8 (0,2) 7,8 (0,1) 7,7 (0,4) 7,6 (0,2) 7,5 (0,5) 6,3 (0,3) 5,2 (0,6) 4,9 (0,4) 4,6 (0,4) 4,3 (0,4) 4,2 (0,2) 4,1 (0,4) 4,0 (0,4) 3,9 (0,3) 3,8 (0,2) 3,7 (0,4) 3,5 (0,2) 3,4 (0,2) 2,7 (0,3) 2,4 (0,4) 2,3 (0,4) 2,2 (0,2) 2,2(0,3) 2,2 (0,3) 2,1 (0,5) 2,1 (0,3) 2,0 (0,2) 1,8 (0,3) 1,7 (0,2) 1,6 (0,6) 1,5 (0,4) 1,3 (0,4) 0,7 (0,2)	The test showed greater aging for the microhibrid composites, revealing a significant color change. The microparticulate composites did not show any change of color.
Furuse et al.[10]	2008	QuiXfil Tetric EvoCeram Filtek Silorane Herculite XRV	192 hours of photoaging	6,58 (0,19) 4,65 (0,19) 1,70 (0,45) 1,46 (0,23)	The Quixfil and Tetric EvoCeram composites presented a greater color change, while the Herculite XRV and Filtek Silorane composites exhibited the lowest change.
Gaintantzopoulou et al.[11]	2009	TPH Spectrum/One-Up Bond F TPH Spectrum/Optibond Solo Plus TPH Spectrum/Adper Prompt L-Pop	30 days immersion in water/ 360 hours of photoaging	Immersion in water 4,4 (0,8) 3,0 (0,5) 2,9 (0,4) Photoaging 3,8 (0,9) 3,2 (0,9) 2,8 (0,5)	The TPH spectrum composite when associated with the One-Up bond showed the highest values of color change for both methods.
Hosoya et al.[12]	2009	Filtek Supreme XT Clear Estelite **Σ** Inc Filtek Supreme XT A2E Estelite **Σ** OA2 Filtek Supreme XT A2B Estelite **Σ** C2 Estelite **Σ** A2 Estelite **Σ** OA3 Filtek Supreme XT A3B Estelite **Σ** A3 Estelite **Σ** B3 Filtek Supreme XT C2B Filtek Supreme XT A2D Filtek Supreme XT A3D	Stored for 1 year in a container with 100% humidity	7,07 2,93 2,54 2,43 1,97 1,82 1,77 1,70 1,56 1,49 1,49 1,43 1,30 1,10	The color change is influenced by the color of each composite resin. Filtek Supreme XT Clear showed the highest values of ΔE.

Table 1 (continuation): Characteristics of studies in relation to the aging factor.

AUTHOR	YEAR	COMPOSITE RESINS	AGING METHODOLY	ΔE (STANDARD DEVIATION)		CONCLUSION
Pires-de-Souza et al.[13]	2011	P90 Filtek Z350 Esthet X Filtek 250	348 hours of accelerated artificial aging	18,6 (2,20) 9,82 (1,20) 9,21 (5,00) 8,66 (2,35)		After aging, all composite resins exhibited color change above the clinically acceptable levels.
Celik et al.[14]	2011	Clearfil Majesty Esthetics Gradia Direct Filtek Z250 Tetric Evo Ceram Premise Ceram X Duo Esthet X Filtek Supreme XT Tetric N Ceram SpectrumTPH3	Immersed for 30 days in distilled water	6,29 (1,40) 4,11 (1,09) 3,44 (1,42) 2,31 (0,39) 2,22 (1,97) 2,19 (0,79) 1,94 (0,79) 1,78 (0,27) 1,6 (0,45) 1,26 (0,78)		The highest color change was presented by Clearfil Majesty Esthetics and the lowest by SpectrumTPH3.
Drubi-Filho et al.[15]	2012	Tetric Ceram Filtek P90 Filtek Z250	300 hours of accelerated artificial aging	3,33 (0,52) 3,06 (0,36) 1,38 (0,66)		The Tetric Ceram presented the lowest color stability, followed by Filtek P90 and Filtek Z250.
Diamantopoulou et al.[16]	2013	Filtek Supreme XT Dentine A1 Enamel Plus Hri Dentine UD1 IPS Empress Direct Dentine A1 Miris 2 Dentine S1 TPH Spectrum A1 Miris 2 Enamel WB Enamel Plus Hri Enamel UE3 Filtek Supreme XT Dentine A1 IPS Empress Direct Enamel A1	Immersed for 30 days in distilled water	7,94 (0,62) 4,68 (0,29) 4,32 (0,20) 4,20 (0,31) 3,33 (1,21) 3,16 (1,07) 2,70 (0,74) 2,13 (0,87) 1,90 (1,10)		The test revealed significant changes in color after one month of water aging for Filtek D A1 (dentin), Miris S1 (dentin) and Miris WB (enamel).
Uchimura et al.[17]	2014	Charisma Opal Filtek Z350 XT Opallis	Stored dry or in artificial saliva 21 days	Dry 3,76 (0,25) 2,84 (0,30) 2,16 (0,13)	Artificial Saliva 3,89 (0,31) 2,87 (0,15) 2,18 (0,30)	After 21 days there was a small change in color for both methods, and saliva storage caused the highest change.
Oliveira et al.[8]	2014	Filtek Z350 XT IPS Empress Direct	300 hours of accelerated artificial aging	26,7 (4,2) 20,6 (3,9)		IPS showed greater color stability, but both composites had significant color change.
Ceyhan et al.[18]	2014	Filtek Supreme Ultra Flow A1 Filtek Supreme Ultra Flow A3 Filtek Z250 A3 Filtek Z250 A1 Tetric EvoFlow A1 Tetric EvoFlow A3	180 cycles in accelerated aging chamber	4,0 (0,2) 3,5 (0,8) 2,0 (0,7) 1,6 (0,2) 1,2 (0,3) 0,9 (0,3)		The Tetric EvoFlow presented the lowest values of ΔE, followed by Filtek Z250 and Filtek Supreme Ultra Flowable.
Iskander et al.[19]	2015	Filtek Z350 XT B1 Filtek Z350 XT A3	Xenon light	50 hours 5,43 (0,43) 3,83 (0,27)	100 hours 7,19 (0,54) 4,67 (0,39)	The B1 composite resin presented the greatest color change after aging.
Mansouri et al.[20]	2018	Filtek Z250 XT Filtek Bulk-Fill	Immersion in water for 56 days	2,48 (0,78) 1,43 (0,83)		Bulk-Fill composites presented greater color change, but the change was clinically acceptable.

Table 2: Characteristics of the studies in relation to the pigmentation factor.

AUTHORS	YEAR	COMPOSITE RESINS	IMMERSION TIME
Fontes et al.[21]	2009	Filtek Z350 A2E	4h for 7 days
Park et al.[22]	2010	Ceram X Grandio Filtek Z350 XT	21 days
Nasim et al.[23]	2010	Helimolar Spectrum TPH Filtek Z350	30 days
Mundim et al.[24]	2010	Esthet X SureFil Filtek Z250	15 days
Lepri et al.[25]	2012	Filtek Z250	30 days
Erdemir et al.[26]	2012	Clearfil Majesty Posterior Filtek Supreme Clearfil APX Filtek Z250	6 months
Arocha et al.[27]	2013	Filtek Silorane Filtek Z250 Tetric EvoCeram Venus Diamond Grandio	30 days
Falkensammer et al.[6]	2013	Tetric Evoceram Gradia Direct Anterior	28 days
Al-Samadani KH[28]	2013	Filtek Z350 XT Artist GC Fuji 2 Filtek Z250	30 days
ElEmbaby et al.[2]	2014	Tetric Evo Ceram Filtek Z350XT IPS Empress Direct	24 hours
Farah et al.[7]	2014	Filtek Z350XT Tetric N Ceram	7 days
Spina et al.[29]	2015	Herculite Classic Durafill VS Luna	30 days

IMMERSION SUBSTANCE ΔE (STANDARD DEVIATION)					CONCLUSION
Coffee 9,1 (2,5)		Mate herb 8,0 (0,7)		Grape juice 17,6 (1,5)	Grape juice was the drink that caused the most pigmentation.
Coffee 4,0 (0,3) 5,3 (0,5) 3,4 (0,8)	Green tea 1,8 (0,3) 2,7 (0,5) 1,9 (0,4)	Distilled water 1,9 (0,1) 1,7 (0,5) 2,6 (0,2)		Alcohol 50% 2,1 (0,3) 2,0 (0,4) 1,7 (0,1)	Of all the tested solutions, coffee was the one that presented clinically unacceptable pigmentation. There was no difference between the composites.
Indian Tea 0,93 (0,03) 1,03 (0,02) 2,60 (0,04)		Pepsi 2,31 (0,02) 0,89 (0,02) 0,43 (0,02)		Distilled water 2,50 (0,02) 1,56 (0,02) 1,12 (0,02)	The composite Filtek Z350XT had a greater color change when immersed in tea, whereas the Helimolar presented the highest change in both distilled water and Pepsi.
Coffee 3,67 (0,64) 3,57 (0,98) 4,85 (1,33)		Coke 1,10 (0,26) 0,79 (0,40) 0,81 (0,16)		Distilled water 0,66 (0,19) 0,33 (0,08) 0,38 (0,14)	Coffee was the substance that caused most changes in color for all composite tested.
Schweppes 1,963 (0,54)	Ypióca Lemon 1,769 (0,52)	Red Wine 6,727 (0,78)		Artificial Saliva 0,712 (0,30)	Red wine promoted the highest pigmentation, followed by schweppes and Ypióca. .
Powerade 4,95 (0,50) 6,62 (0,65) 8,52 (0,53) 7,47 (0,35)	Red Bull 5,41 (0,80) 6,70 (0,41) 8,75 (0,38) 8,46 (0,39)	Burn 6,97 (0,41) 8,77 (0,58) 9,95 (0,29) 9,24 (0,71)		Distilled water 2,91 (0,28) 3,95 (0,36) 5,11 (0,48) 5,44 (0,53)	All composites had significant color change in all solutions except for the Clearfil Majesty Posterior, that presented no significant change in distilled water.
Coffee 7,6 (3,4) 20,1 (2,3) 23,7 (2,3) 16,4 (1,5) 29,9 (9,1)	Black Tea 12,9 (3,6) 16,9 (5,9) 29,1 (3,5) 12,7 (2,3) 19,0 (6,1)	Red Wine 8,1 (1,5) 30,2 (7,7) 26,3 (8,5) 16,4 (4,7) 23,8 (4,8)	Coke 2,9 (0,7) 1,4 (0,2) 3,6 (0,6) 2,9 (0,5) 2,6 (0,5)	Orange Juice 3,4 (1,2) 7,3 (1,8) 3,3 (1,0) 3,8 (0,6) 3,9 (0,8)	The highest color change was found on Filtek Z250 when immersed in red wine, and the lowest color was found on the same composite, but when immersed in Coke.
Black Tea 2,5 (1,0) 2,5 (0,5)	Red Wine 13,0 (2,0) 19,0 (2,5)	Chlorhexidine 1,0 (0,5) 0,5 (0,1)	Sodium Fluoride 2,0 (0,5) 1,8 (0,2)	Distilled water 1,5 (0,5) 1,5 (0,2)	Of the beverages tested, the red wine caused the greatest color change. Oral rinses did not produce significant color change.
Arabic Coffee 2,90 2,83 3,27 2,92	Turkish Coffee 1,63 1,41 1,29 1,07	Nescafé (soluble coffee) 0,67 0,59 0,68 0,58	Distilled water 0,12 0,13 0,23 0,12		After 30 days, the composites immersed in Arabica coffee showed the highest pigmentation in the GC Fuji 2 composite.
Antiseptol 6,38 (0,28) 1,72 (0,45) 0,61 (0,17)	Flucal 15,27 (0,40) 4,53 (0,25) 2,59 (0,29)	Listerine 9,41 (0,37) 2,90 (0,23) 1,25 (0,10)			For all solutions, the Tetric EvoCeram caused the greatest color change, being clinically unacceptable.
Coffee 15,87 (0,45) 11,83 (0,49)	Black tea 12,52 (0,29) 8,87 (0,34)	Distilled water 0,39 (0,22) 0,91 (0,36)			Tetric Nceram showed a lower color change than the Filtek Z350 XT for all beverages.
Coffee 2,68 (0,71) 3,81 (0,50) 4,85 (0,51)	Coke 1,97 (0,73) 2,27 (0,23) 4,38 (0,37)	Wine 5,30 (1,36) 6,78 (1,03) 8,07 (0,53)	Water 1,83 (0,35) 2,36 (0,95) 3,59 (0,35)		The Luna composite presented the greatest color change for all beverages and Herculita the smallest. For all the composites, the red wine caused more pigmentation.

Table 2 (continuation): Characteristics of the studies in relation to the pigmentation factor.

AUTHORS	YEAR	COMPOSITE RESINS	IMMERSION TIME
Gregor et al.[30]	2016	Filtek Silorane Ceram X Duo Tetric EvoCeram Dyract	99 days
Arregui et al.[31]	2016	Premise Flowable Vertise Flow Sonic Fill Venus Bulk Fill Venus Diamond Flow Tetric Evoflow SDR Filtek Supreme XTE Filtek Bulk Fill	21 days
Ardu et al.[4]	2017	Estelite Posterior ELS Saremco Filtek Supreme Inspiro SN Venus Diamond Miris 2 NR Filtek Silorane	28 days
Antonov et al.[32]	2016	Gradia Direct	14 days
Habib et al.[33]	2017	Grandio SO Filtek Z350XT Filtek Z250 XT	7 days
Choi et al.[34]	2018	Filtek Z250 Dyract Beautifill 2	5 days
Tavangar et al.[35]	2018	Filtek Supreme Filtek Z250 Rok	7 days

IMMERSION SUBSTANCE ΔE (STANDARD DEVIATION)						CONCLUSION
Coffee 3,4 23,6 16,1 8,9	Coke 2,4 2,3 1,5 9,2	Orange Juice 2,4 10,3 3,9 6,0	Black Tea 2,9 10,4 8,0 2,0	Red Wine 1,8 27,9 21,7 11,0		All samples presented color change after the immersion period, and the Ceram X Duo presented the highest change for all beverages.
Coffee 16,16 14,43 16,31 33,64 28,37 15,35 25,96 14,29 21,66	Black Tea 14,06 4,68 18,10 32,55 29,11 25,17 17,37 9,11 28,30	Coke 1,65 2,10 2,75 8,83 1,81 1,10 3,17 1,17 2,19	Orange Juice 4,67 2,74 7,38 5,45 5,74 6,73 7,14 5,6 10,51	Red Wine 10,65 21,58 14,25 29,81 31,13 28,28 27,38 8,28 29,56		In distilled water, Filtek Bulk Fill exhibited the lowest ΔE, in coffee and red wine was the Filtek Supreme XTE Flow that presented the lowest values. For immersion in Coca-Cola, tea and orange juice, the Tetric EvoFlow and Vertise Flow resin presented the lowest values of ΔE, respectively.
Coffee 15,4 31,7 23,2 31,3 27,6 29,3 20,4 6,6	Black tea 9,9 15,9 13,3 20,1 15,1 19,6 12,2 5,1	Orange Juice 5,2 5,3 4,3 6,6 9,0 5,8 6,0 3,9	Coke 2,0 2,6 2,4 3,2 7,0 3,8 2,2 3,6	Red Wine 29,0 46,7 49,0 50,3 47,0 44,6 52,4 45,9	Saliva 1,9 2,4 5,3 3,8 2,6 1,5 1,8 3,3	When immersed in coffee, the Filtek Silorane showed the lowest color change, while Venus Diamond, ELS and Filtek Supreme had the highest values. For immersion in Coca-Cola and orange juice, the Estelite Posterior showed lower variations, while Inspiro SN showed the highest values. In red wine, Estelite Posterior presented the lowest results, while Saremco Microhybrid and Filtek Supreme presented the the highest values.
Bernard 9,0 (0,8)	Guinness 7,2 (0,6)	Erdinger 6,5 (0,5)	Leffe 5,1 (0,6)	Tuborg 4,8 (0,3)	Distilled water 0,4 (0,1)	The Bernard beer generated greater color change and Tuborg the lowest.
Chocolate milk 6,24 (1,96) 2,81 (1,07) 3,34 (1,66)	Strawberry Juice 3,98 (3,08) 4,83 (2,31) 4,44 (1,79)	Orange soda 6,17 (3,06) 3,27 (2,64) 3,98 (1,77)	Distilled water 4,21 (1,41) 3,86 (1,41) 2,77 (1,70)			All beverages had the potential to change the color of composite resins. Filtek Z250 XT and Grandio resin had the highest and lowest color change, respectively.
Coke 0,65 (0,47) 3,40 (0,96) 3,76 (1,88)	Orange Juice 1,15 (0,69) 1,98 (0,90) 2,02 (0,88)	Coffee 3,58 (0,40) 4,30 (0,80) 4,85 (0,85)	Energy Drink 1,64 (0,26) 3,05 (1,71) 2,87 (1,02)	Mineral Water 2,45 (0,73) 1,82 (1,34) 0,65 (0,46)		The coffee caused the highest change of color for all tested composites. The Filtek Z250 resin presented a clinically unacceptable change only in coffee.
Coke 1,80 (0,38) 2,80 (0,29) 2,60 (0,35)		Coffee 5,80 (0,43) 3,40 (0,33) 5,20 (0,44)		Distilled water 1,70 (0,38) 1,20 (0,26) 1,80(0,30)		All composites presented color change, however the composites immersed in coffee showed a unacceptable clinically alteration.

DISCUSSION

This study evaluated several articles about color alteration with the aim of analyses all the information and give to the dentist the knowledge needed to improve the performance and the longevity of composite resin restorations.

The Table 1 results show that all the composite resins presented color alteration when submitted to aging procedures. The color alteration after a period is usually related with the chemical composition of composites. In dentistry, the most used photoinitiator system is the camphorquinone associated with third amines as co-initiator. This system may cause yellowing of the composite after time, as shown in the photoaging tests.[15] Moreover, after polymerization some non-reacted amines can also reduce the color stability of composite resins.[36] Some composites have iodine salt in the composition to improve the photopolymerization process. This compound can react with the non-reacted amines and promote the formation of new amines that will oxidize and cause color alteration with time.[13,37] Another factor that can promote color alteration is the unsatisfactory polymerization of the composite resins. The incomplete polymerization generate lower degree of conversion and the unconverted chemical bonds can oxidize over time, causing color alteration.[16] The relation between the degree of conversion and the photoinitiator systems is described in the Part 3 of this literature review.

The composition of composites may also modified the water sorption by the material, which can provide color alteration. The monomers TEGDMA, which are very hidrofilic, attract more water if compared with the Bis-GMA and UDMA monomers.[13] Furthermore, the size of the particles affects the water penetration between the molecules, increasing the water sorption.[14] Another factor that can increase water sorption is the association of composites and acid bond systems.[11] The Part 1 of this literature review discusses the composition of composite resins and their characteristics in detail.

Beyond the aging process, the composite resins can also pigmented by the action of different substances. All the composite resins evaluated in this review presented color alteration, regardless chemical composition of the material. However, studies shown that the particle size is directly related with pigmentation, because it allows pigments of drinks and foods to penetrate into the material even after the polymerization. Thus, large particles promote greater pigmentation than small particles.[26]

The sorption of liquids containing pigments are influenced by hydrophilic monomers, as in the water sorption of aging procedures.[27,38] The restoration surface also affects the pigmentation process. Composite resins with higher surface roughness presented greater pigmentation, because the fixed pigments in the surface grooves are difficult to clear and remove. [23] Acid drinks can also change the composite resin surface and the organic matrix composition, which increases the pigments on the surface and promotes color alteration.[33] The red wine has acid pH and many pigments particles that cause higher pigmentation.[6,25]

The difficulty to find articles that used the same standardization of samples and storage conditions was a limitation of this literature review. Although many studies used the same immersion substances, the time and the protocols performed in the studies presented great variation, which made it difficult to compare the results. Thus, more standardized studies are necessary to compare the results. This literature review selected only laboratory studies, so the results obtained may not represent the clinical reality. Future investigations involving randomized clinical trials should be performed in order to verify the data obtained in this review.

The composite resins are used in the daily routine of the dental clinics. It is important to know the factors related with their color change to increase the longevity of the restorations. To avoid color alteration due to aging, it is necessary to perform a proper polymerization of the material and chose composites with smaller particles to avoid the water penetration. In addition, it is recommended to perform a correct protocol of finishing and polishing with periodic follow-up appointments, and to advise the patient about the effect of foods and beverages, in order to manage the pigmentation of restorative materials.

CONCLUSION

Within the limitations of this study, it can be conclude that the color alteration due to the presence of pigments and the aging influences the longevity of composite resin restorations. These factors must be properly considered and managed by the dentist in order to avoid the failure of composite resin restorations.

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