The chameleon effect of monochromatic composite resin: A systematic review and meta-analysis

ABSTRACT

Aims: The aim of this systematic review was to evaluate the optical properties of monochromatic composite resins and conventional composite resins in direct restorations in permanent teeth.
Study design:A systematic review and meta-analysis.
Methodology: The searches were carried out in July and August, in the following databases:: Medline (PubMed), Web of Science, ScienceDirect and Google Scholar. The articles were selected, first by title, followed by reading the abstract and finally the complete work. Two independent meta-analyses were performed using Review Manager 5.4 software.
Results: Two hundred and eleven articles were found, 6 articles were included in this systematic review and, among these, 4 were included in the meta-analysis. The meta-analysis when comparing monochromatic resins and conventional composite resins, using color stability data showed greater optical performance of the monochromatic resin for subgroups A2 and A3. After analyzing the age data according to the Coffee and Tea subgroups, the monochromatic resin showed no statistical difference. For color variation during bleaching, the monochromatic resin showed statistically lower color variation. For color matching, conventional resins showed higher shade matching ability compared to monochromatic composite.
Conclusion: Therefore, the monochromatic resin presented greater color stability in shades A2 and A3 and presented better results in terms of color variation compared to the conventional composite resin after bleaching.

Keywords - Composite Resin; Color; Monochromatic Resin; Chameleon Effect; Unicromatic Resin.

1. INTRODUCTION

Composite resins are defined as the three-dimensional combination of at least two chemically different materials with a distinct interface separating these components, namely an organic matrix combined with an inorganic filler and a bonding agent that adheres to both the inorganic portion and the matrix. This definition is part of a comprehensive study on aesthetic restorative materials conceived by Dr. Rafael Bowen in the late 1950s, which culminated in one of the main composites marketed and used currently in dental clinics, namely bisphenol glycidyl methacrylate (Bis-GMA) enhanced with inorganic filler particles. This new hybrid molecule showed high molecular weight, reduced polymerization shrinkage, increased rigidity, and rapid setting reaction, thus reinforcing the improvement of the physical and chemical properties of composite resins used for restorations [1].

Thus, composite resins have become the material of choice in Restorative Aesthetic Dentistry due to their characteristics, making them adaptable to different clinical situations. Additionally, their longevity, good resistance, adhesion to dental structure, ease of handling, aesthetic nature, and biocompatibility, combined with affordability, have made them a highly viable treatment modality in light of the increasing aesthetic demand of today's society, promoting the well-being and self-esteem of patients seeking dental harmony [2]. However, presently, due to the current demands for improvement of this material, there is a wide variety of composite resins available on the dental market, which makes it challenging for professionals to choose the best option for clinical use. This is particularly true when it comes to color selection, a crucial step in restorative treatment [3].

Therefore, aiming to simplify aesthetic restorations, reduce clinical time, avoid mistakes due to wrong color selection, and minimize expenses on purchasing various composite resins, as well as to achieve patient satisfaction and promote technological advancement within the field of dental materials, the monochromatic resin with a chameleon effect emerged. This resin has the ability to mimic the natural color of the tooth, eliminating the color selection step of a conventional restoration [4]. Also known as metamerism. These resins, also called chameleon composites, exhibit high translucency and have only one shade, making them suitable for all restorative classes using the "Wide Color Matching" concept with the application of just one syringe [5]. It is important to note that tooth color is created by the interaction of light with the optical properties of enamel and dentin. A monochromatic resin, with its unique opacity, acts as an intermediary between these two layers, allowing it to present a color similar to the patient's natural tooth.

However, one of the obstacles to asserting the effectiveness and clinical applicability of monochromatic resins is the scarcity of studies on this subject. In this regard, the aim of the article was to conduct a systematic review and meta-analysis to evaluate and compare the laboratory efficacy of monochromatic composite resins compared to conventional composite resins in direct restorations in permanent teeth.

2. METHODOLOGY

2.1 Study Description

The present systematic review was conducted following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) [6] guidelines and was registered in the International Prospective Register of Systematic Reviews (PROSPERO; CRD42023451739). The PICO (Patients/Population; Intervention; Comparison; Outcomes) process was used to formulate the research question: In in vitro studies with permanent teeth (P), do composite resins (monochromatic) exhibiting chameleon effect (I) when compared to conventional resins (C) show better results regarding optical properties (O)?

2.2 Literature Search and Information Sources

The search was carried out in July and August 2023, in the following databases:Medline (PubMed), Web of Science, and ScienceDirect. Additionally, grey literature was assessed through Google Scholar. The search strategy used was as follows: PubMed and Web of Science: (Monoshade OR "Single-Shade" OR "Chameleon effect") AND (Composite Resin OR Resin, Composite OR Resins, Composite OR Materials, Dental OR Dental Material OR Material, Dental) AND (Colors OR Color OR Esthetics, Dental OR Esthetic, Dental OR Dental Esthetic OR Dental Esthetics OR color matching OR structural color OR shade matching OR blending OR optical properties). ScienceDirect and Google Scholar: (Monoshade OR "Single-Shade" OR "Chameleon effect") AND ("Composite Resin" OR Resin, Composite OR Resins, Composite).

2.3 Study Selection and Eligibility Criteria

Two researchers (CPAG and EMBO) independently conducted the search protocol and compiled the references using EndNote version X7 software (Clarivate Analytics©, 22 Thomson Place). Duplicates were removed in the initial stage. Subsequently, selection was performed by reading the titles, followed by reading the abstracts, and finally, the full articles were reviewed. At this stage, it was determined which studies should be included in the present systematic review. In cases of disagreement, a third author (CTPA) was consulted.

2.3.1 Inclusion Criteria

(1) Laboratory trials on permanent teeth that included tests evaluating any type of optical property in monochromatic resins, with conventional composite resins as the control group;
(2) There were no language or date restrictions.

2.3.2 Exclusion Criteria

(1) Case reports, case series, editorials, conference abstracts, dissertations, theses, pilot studiesand reviews;
(2) Studies that did not compare single-shade composite resin with multi-shade composite resin;
(3) Studies using acrylic teeth, composite resin disks, or indirect ceramic block restorations.

2.4 Data Extraction

When available, the following data were extracted from the included studies: year and country of publication, study design, objective, methodology, results, and conclusions.

2.5 Quality Assessment

To assess the quality of the included studies, the RoBDEMAT tool was used, which considers four domains to estimate the risk of bias: D1 – allocation and planning bias (control group, sample randomization, and sample size justification); D2 – sample preparation bias (sample standardization and identical sample materials and experimental conditions between groups); D3 – outcome assessment bias (adequate and standardized test procedures and results, and operator blinding); and D4 – data treatment and outcome reporting bias (statistical analysis and result reporting). Thus, the risk of bias for each study was classified for each domain as adequate/sufficiently reported, insufficiently reported (no information or uncertain), or not adequate/not reported.

2.6 Statistical Analysis

Two independent meta-analyses were conducted with the data on color stability and color change after bleaching using Review Manager 5.4 software (The Nordic Cochrane Centre, The Cochrane Collaboration, Copenhagen, Denmark). Regarding color stability, the data were divided into subgroups according to tooth color and conventional resin color (A2 or A3) and according to the aging method (coffee or tea). The statistical method chosen was the Inverse Variance, and a random-effects model was used. The effect measure employed was the mean difference (MD) with a 95% confidence interval. Heterogeneity was assessed using the I2 test.

3. RESULTS

Figure 1 shows the flowchart for the article selection process [6]. The search strategy yielded a total of 211 articles. After excluding duplicates, titles were screened, followed by abstract readings. 31 articles were selected for full-text analysis, of which only 6 studies met the eligibility criteria and were included in this review, and 4 entered the meta-analysis.

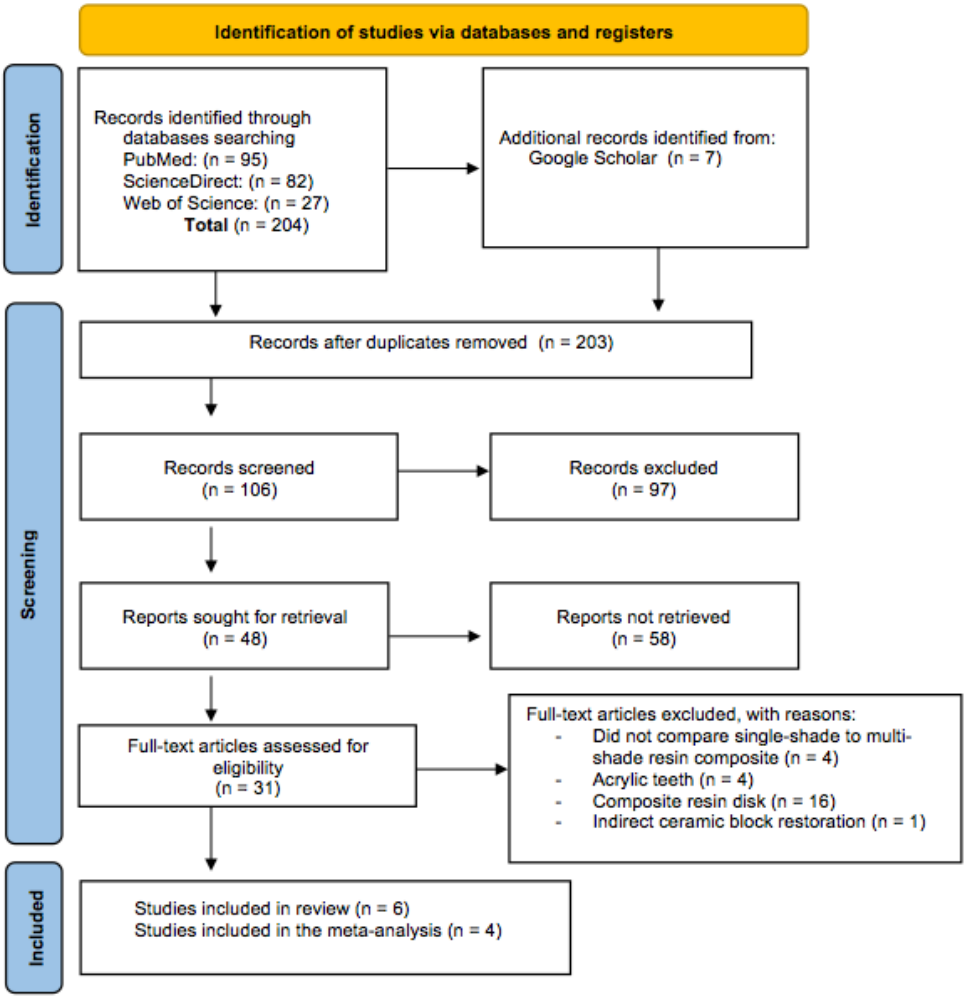

Figure 1. Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ 2021;372:n71. doi: 10.1136/bmj.n71

3.1 Qualitative Analysis

Color stability [7-10] and properties such as the effect of external bleaching on color change [8, 10] were evaluated through qualitative and quantitative analyses. Color matching [10-12] and translucency [12] were evaluated only through qualitative analysis. The included studies assessed the optical properties of monochromatic resins compared to conventional composite resins in extracted permanent teeth.

Table 1 displays the characteristics of the studies included in the review and meta-analysis. The countries that conducted the most research on this subject were Egypt (3 studies) [8-10]. Two articles were found dated from the year 2023 [10, 11]. The most commonly used chameleon resin in these selected studies was Estelite OMNICHROMA (Tokuyama Dental, Tokyo, Japan), which appeared in 6 studies [7-12].

Table 1. Study Characteristics

AUTHOR/ YEAR/	OBJECTIVE	MATERIALS AND	RESULTS (MEAN/SD)	CONCLUSION

COUNTRY		METHODS		
Ahmed *et al.*, 2022 Saudi Arabia	Investigate the color stability of Omnichroma compared to micro-hybrid composite	60 (n = 20/group) extracted human upper premolars, prepared with Class V cavities on the buccal (with Omnichroma) and palatal surfaces (with Filtek Z250); aging type: distilled water; aging time: 24h; color evaluation instrument: VITA Easyshade	**Filtek Z250 (3M ESPE; St. Paul, MN, EUA):** Pepsi-> A2: 5.14 (2.69), A3: 4.78 (2.54), B2: 3.92 (2.44), B3: 3.76 (1.56) Coffee-> A2: 7.16 (4.21), A3: 7.60 (2.62), B2: 7.26 (1.02), B3: 8.50 (3.22) Milk Tea -> A2: 5.42 (2.13), A3: 5.30 (1.90), B2: 6.02 (1.32), B3: 2.82 (2.18) **Omnichroma (Tokuyama Dental Corporation, Tokyo, Japan):** Pepsi-> A2: 7.26 (2.64), A3: 6.26 (1.51), B2: 6.68 (1.41), B3: 4.58 (2.01) Coffee-> A2: 5.34 (3.32), A3: 5.94 (1.45), B2: 5.54 (2.06), B3: 6.54 (1.63) Milk Tea -> A2:1.42 (1.69), A3: 1.16 (0.30), B2: 1.94 (0.48), B3: 2.76 (0.96)	The immersion of teeth in beverages with different pH and dye showed apparent color alterations in both smart monochromatic composites and micro-hybrids. The choice of composite resin material should be wisely selected depending on the patient's social habits and beverage consumption.
Cruz da Silva *et al.*, 2023 Paraíba, Brazil	Evaluate color match of 2 monochromatic composite resins to multicolored composite resins in extracted human teeth	40 upper central incisors and upper and/or lower molars with intact vestibular surfaces {Z250 XT (G1) = 20; OM (G2) = 10; Vittra APS (G3) =10}; aging type: distilled water; aging time: 72h; color evaluation instrument: VITA Easyshade	**Z250 XT (3M ESPE) - A1 a A4:** 6.80 ± 3.8 **OMNICHROMA (Tokuyama Dental, Tokyo, Japan):** 18.6 ± 8.6 **Vittra APS Unique (FGM, Joinville, Brazil):** 16.8 ± 4.9	The multishade resin demonstrates better color matching than monochromatic resins. In the visual assessment, all groups showed acceptable color matching; however, single-shade composite resins exhibited better matching values than multicolored resin.
Diab *et al*., 2022 Cairo, Egypt	Study the effect of external bleaching on color change of single-shade universal composite versus nanoparticle-filled composite resin in Class V restorations	20 extracted human premolars (n=10/group) color A3, prepared with Class V cavities; aging type: distilled water; aging time: 24h/1 week/1 month; color evaluation instrument: VITA Easyshade	**Z350 XT (3M/ESPE, St. Paul, MN, USA):** 24h: 4.73 (2.24); 1 week: 4.86 (2.29); 1 month: 3.53 (1.49) **OMNICHROMA (Tokuyama Dental, Tokyo, Japan):** 24h: 3.79 (1.56); 1 week: 5.35 (2.41); 1 month: 7.66 (1.97)	External bleaching can affect the aesthetics of Class V composite resin restorations, and the type of composite resin can influence color change.

Gamal *et al*., 2022 Cairo, Egypt	Evaluate color change of a single-shade composite restorative material and compare it with a fiber-reinforced composite (FRC) restorative material after storage in staining beverages	30 restored teeth, extracted human premolars, (OM, n = 30) vestibular surface and (FRc, n = 30) palatal surface; prepared trapezoidal Class V cavities; aging type: distilled water at 37°C; aging time: 24h/72h; color evaluation instrument: VITA Easyshade	**Fiber-reinforced composite:** Coffee -> 24h: 10.4 ± 2/ 72h: 16.2 ± 2.9 Tea -> 24h: 5.5 ± 0.9/ 72h: 7.5 ± 2.1 **OMNICHROMA (Tokuyama Dental, Tokyo, Japan):** Coffee -> 24h: 12.2 ± 3.2/ 72h: 18.1 ± 3.1 Tea -> 24h: 5.8 ± 2.8/ 72h: 7.7 ± 2	The structural color property of OM may enhance the perception of restoration color to compensate for color changes in the surrounding structure, especially in patients who have a higher affinity for consuming pigmented foods and beverages.
Kobayashi *et al*., 2021 Tokyo, Japan	Evaluate the effect of structural color phenomenon in composite resin on color matching in human incisors	30 extracted human central incisors; aging type: 100% relative humidity and 37°C; aging time: 24h; color evaluation instrument: Crystaleye; OLYMPUS, Tokyo, Japan	**Estelite Σ Quick (ESQ; Tokuyama Dental):** 22.6 (0.73) **Clearfil AP-X (APX; Kuraray Noritake Dental, Tokyo, Japan):** 24.2 (0.79) **OMNICHROMA (Tokuyama Dental, Tokyo, Japan)**: 24.1 (0.29)	The single-shade composite containing 260 nm spherical fillers developed the structural color phenomenon and a broad spectrum of reflection, which could contribute to improving color matching for teeth of various shades.
Shaalan & El-Rashidy, 2023 Cairo, Egypt	Evaluate the color matching ability and stability of a single-shade composite compared to a multishade composite after aging and bleaching in an in vitro model	40 human premolars (n=20/group), prepared with Class V cavities, subgroup: distilled water or coffee (n=10) and shade, A2 or A3 (n=5 each); aging type: distilled water or coffee at 37°C; aging time: 24h/12 days; color evaluation instrument: VITA Easyshade	**Filtek Z350XT (3M ESPE, St. Paul, EUA):** FT – Water: (A2) → Baseline: 1.57(0.38), 1 day: 2.08(0.48), 12 days: 2.78(0.35); (A3) → Baseline: 1.69(0.39), 1 day: 2.09(0.49), 12 days: 2.96(0.42); FT – Coffee: (A2) → Baseline: 1.60(0.37), 1 day: 3.58(0.25), 12 days: 8.34(0.68); (A3) → Baseline: 1.65(0.31), 1 day: 3.52(0.72), 12 days: 8.28(0.82). // before and after bleaching: (A2) → before: 8.34(0.68), imedt: 5.30(0.21), 2 weeks: 5.42(0.38); (A3) → before: 8.28(0.82), imedt: 5.58(0.42), 2 weeks: 5.60(0.34) **Omnichroma (Tokuyama Dental, Tokyo, Japan):** OM – Water : (A2) → Baseline: 2.98(0.39), 1 day: 3.18(0.33), 12 days: 3.50(0.23); (A3) → Baseline: 4.56(0.41), 1 day: 4.62(0.42), 12 days: 5.50(0.43); OM – Coffee : (A2) → Baseline: 3.00(0.28), 1 day: 4.02(0.40), 12 days: 5.52(0.16); (A3)) → Baseline: 4.45(0.35), 1 day: 5.43(0.38), 12 days: 6.30(0.35). // before and after bleaching: (A2) → before: 5.52(0.16), imedt: 3.41(0.31), 2 weeks: 3.72(0.49); (A3) → before: 6.30(0.35), imedt: 4.45(0.32), 2 weeks: 4.75(0.44)	The multicolored composite exhibited superior immediate shade-matching capability compared to the monochromatic composite. Both materials showed low color stability after simulated one-year clinical service aging, with immersion in coffee resulting in significant discoloration. Bleaching of coffee-stained restorations significantly reduced discoloration but failed to match the color of the surrounding bleached dental structure.

Legend: OM: Omnichroma; FT: Filtek; FRc: Fiber-reinforced composite.

3.2 Meta-Analysis

Color Stability

For the A2 subgroups (MD: -2.80; 95% CI –3.41, -2.20; p < 0.00001) and A3 (MD: -1.95; 95% CI –2.70, -1.20; p < 0.00001), the chameleon resin exhibited statistically significant greater color stability compared to conventional composite resin. In these subgroups, no heterogeneity was detected (I2=0%). However, when assessing the coffee subgroup (MD: -0.66; 95% CI –3.12, 1.80; p=0.60) and tea subgroup (MD: -1.95; 95% CI –6.20, 2.30; p=0.17), the chameleon resin did not show superior results to conventional resin. Heterogeneity in these analyses was high, ranging from 82% to 93%, as depicted in figure 2.

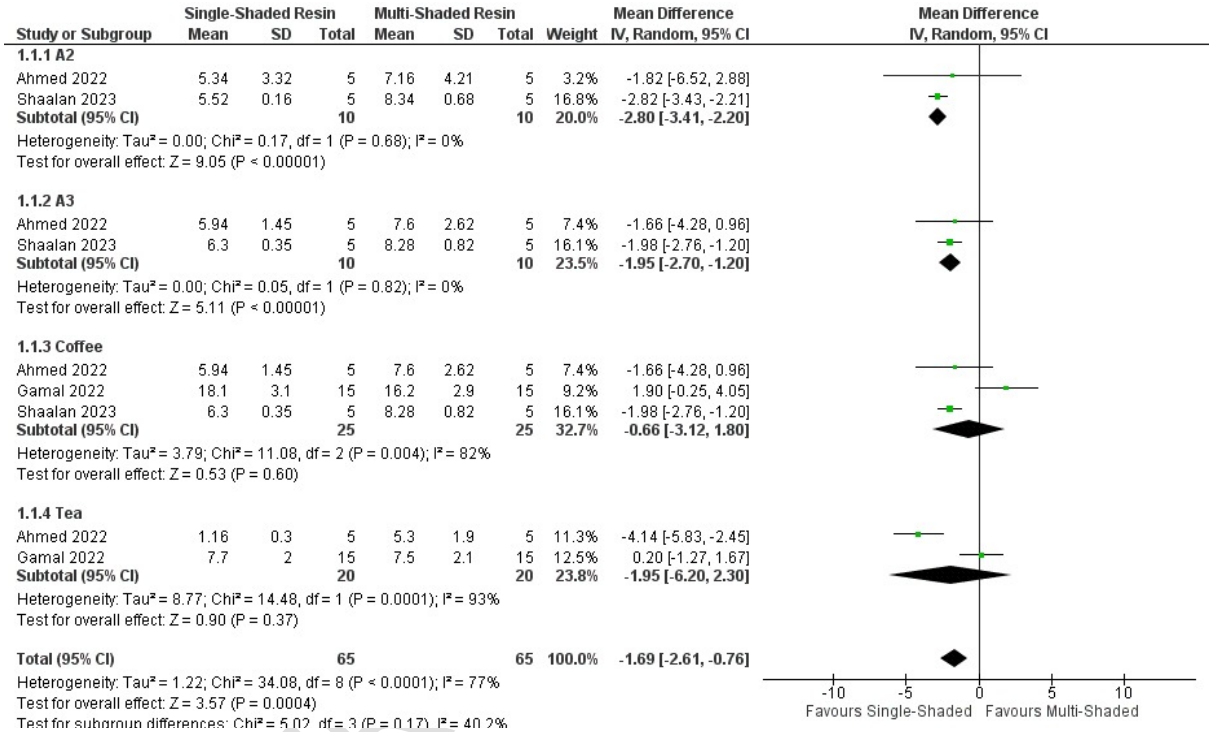

Figure 2. Forest plot showing color stability of chameleon resin compared to conventional composite resin. CI, confidence interval; SD, standard deviation.

3.3 Second Meta-Analysis

Color Variation during Bleaching:

In this analysis, the chameleon resin exhibited statistically lower color variation (MD: -0.78; 95% CI –1.09, -0.47; p < 0.00001) compared to conventional composite resin. No heterogeneity was detected among the studies (I2=0%), as shown in Figure 3.

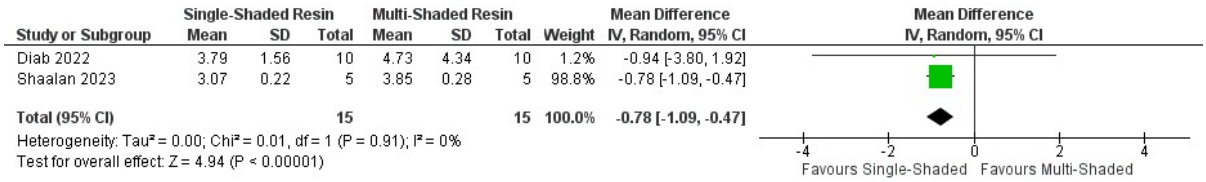

Figure 3. Forest plot showing color variation after bleaching of chameleon resin compared to conventional composite resin. CI, confidence interval; SD, standard deviation.

3.4 Bias Risk Analysis

According to the domains analyzed in the RoBDEMAT tool, considering the first domain D1, all studies employed a control group, with conventional composite resin restorations considered as the control. Of the six selected studies, two reported having randomized the samples [8, 10]. Only three studies conducted sample size calculation [7, 8, 10]. In domain D2, in two studies, it was described that they followed the manufacturer's instructions in using the materials [7, 8]. Five studies reported identical experimental conditions between the groups [7-10,12]. In domain D3, all studies provided sufficient information to allow replication of the tests. None of the studies reported operator blinding in the fabrication of the samples. Now, regarding operator blinding in the testing machine, none of the studies described whether it was performed. Finally, in domain D4, all six articles presented sufficiently detailed statistical analyses [7-12]. Most studies adequately reported outcomes and adopted appropriate testing conditions, control groups, and statistical analyses. Only one study did not sufficiently detail the outcome data [12]. The authors of this review did not identify any other potential sources of bias. The results for the risk of bias of the included studies are shown in Figure 4.

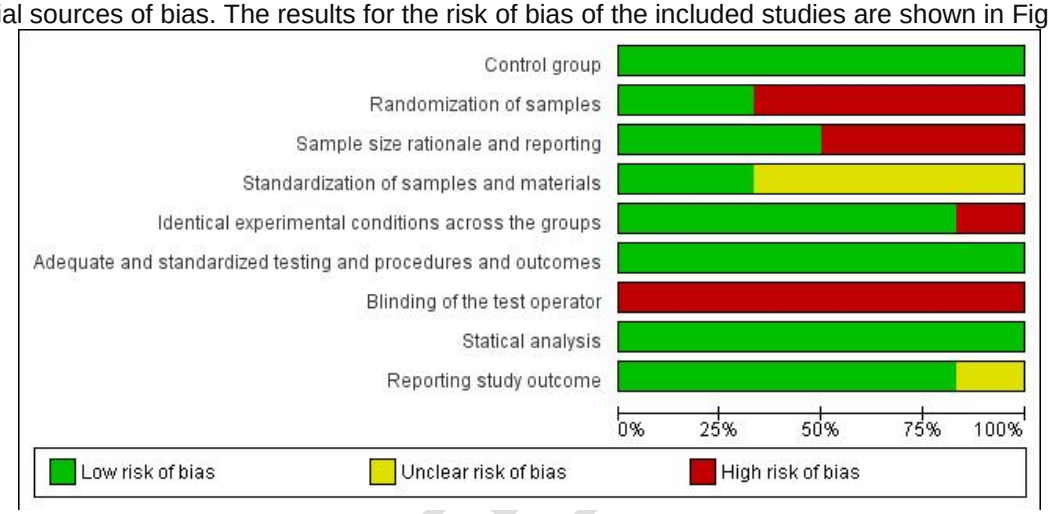

Figure 4. Bias Risk - Green color indicates Adequate/Sufficiently Reported, yellow color indicates Insufficiently Reported, and red color indicates Inadequate/Not Reported.

4. DISCUSSION

Monochromatic resins present a phenomenon known as the "chameleon effect" or "blending effect," allowing a resin to blend and acquire a color similar to the surrounding dental structures [11]. This study aimed to conduct a systematic review to evaluate and compare the laboratory efficacy of monochromatic composite resins and conventional composite resins in direct restorations in permanent teeth. Currently, there is a limited number of articles in the research literature on this subject, making this study essential for the field of dentistry.

Color stability of composite resin is one of the key parameters to be evaluated and one of the most critical aspects in ensuring the clinical success of restorations. Several etiological factors contribute to color variation in resin composites, such as patient oral hygiene, chromogenic foods and beverages (such as tea, coffee, soda), tobacco, as well as the degree of resin polymerization and the type of initiator used [13, 14]. Previous studies have indicated the detrimental effect of these factors, such as the mentioned beverages, on conventional composites.

In one of the articles evaluated in this review, Ahmed *et al.* [7] demonstrated that the two composites analyzed, monochromatic and conventional, had different responses regarding immersion in different beverages (Pepsi, coffee, tea with milk), suggesting special caution regarding the selection of restorative materials for different patients, taking into account their dietary habits and beverage consumption, not just aesthetic concerns, but also considering long-term color stability. This is also evident in the findings of Alhamdan *et al.* [15] who showed that the color stability of Omnichroma composite (OM) depends on the staining medium, with compromised color stability compared to conventional resin composite in cola and comparable color stability to conventional resin composite in coffee.

These pieces of evidence highlight the importance of immersion medium influence on color stability, which is directly related to the pH of the food consumed by the patient in their diet. Ahmed *et al.* [7] even suggest that one reason for conventional composite resisting cola stains more than

monochromatic composite is related to the acidic pH of cola, which causes erosion of the resin restoration's surface texture and increases water absorption, affecting its affinity with stains. On the other hand, Omnichroma, being a colorless material with color properties based on structural color, ends up reflecting similar tones to the surrounding teeth [15]. Thus, the restoration with this material will replicate the pigmentation of the abraded resin due to the influence of cola pH, thereby exhibiting lower color stability. Additionally, considering the report by Brewer *et al.* [16] changes in the size and type of filler greatly influence color stability and optical properties of the material. Another aspect that can further endorse this behavior is the fact that Omnichroma resin consists only of specific spherical particles of uniform size, which improves light reflection within a specific wavelength and consequently enhances its chameleon effect. However, according to Sarkis [7] coffee and black tea cause more discoloration than cola, which can be explained by the acidity of these beverages, thereby enhancing the sorption phenomenon and increasing the permeability of dye particles present therein [18, 19]. Furthermore, it is noted that tea causes more pigmentation than coffee due to its lower pH and fluoride content with extremely important chromogenic effect, as it contributes to staining issues on teeth [20].

Since color stability is an essential factor for the longevity of aesthetic outcomes in dental restorations, another study in this review that also investigated the effect of staining beverages on color stability in single-shade composite and obtained the same result regarding greater discoloration from coffee and tea compared to cola soda, drew attention to raising awareness among patients about the effects of beverages on oral health [9]. These results are consistent with the study by Bagheri *et al.* [21]. which discussed the difference in polarity of these foods, with coffee having low polarity resulting in increased penetration of substances into its organic phase, and tea having high polarity, which through adsorption, precipitates stains on the surface of the tooth.

Diab *et al.* [8] demonstrated in an investigation regarding the bleaching effect on the color change of resin composites that the monochromatic composite showed structural color difference after dental bleaching when compared to conventional composite, explained by the composition of this composite. The particle size of the nanometric composite, being finer and having silica and zirconia/silica fillers, proved to be more resistant to bleaching and therefore more resistant to color change. Della Bona *et al.* [22] explained in their study that this relationship with the higher filler content of the nanocomposite would decrease the degree of water sorption and increase the conversion rate of this composite, which consequently would increase its resistance to the chemical agent hydrogen peroxide.

Regarding bleaching, Shaalan & El-rashidy [10] showed that bleaching stained coffee restorations significantly reduced the discoloration of the restorations but failed to match the color of the surrounding bleached dental structure. In this regard, Mohamad Habibullah *et al.* [23] observed that single-shade composite, due to the composition of its Bis-GMA-free organic matrix and its spherical filler particles, yielded a more significant result compared to multicolored composite. Regarding this unique spherical filling, the author elucidates that due to their structural color, these resin composites can promote excellent color adaptation.

Furthermore, Shaalan & El-rashidy [10] also explained in their study about color matching, showing that multicolored composite showed higher capability of immediate matching with lighter tooth shades compared to monochromatic composite, which was explained by the blending effect, corresponding to the reduction of color difference between the material and the tooth, and the material's translucency, with a respective increase thereof. This topic is further clarified by Sanad *et al.* [24] who explain that this high translucency ends up reflecting the shade of the surrounding walls. Paravina *et al.* [25] on the other hand, also highlight that increased translucency enhances the blending effect of the composite. Conversely, the lack of matching of multicolored composite with darker tooth shades could be attributed to the reduction in the amount of light reflected from teeth with such coloration.

Moreover, regarding color matching and the blending effect (chameleon effect) of universal shade composite, Shinoda e Ikeda [26] reported that simultaneous color contrast, which corresponds to the shift of color towards the complementary color of the environment, is opposite to the blending effect. This color shift is related to the spatial characteristics of color assimilation and contrast, phenomena of apparent color change caused by a neighboring color. In color assimilation, colors appear to blend with adjacent colors, whereas in color contrast, a region of uniform color within a different color area appears more distinct from the surrounding color. In the latter, a region of uniform color surrounded by a different color appears more distinct than its surroundings, a phenomenon explained by local mechanisms such as lateral inhibition between retinal cells, distribution of photoreceptors, or receptive field size.

Cruz da Silva *et al.*[11] showed that single-shade composite resins showed better color

matching values than multicolored resins, only in the visual assessment. However, this was not observed in the instrumental evaluation. Nevertheless, in clinical terms, single-shade composite resins appear promising for simplifying the shade selection process, without compromising the aesthetic outcome of the restorative procedure. The VITA Easyshade Advance 4.0 spectrophotometer was used in this study, as well as in several other studies studies [27, 28, 29], proving to be feasible for reducing imperfections and inconsistencies in visual matching. This color matching may also be related to the size of the restoration cavity, as clarified in the study by Paravina et al. studies [25], who worked with different depths and concluded that increasing cavity size may decrease the chameleon effect of resin composite restorations.

Assessing the effect of structural color in composite resin on color matching in human incisors, Kobayashi *et al.*[12], studies concluded that single-shade composite containing 260 nm spherical fillers developed a greater potential for color matching compared to conventional resin composites, which could contribute to improving the color matching of teeth with various shades. This phenomenon of structural color is explained, according to Arikawa *et al.* studies [30], by the size and shape of Omnichroma fillers, as well as its property of higher straight-line light transmission without light diffusion transmission, which may contribute to improving the color matching of the restoration in a complex manner.

The laboratory assays were the chosen study design for this review and meta-analysis, due to the scarcity of clinical studies at the time of the search. Such studies constitute the base of the evidence pyramid, as laboratory conditions are tested in controlled environments and represent the first step in the research process studies [31]. Many of the limitations of the design of these studies are related to "randomization of samples," "identical experimental conditions between groups," and "justification and reporting of sample size." Additionally, the domain of "operator blinding" was not described in any study included in this review. The studies obtained moderate and good results in the quality analysis. Overall, the included studies showed good quality regarding the assessment of bias risk. The main limitation of this work is the lack of standardization in the methodology of the primary studies. Further studies are needed to conduct randomization, blinding, and methodological standardization among studies.

The monochromatic resin with the effect known as chameleon has been a trend in use due to its ability to mimic the natural color of the tooth, dispensing with the color selection step of a conventional restoration and reducing the variety of shades during the procedure. This study presents considerations that contribute to its significance in the dental research scenario. An important advantage was the use of meta-analysis, enabling comparisons and increasing the study's contribution to evidence-based decision-making in dental practice. Although the inclusion of a significant number of articles would increase the scope and robustness of the analysis, the scarcity of studies on this subject involving systematic review was a limitation of the research. Another limitation concerns the inclusion only of in vitro studies, due to the scarcity of in vivo studies at the time of article selection. Although in vitro investigations provide valuable information on the optical properties of dental materials and restorations, they cannot fully replicate the oral cavity environment. Nevertheless, our study serves as a starting point for future steps in research on chameleon resin; randomized clinical studies with significant follow-up time should be conducted to provide a better understanding of the performance of these materials. Despite the scarcity of clinical studies on this subject to affirm the effectiveness and clinical applicability of monochromatic resins, this research greatly contributes to evidence-based decision-making in dental practice.

5. CONCLUSION

From the findings of this systematic review study, it can be concluded that chameleon resin demonstrated better results regarding optical properties, showing higher values compared to conventional composite resins in terms of color stability, as well as demonstrating better behavior regarding color variation after dental bleaching. Regarding color matching, studies comparing conventional composite to monochromatic composite concluded that conventional resins showed higher hue matching capacity compared to monochromatic composite.

6. REFERENCES

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