Available online at http://www.journalijdr.com

IJDR

ISSN: 2230-9926

International Journal of Development Research

Vol. 08, Issue, 11, pp.24304-24309, November, 2018

ORIGINAL RESEARCH ARTICLE OPEN ACCESS

COLOR-MATCHING ACCORDING TO THE USE OF LIGHT-CURING CHARACTERIZING MATERIALS AND COMPOSITE RESIN THICKNESSES

[1]Donato, T.R., [2]Cavalcanti, A.N. and [2,*]Mathias, P.

[1]Tais Rocha Donato, Dental Surgeon, Master, Faculty of Dentistry, Federal University of Bahia, Salvador, Bahia, Brazil
[2]Department of Clinical Dentistry, Faculty of Dentistry, School of Dentistry, Federal University of Bahia, Brazil

ARTICLE INFO

Article History:

Received 18th August, 2018
Received in revised form
21st September, 2018
Accepted 23rd October, 2018
Published online 30th November, 2018

Key Words:

Dental Aesthetics,
Permanent Dental Restoration,
Dyes,
Tooth Discoloration.

ABSTRACT

This study aimed to evaluate the ability of light-curing characterizing material sand two thicknesses of composite dentin resin on masking differents dark substrates. 320 composite resin specimens were divided into 6 experimental groups (n=50), which were divided into 5 subgroups (n=10) according to the different characterizing material sand resin coverage thicknesses; and 2 control groups (n=10). The darkened bases were made in laboratory composite resin, in colors DA4, DB4 and DC4. On each resin, three different characterizing materials (white, ocher, opaque) were used and covered with DA2 composite with two different thicknesses. A spectrophotometer was used to assess the color parameters, following the CIEL*a*b* system standards. The values of L*, a* and b* were assessed, and the statistical analysis was performed with the ANOVA, Tukey and Student t tests. For the L* axis, higher values were found for white and opaque materials; for the variable a*, superior results were achieved with the ocher one. The b* axis presented a distinct interaction for each hue and thickness. It is concluded that the choice of dye to be used in an aesthetic restoration in darkened tooth is directly related to the initial determination of the color of the tooth to be restored.

Citation: Donato, T.R., Cavalcanti, A.N. and Mathias, P., 2018. "Color-matching according to the use of light-curing characterizing materials and composite resin thicknesses", *International Journal of Development Research*, 8, (11), 24304-24309.

INTRODUCTION

Dental discoloration is one of the main causes of dissatisfaction in the aesthetics of the smile. The aesthetic impairment becomes even greater when there is a darkening of isolated units, usually related to endodontic treatment and its sequelae or to dystrophic calcifications (Miotti *et al.,* 2017, Griffiths *et al.,* 2008). This darkening in unitary teeth usually constitutes as a great challenge in restorative dentistry due to the difficulty in removing the deepest pigments with whitening techniques (Griffiths *et al.,* 2008) and the complexity of the restorative techniques used to mask this dental darkening (Rouhani, Akbari and Farhadi-Faz 2016). When there is a large colorimetric difference between the darkened tooth and the desired color, represented by the color of the adjacent teeth, this restorative challenge becomes even greater (An *et al.,* 2013).

***Corresponding author:* Mathias, P.**
Department of Clinical Dentistry, Faculty of Dentistry, School of Dentistry, Federal University of Bahia, Brazil

Variables such as type, thickness and color of the aesthetic restorative material, use of light-curing characterizing materials may interfere with the final result, the restorative technique and the amount of tooth wear necessary to mask the color of the dental substrate (Arimoto *et al.,* 2010, Naemi *et al.,* 2012). The required thickness of tooth wear and consequent thickness of restorative material to mask a darkened tooth does not constitute a consensus in the literature (Darabi *et al.,* 2014, Shadman *et al.,* 2015). The wear traditionally recommended for this purpose ranges from 0.5mm (Kim *et al.,* 2009) to 1.5mm in thickness (Darabi *et al.,* 2014), the definition depending on the difference between the desired color and the base color. To minimize the need for tooth loss and to diminish the effects of background color, opaque resins compositions and opacifiers can be used in the innermost layers of aesthetic restorations, such as composite resin restorations, favoring positive results (Dias *et al.,* 2001). A diversity of color parameters (hue, chroma and luminosity) can be found in the devitalized and darkened teeth (Joiner 2004), and it is not clear in the odontological literature how the combination of colors help neutralizing very saturated hues.

The study of the interaction between colors can provide information about the proper use for several shades of light-curing characterizing materials on darkened substrates so that smaller thicknesses of restorative material are required to obtain the desired color for the dentin substrate. This study proposes to evaluate the ability of three shades of light-curing characterizing materials (LCCM) associated with two thicknesses of composite resin in masking substrates with three different saturated hues, following parameters of the CIEL*a*b* system (Commission Internationale de L'Eclairage). The hypotheses tested were that there was a difference in masking ability between the LCCM, as well as in their interaction with each hue tested; and that dentin composite thicknesses interfere with the color-match of the different discolored substrates.

MATERIALS AND METHODS

For the development of this study, the following materials were used:

- Composite micro particulate laboratory resin (Resin Lab Master - Wilcos) in A4, B4 and C4 colors. Served as simulated discolored substrates.
- Light-curing characterizing materials (LCCM) (IPS Empress Direct Color – Ivoclar Vivadent) in white, ocher and opaque colors.
- Composite nanohybrid resin (Opallis - FGM) with dentin opacity and A2 in color.

320 specimens were prepared and divided into 6 groups according to the base, LCCM and the coverage resin thickness. Each group was divided into 5 subgroups according to the LCCM (white, ocher, opaque and without LCCM) and controls of the respective saturated bases. The test specimens made with the resin coverage were also used as control (n = 10), as described in Chart 1. Four bipartite metal matrices were used for the preparation of the test specimens, all with 4mm in diameter and showing thickness variations in the heights of: 1.5mm, 1.6mm, 2.0mm and 2.5mm. The first matrix (1.5 mm) wasused for the composite resins that simulated the darkened bases (A4, B4, C4), which were inserted in a single increment. A strip of polyester and a weight of 500mg were placed on the matrix and left for 30 seconds for the flow of excess material. After weight removal, the composites were photoactivated for 3 minutes, according to the manufacturer's instructions, using the LED light unit (Valo - Ultradent), with light intensity of 1400mW/cm^2. After the preparation of the darkened bases, each was embedded in the second matrix (1.6 mm), for the deposition of the respective light-curing characterizing materials (LCCM) in a constant thickness of 0.1mm. The same procedures for the flow of excess material were carried out, followed by photoactivation, for 40 seconds.

Chart 1. Distribution of the specimens in the respective groups and subgroups (n=10)

Groups 1.5 mm		Subgroups 0.5 mm	
1	Base A4	White	DA2 covarage
		Ocher	
		Opaque	
		No LCCM	
		Control DA4 (no coverage)	
2	Base B4	White	DA2 covarage
		Ocher	
		Opaque	
		No LCCM	
		Control DB4 (no coverage)	
3	Base C4	White	DA2 covarage
		Ocher	
		Opaque	
		No LCCM	
		Control DC4 (no coverage)	
Control	DA2 2.0 mm		

Groups 1.5 mm		Subgroups 1.0 mm	
4	Base A4	White	DA2 covarage
		Ocher	
		Opaque	
		No LCCM	
		Control DA4 (no coverage)	
5	Base B4	White	DA2 covarage
		Ocher	
		Opaque	
		No LCCM	
		Control DB4 (no coverage)	
6	Base C4	White	DA2 covarage
		Ocher	
		Opaque	
		No LCCM	
		Control DC4 (no coverage)	
Control	DA2 2.5 mm		

The base/LCCM set was then coupled to a third metal matrix, which height depended on the respective experimental group (2.0mm or 2.5mm). Such matrix was used for insertion of the composite resin with dentin opacity (DA2) in a single increment (0.5 or 1.0 mm). The procedures for flow of the material remained the same and the photoactivation occurred for 40 seconds. After preparation, the specimens were stored in distilled water at 37°C, for 24 hours and then polished in metallographic polisher with 1200 and 2000-gritsand paper under constant irrigation with water. At the end of the polishing, the specimens were individually submitted to ultrasonic bath (CBU-100 / 1L, PLANATC) containing distilled water for 2 minutes. For the control groups, only one matrix was used (in the thicknesses of 2.0 or 2.5mm), which had its interior filled completely by the respective resins studied.

Evaluation of color parameters according to CIEL*a*b* system: The color measurements of all specimens were performed on a reflection spectrophotometer (UV-2600; Shimadzu) using the UV Probe program (Shimadzu), in which reflectance spectra of the specimens were obtained in a spectrum of visible light from 380 to 780 nm. Then, the spectra of each specimen were transported to the Color Analysis program for color evaluation following the parameters of the CIEL*a*b* system, with standardization of the D65 illuminant (Lee 2016). This system corresponds to a three-dimensional color universe in which the axes are identified by L*, a* and b*. Equivalent distances between coordinates correspond to similar color differences in their perception. The L* axis represents the brightness of an object and is quantified on a scale ranging from zero (pure black) to 100 (pure white). The coordinates a* and b* represent the chromatic characteristics of the object along the green-red and blue-yellow axes, respectively. The color analysis was performed in the comparison between the test specimens of each group with their respective control (dark control) and the control DA2 (control), in order to verify the effect of the restorations using different LCCM and resin thicknesses coverage. The parameters L*, a* and b* were analyzed separately to classify the type of colorimetric change caused by each LCCM and their interaction with the different darkened bases.

Statistical analysis: The L*, a* and b* data were determined by the Kolmogorov–Smirnov test to follow a normal distribution. Then, a one-way ANOVA followed by Tukey's post hoc HSD multiple comparisons procedure was performed to analyze the effects of the LCCM, in the respective base and composite dentin thickness. Then, the effect of the two dentin thickness on the luminosity was compared using the Student t test. Statistical significance was set at $\alpha = 0.05$. Statistical analysis was carried out using the SAS 9.1 software (SAS Institute Inc. Cary, NC, USA).

RESULTS

Tables 1 to 6 show the mean and standard deviation of the L*, a* and b* data obtained in the color ratios of the bases with the tested LCCM and the two coverage resin thicknesses. Statistical analysis showed significant differences between all levels tested in all variables ($p < 0.0001$). The analysis of the luminosity of the groups with 1mm thick cover resin showed, for all the bases, that the ocher LCCM decreased significantly the luminosity of the restoration. However, the groups that used the opaque and white LCCMs presented increased luminosity when compared to the respective dark controls and the groups without LCCM (Table 1). The same analysis was observed for the groups with 0.5mm coverage resin with the use of ocher LCCM, presenting the worst results. The ocher LCCM group presented values of luminosity inferior to the dark control, in all bases tested. The white and opaque LCCMs showed higher luminosity with the bases B4 and C4, when compared to the respective dark controls and the groups without LCCM, whereas for the A4 base, the opaque LCCM presented similar behavior to the group without LCCM (Table 2). In the analysis of the variable a*, for all the bases, in the two coat resin thicknesses, the most distant LCCM from the ideal was the white, followed by the opaque. The use of these two LCCMs resulted in values lower than the respective dark controls and the groups without LCCM. The ocher LCCM presented values higher than the dark control and the groups without LCCM, but still lower than the DA2 control. The groups without LCCM presented values similar to the respective dark controls (Tables 3 and 4). In the analysis of the variable b* for the groups with resin of coverage of 1mm, the LCCM that led to the distancing of the DA2 control was ocher, whereas for the groups with resin of 0.5mm coverage, the LCCM that exerted such behavior was the White one. For A4 bases, in the two thicknesses of cover resin, the LCCM that achieved results closer to the DA2 controls was the opaque, whereas the B4 bases did not result in good interaction with any LCCM tested, since values lower than the dark controls in the two thicknesses were observed. For the C4 bases, in the 1mm thickness, the opaque and white LCCM presented better results, and in the 0.5mm thickness, better results were found by interacting with opaque and ocher LCCMs (Tables 5 and 6). The comparison between the different thicknesses of the control groups showed significant differences for bases A2 and B4 ($p=0.0041$ and $p=0.0072$, respectively. Nocorrelation between the two thicknesses tested were found, so individual colorimetric evaluation for each thickness of the cover resin was analysed.

DISCUSSION

Although most studies of colorimetric evaluations with CIEL*a*b* system use the total color variation (ΔE) (Shadman *et al.,* 2015), the present study opted for the individual colorimetric evaluation of each color parameter, in order to determine the direction of the color changes, by the analysis of the axes L*, a* and b*.This evaluation is able to determine variation in luminosity and chromium, individually, allowing the identification of modification caused by the darkened bases in the restorations, since it is known that the teeth staining causes changes in these variables, interfering in the final result of the composite resin restorations (An *et al.,* 2013). Furthermore, the calculation of ΔE presupposes two evaluations carried out in the same sample, at different times (Shadman *et al.,* 2015, An *et al.,* 2013). In the methodology of the present study, the specimen was evaluated in a single moment. The masking ability of a restoration is related to the translucency of the restorative materials used (Kim *et al.,* 2009, Lee 2016) and the thickness of dental wear (Kim *et al.,* 2009, Ikeda *et al.,* 2005). According to Darabi *et al.,* (2014), one of the limitations of the use of composite resin in darkened teeth is its low capacity to change a dark surface, in reduced thickness. A possible aid to situations where masking is not completely achieved by the exclusive use of a composite resin is the combination of different composite resins

Table 1. Averages (standard deviation) of the L* axis for the relation of the different base colors with the light-curing characterizing materials (LCCMs) tested, and the coating resin in the thickness of 1mm

BASE	DARK CONTROL	LCCM				CLEAR CONTROL (A2)	Tukey
		WHITE	OCHER	OPAQUE	NO LCCM		
A4	87.95 d (0.43)	90.01 b (0.36)	86.50 e (0.32)	89.70 b (0.3)	89.15c (0.38)	91.54 a (0.35)	p<0.0001
B4	88 c (0.3)	90.28 b (0.38)	86.95 d (0.42)	90.31 b (0.39)	89.94 b (0.28)	91.54 a (0.35)	p<0.0001
C4	85.16 e (0.37)	89.25 b (0.35)	85.70 d (0.3)	89.71 b (0.35)	87.73 c (0.38)	91.54 a (0.35)	p<0.0001

Means followed by distinct letters represent statistical significance within the same row (1-way ANOVA / Tukey, α = 5%).

Table 2. Averages (standard deviation) of the L* axis for the relation of the different base colors with the light-curing characterizing materials (LCCMs) tested, and the coating resin in the thickness of 0.5 mm

BASE	DARK CONTROL	LCCM				CLEAR CONTROL (A2)	Tukey
		WHITE	OCHER	OPAQUE	NO LCCM		
A4	88.27 d (0.36)	90.43 b (0.43)	86.10 e (0.38)	89.43 c (0.4)	89.54 c (0.37)	92.05 a (0.33)	p<0.0001
B4	88.48 d (0.39)	90.06 bc (0.47)	86.89 e (0.8)	90.55 b (0.38)	89.75 c (0.35)	92.05 a (0.33)	p<0.0001
C4	85.3 d (0.52)	89.26 b (0.45)	85.13 d (0.7)	88.84 b (0.33)	87.10 c (0.46)	92.05 a (0.33)	p<0.0001

Means followed by distinct letters represent statistical significance within the same row (1-way ANOVA / Tukey, α = 5%).

Table 3.Averages (standard deviation) of the a* axis for the relation of the different base colors with the light-curing characterizing materials (LCCMs) tested, and the coating resin in the thickness of 1 mm

BASE	DARK CONTROL	LCCM				CLEAR CONTROL (A2)	Tukey
		WHITE	OCHER	OPAQUE	NO LCCM		
A4	2.27 d (0.17)	1.38 e (0.17)	2.99 b (0.2)	2.11 d (0.08)	2.56 c (0.12)	4.02 a (0.15)	p<0.0001
B4	2.74 d (0.11)	1.54 f (0.31)	3.56 b (0.19)	2.38 e (0.08)	3.01 c (0.11)	4.02 a (0.15)	p<0.0001
C4	2.03 c (0.05)	0.98 f (0.06)	2.54 b (0.07)	1.35 e (0.12)	1.89 d (0.1)	4.02 a (0.15)	p<0.0001

Means followed by distinct letters represent statistical significance within the same row (1-way ANOVA / Tukey, α = 5%).

Table 4. Averages (standard deviation) of the a* axis for the relation of the different base colors with the light-curing characterizing materials (LCCMs) tested, and the coating resin in the thickness of 0.5 mm

BASE	DARK CONTROL	LCCM				CLEAR CONTROL (A2)	Tukey
		WHITE	OCHER	OPAQUE	NO LCCM		
A4	2.59 c (0.13)	0.99 e (0.19)	3.28 b (0.3)	1.55 d (0.19)	2.65 c (0.09)	3.97 a (0.11)	p<0.0001
B4	2.83 c (0.12)	1.08 e (0.16)	3.18 b (0.15)	2.08 d (0.07)	2.90 c (0.11)	3.97 a (0.11)	p<0.0001
C4	2.17 c (0.11)	0.85 d (0.09)	2.68 b (0.3)	1.03 d (0.15)	2.17 c (0.1)	3.97 a (0.11)	p<0.0001

Means followed by distinct letters represent statistical significance within the same row (1-way ANOVA / Tukey, α = 5%).

Table 5.Averages (standard deviation) of the b* axis for the relation of the different base colors with the light-curing characterizing materials (LCCMs) tested, and the coating resin in the thickness of 1 mm

BASE	DARK CONTROL	LCCM				CLEAR CONTROL (A2)	Tukey
		WHITE	OCHER	OPAQUE	NO LCCM		
A4	8.23 c (0.4)	7.88 c (0.57)	6.58 d (0.29)	8.84 b (0.28)	7.89 c (0.41)	11.21 a (0.36)	p<0.0001
B4	10.04 b (0.25)	8.75 c (0.44)	8.15 d (0.3)	8.19 d (0.31)	8.66 c (0.36)	11.21 a (0.36)	p<0.0001
C4	5.47 e (0.35)	7.22 b (0.21)	5.98 d (0.26)	6.78 bc (0.47)	6.39 cd (0.47)	11.21 a (0.36)	p<0.0001

Means followed by distinct letters represent statistical significance within the same row (1-way ANOVA / Tukey, α = 5%).

Table 6.Averages (standard deviation) of the b* axis for the relation of the different base colors with the light-curing characterizing materials (LCCMs) tested, and the coating resin in the thickness of 0.5 mm

BASE	DARK CONTROL	LCCM				CLEAR CONTROL (A2)	Tukey
		WHITE	OCHER	OPAQUE	NO LCCM		
A4	9.07 b (0.27)	5.25 d (0.54)	7.63 c (0.92)	7.73 c (0.4)	7.20 c (0.16)	11.80 a (0.58)	p<0.0001
B4	9.96 b (0.52)	6.05 e (0.36)	8.43 cd (0.87)	8.14 d (0.39)	8.94 c (0.36)	11.80 a (0.58)	p<0.0001
C4	6.19 c (0.23)	4.28 d (0.3)	6.93 b (0.44)	6.20 c (0.45)	6.02 c (0.36)	11.80 a (0.58)	p<0.0001

Means followed by distinct letters represent statistical significance within the same row (1-way ANOVA / Tukey, α = 5%).

(Paravina *et al.,* 2005) as well as its combination with thin layers of light-curing characterizing materials (LCCM) inserted on the substrate to be masked, below the dentin layer. Most of the studies use color C4 (An *et al.,* 2013, Kim *et al.,* 2009, Shadman *et al.,* 2015) as a dark background marker because it represents the darker color of the Vita scale in the evaluation of the variable L* (An *et al.,* 2013). In the present study, the choice of different darkened bases (A4, B4 and C4) was based on the fact that the colorimetric interaction does not occur in a unique way, and therefore, in the fact that not every dark substrate presents an optical behavior similar to that of a C4 substrate.

The identification of the color parameters of the darken substrate is an important step in the accomplishment of previous restorations and must be done before choosing the color of the LCCM, since it will guide the strategy for the restorative technique (Dias, Pereira and Swift Jr 2001). The importance in identifying the color of the substrate in the restorations led the present study to evaluate the color interaction between resinous LCCMs and the different darkened hues, increasing possibilities and safety in challenging clinical procedures. According to Kim *et al.,* (2009) and An *et al.,* (2013), darken substrates can influence the luminosity of restorative materials and, consequently, cause chromatic changes such as grayishness in the final result of the restoration. However, light opaque materials have the capacity to increase the luminosity of the restoration, increasing the amount of reflected light (An *et al.*2013). In the present study, for the three bases tested, the coverage with composite resin A2 in 0.5mm and 1.0mm thickness, associated or not to the use of opaque and white LCCMs, was able to increase the luminosity. However, in none of the conditions studied, the luminosity was equivalent to that presented by control DA2. This result suggests that even without reaching the value presented by the mean of DA2 control group, there was a significant increase of the luminosity in the restored sets, when associated or not to the use of white and opaque LCCM. The use of the ocher LCCM, however, reduced the luminosity in all conditions tested, except for the base C4, covered by 1.0mm of resin. This particularity found for the C4 base can be justified because the C4 is the one with the lowest luminosity ($L^*=85.16$), and for this reason, the interaction with a higher luminosity material (DA2 $L^*=91.54$) in a thickness of 1.0mm of coverage was enought to mask it, reducing the interference of the ocher dye, in the luminosity. This is strenghten due to the fact that when the thickness of the cover resin was reduced to 0.5mm, the use of this same LCCM resulted in values presented by the C4 base, without overlapping of any LCCM. The use of higher cover resin thicknesses was also able to improve the masking of darkened bases in other research (An *et al.,* 2013, Darabi *et al.,* 2014, Kim *et al.,* 2009). In all other conditions, when the C4 base was coated with white or opaque LCCM or only with the coating resin DA2, regardless of the thickness of the coating resin, an increase in luminosity was observed.

The use of a thin layer of 0.1mm of LCCM in the white and opaque colors was efficient for raising the luminosity of the darkened bases. This increased luminosity obtained in the present study is in agreement with the study by Ikeda *et al.,* (2005) which demonstrates that opaque tones are not easily affected by the background color, such as less opaque tones. According to An *et al.,* (2013), changes in luminosity alone appear to be able to generate a masking effect on composite resin restorations, which reinforces the importance of the evaluation of this parameter. As regards the coordinates a* and b*, the results of this study were variable. The same LCCMs presented as positive (white and opaque) by the increase of the luminosity of the restoration, when evaluated from the perspective of the variable a*, presented negative results, since they distanced themselves from the values obtained by the DA2 controls, except for the opaque LCCM in the base A4 and thickness of 1mm, which did not significantly change the respective variable. This result suggests that the color of the LCCM interfered in the final color of the composite resin, due to the translucency inherent to the covering material, even when the resin was used in a larger thickness (1mm). This LCCM color reflection effect – which had a whitish characteristic – through the cover resin can result in an artificial appearance of the restoration (Stevenson and Ibbetson 2010), reaching the bleaching effect of the substrate, but not the desired effect of harmonization with the remaining dentin and with adjacent teeth. Therefore, although opaque colors lead to good results in the masking of darkened bases, especially due to the increase in brightness (Miotti *et al.,* 2017, Villarroel *et al.,* 2011), its large-scale use should be viewed with caution. For the a* axis, favorable results can be observed after the application of the ocher LCCM, regardless of the thickness of the covering resin and the darkened base tested. In all the studied conditions, this LCCM was able to provide some reddish element to the restored sets, approaching their values to the values found in the positive control. Despite the reduction of luminosity, in most restored sets, the application of ocher LCCM, in determined places and in established quantities, can contribute to the maintenance of a more natural aspect to the restorations of darkened teeth. For this, new compositions and color interactions of LCCMs and/or other bases should be studied.

In the b* axis, larger colorimetric variations were found. For the A4 base at the 1 mm thickness, the only LCCM that presented superior results compared to the dark control, was the opaque one. White LCCMs or the condition without dye presented similar values to the negative control. For the 0.5mm thickness, all situations resulted in a decrease in the value of b*, reducing the amount of visible yellow in the restoration. For shade B, the values in the b* axis were reduced in all conditions studied, regardless of the use of the LCCM or the thickness of the covering resin, suggesting that the use of LCCMs in bases of this shade does not seem necessary. For the C hue, in the 1mm thickness, all interactions showed values higher than the dark control, suggesting that the thickness of the covering resin compensated for the difference between the LCCM, possibly because it is the color that is more distant from the ideal, among those studied; thus, it achieves a better response in the interaction with the materials. For the thickness of 0.5mm, the only interaction that resulted in a positive value in relation to the dark control was ocher, while the other interactions did not result in significant statistical differences or presented values lower than the dark control. The chromatic perceptions of aesthetic restorations are closely related to the background used for their observation. According to Villarroel *et al.,* (2011), composite resins with translucent characteristics are sensitive to the white background used for spectrophotometric evaluations, presenting increase of value and chroma in these situations. In the present study, after comparing the luminosity between the same materials at different thicknesses, there was a significant difference for the resins A2 and B4, where the lower thickness presented results of greater luminosity in comparison with the greater thickness (difference between thicknesses: A2 $L^*=0.51$, B4$L^*=0.48$), suggesting that the white background, used in the methodology of this study, influenced the comparison between both. This result shows that the evaluation of the same hue, but in different thicknesses, can cause variation in the final result of the variables, making it impossible to compare the groups that used different thicknesses of coverage resin. In order to achieve a good aesthetic result, besides the domain of the technique employed, knowledge about the optical behavior of the resinous materials is important. The present study demonstrated that the use of white or opaque LCCMs was able to raise the luminosity (L*) in all LCCMs tested, even when a 0.5mm coating resin was used. As for the variable a*, the ocher LCCM was able to raise the values in all shades and thicknesses studied. In the analysis of the b* axis, the opaque dye presented good results in the interaction with hue A, in the thickness of 1 mm. While all interactions resulted in positive values in the b* axis for the hue C, in that same thickness. For the 0.5mm thickness of the cover resin, the use of resin LCCMs was not able to improve any of the color parameters evaluated for hue A, while hue B did not interact positively for any tested interaction and no thickness, on the b* axis. Therefore, the hue of the tooth to be restored and the aesthetic objective – value-oriented or chroma-based changes – must be determined prior to the choice of resinous opacifiers to achieve the desired clinical success. Therefore, the hypothesis that there was a difference in masking ability between the different LCCM, as well as their interaction with the dark shades tested, can be accepted; and that the change in the thickness of the coating resin interferes in the final result of the restoration, being 1 mm, the thickness tested that more presents the capacity of alteration of colorimetric parameters for the bases tested. Although the masking of darkened teeth is influenced by several factors, making it difficult to determine the factor that most influences the final result of an aesthetic restoration (An *et al.,* 2013), the incorporation of LCCM in composite resin restorations may interfere in their optical characteristics, so that the thickness of the material and consequently the need for dental wear decrease, making the restorative procedure less invasive, in cases of dental discoloration.

Acknowledgements: The author thanks the Foundation for Research Support of the State of Bahia, for the financing of this research, through the granting of a scholarship, number BOL0366/2016.

Conflict of Interests: The author declared no conflict to interests.

REFERENCES

An JS, Son HH, Qadeer S, Ju SW, Ahn JS. 2013. The influence of a continuous increase in thickness of opaqueshade composite resin on masking ability and translucency. *Acta Odontologica Scandinavica*, 71: 120-129.

Arimoto A, Nakajima M, Hosaka K, Nishimura K, Ikeda M, Foxton RM, Tagami J. 2010. Translucency, opalescence and light transmission characteristics of light-cured resin composites. *Dental Materials Journal,* 26: 1090-1097.

Darabi F, Radafshar G, Tavangar M, Davaloo R, Khosravian A, Mirfarhadi N. 2014. Translucency and masking ability of various composite resins at different thicknesses. *J Dent Shiraz Univ Med Sci.,* 15(3): 117-122.

Dias WRL, Pereira PNR, Swift Jr EJ. 2001. Maximizing esthetic results in posterior restorations using composite opaquers. *Journal of Esthetic and Restorative Dentistry,* 13(4): 219-227.

Griffiths CE, Baley JR, Jarad FD, Youngson CC. 2008. An investigation into most effective method of treating tained teeth: an in vitro study. *J Dent.,* 36: 54-62.

Ikeda T, Sidhu SK, Omata Y, Fijita M, Sano H. 2005. Colour and translucency of opaqueshades and body-shades of resin composites. *Eur J Oral Sci.,* 113: 170–173.

Joiner A. 2004. Toothcolour: a reviewoftheliterature. *J Dent.,* 32(1): 3-12.

Kim SJ, Son HH, Cho BH, Lee IB, Um CM. 2009. Translucency and masking ability of various opaque-shade composite resins. *Journal of Dentistry,* 37: 102-107.

Lee YK. 2016. Criteria for clinical translucency evaluation of direct esthetic restorative materials. *Restorative Dentistry and Endodontics,* 159-166.

Miotti LL, Santos IS, Nicoloso GF, Pozzobon RT, Susin AH, Durand LB. 2017. The use of resin composite layering technique to mask discolored background: A CIELAB/ CIEDE2000 analysis. *Operative Dentistry,* 42(2): 165-174

Naemi Akbar H, Moharamzadeh K, Wood DJ, Van Noort R. 2012. Relationship between color and translucency of multishaded dental composite resins. *International Journal of Dentistry,* 1-5.

Paravina RD, Westland S, Kimura M, Powers JM, Imai FH. 2005. Color interaction of dental materials: Blending effect of layered composites. *Dental Materials,* 845-850.

Rouhani A, Akbari M, Farhadi-Faz A. 2016. Comparison of tooth discoloration induced by calciumenriched mixture and mineral trioxide aggregate. *Iranian Endodontic Joural*, 11(3): 175-178.

Shadman N, Kandi SG, Ebrahimi SF, Shoul MA. 2015. The minimum thickness of a multilayer porcelain restoration required for masking severe tooth discoloration. *Dental Research Journal,* 12(6): 562-568.

Stevenson B, Ibbetson R. 2010. The effect of the substructure on the colour of samples/restorations veneered with ceramic: A literature review. *Journal of Dentistry*, 38: 361-8.

Villarroel M, Fahl Jr N, Sousa AM, Oliveira Jr OB. 2011. Direct esthetic restorations based on translucency and opacity of composite resins. *J Esthet Restor Dent.,* 23(2): 73-88.

****