

## Clinical Evaluation of the Effectiveness of Whitening Dentifrices

### Avaliação Clínica da Eficácia de Dentifrícios Clareadores

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#### Abstract

The objective of this clinical study was to evaluate, for 7 weeks, the efficacy of whitening dentifrices and the patients' satisfaction after use. 30 patients were selected who had all the anterior teeth in the upper and lower arches, presenting an initial color A2, evaluated through the Vita Classical color scale (Vita Zahnfabrik, Bad Säckingen, Germany). The participants were randomly divided into 3 groups (n = 10): GA - Colgate® Maximum Antibody Protection (Negative Control), GB - Colgate® Luminous White and GC - Colgate® Luminous White Advanced. The dentifrices were distributed in identical and randomized tubes. The color evaluations were performed at baseline after 7, 15, 30 and 60 days using two methods: subjective evaluation with the Vita Classical (Vita Zahnfabrik, Bad Säckingen, Germany) and Vita Bleachedguide 3D- MASTER (Vita Zahnfabrik, Bad Säckingen, Germany), and objective evaluation using VITA Easyshade Compact® spectrophotometer, Vident, Brea, CA, USA). The patient's satisfaction with the teeth color change was considered. The data were submitted to statistical analysis using ANOVA of three criteria and Tukey post-test ( $\alpha = 0.05$ ). The results showed that there was a statistically significant difference in color in the groups in which the whitening dentifrices were used (GB and GC), in periods between 15 and 30 days. It was concluded that both GB and CG dentifrices presented a whitening action, observed through the subjective and objective scales. However, in the perception of the patient only in the CG group there was a change of color.

**Keywords:** Dentifrices. Tooth Bleaching. Esthetics, Dental.

#### Resumo

O objetivo deste estudo clínico foi avaliar, por 7 semanas, a eficácia de dentifrícios clareadores e a satisfação dos pacientes após o uso. Foram selecionados 30 pacientes que possuísem todos os dentes anteriores nas arcadas superior e inferior, apresentando cor inicial A2, avaliados através da escala de cores Vita Classical (Vita Zahnfabrik, Bad Säckingen, Alemanha). Os participantes foram aleatoriamente divididos em 3 grupos (n=10): GA - Colgate® Máxima Proteção Anticáries (controle negativo), GB - Colgate® Luminous White e GC - Colgate® Luminous White Advanced. Os dentifrícios foram distribuídos em bisnagas idênticas e aleatorizados. As avaliações de cor foram realizadas inicialmente ao uso (baseline), após 7, 15, 30 e 60 dias, utilizando dois métodos: avaliação subjetiva com as escalas de cor Vita Classical (Vita Zahnfabrik, Bad Säckingen, Alemanha) e Vita Bleachedguide 3D-MASTER (Vita Zahnfabrik, Bad Säckingen, Alemanha), e avaliação objetiva através do espectrofotômetro VITA Easyshade Compact®, Vident, Brea, CA, USA). Foi considerada a satisfação do paciente quanto a mudança de cor dos dentes. Os dados foram submetidos à análise estatística, utilizando análise de variância (ANOVA) de três critérios e pós-teste de Tukey ( $\alpha=0.05$ ). Os resultados demonstraram que houve diferença de cor estatisticamente significante nos grupos em que se utilizou os dentifrícios clareadores (GB e GC), nos períodos entre 15 e 30 dias. Conclui-se que ambos os dentifrícios GB e GC apresentaram ação clareadora, observado através das escalas subjetiva e objetiva. Porém, na percepção do paciente apenas no grupo GC houve mudança de cor.

**Palavras-chave:** Dentifrícios. Clareamento Dental. Estética Dentária.

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#### 1 Introduction

The great appreciation of the aesthetics in dentistry and the search for an increasingly white smile made of dental whitening one of the most sought after by patients who wish to improve the appearance of their teeth<sup>1-3</sup>. This quest for the perfect smile has provided the development and improvement of new whitening products, which started to be traded without the need for prescription of medical-dental care<sup>4,5</sup>.

There are on the market called free sale whitening agents (over-the-counter whitening products), these products have as objective to promote the dental whitening through different

methods, such as brushing or mouthwash, being more accessible due to their cost and do not require a prescription and professional follow-up<sup>5,6</sup>. Among these, the whitening dentifrices aforementioned stand out. Some mouth washing products contain up to 1.5% hydrogen peroxide, and as well as the whitening dentifrices, and promise a change in the teeth color<sup>7</sup>.

Some dentifrices have hydrogen peroxide in their composition, however, others are only capable of removing extrinsic stains by abrasive action present in the composition, among them: hydrated silica, calcium carbonate, calcium phosphate alumina, hydrogen orthophosphate; and perlite<sup>6,7</sup>.

These abrasives potentiate the removal of superficial stains and can give idea that occurred the whitening of dental surfaces, but that may not be an objective reduction in the teeth color. The manufacturers of these whitening dentifrices guarantee their effectiveness during the period from 3 days to 4 weeks of continuous use<sup>8,9</sup>.

However, the wide range of products on the market with whitening action makes use of these to become increasingly frequent, generating doubts about the actual effectiveness. Therefore, the objective of this work was to evaluate the clinical efficacy of whitening dentifrices after 7 weeks of use, as well as the patients' satisfaction after this period.

## 2 Material and Methods

The experimental design of this study was based on pre-established criteria. 30 volunteers were selected from the city Francisco Beltrão, PR, Brazil, for this study. Two weeks prior to the procedures, all volunteers underwent a screening, prophylaxis with pumice and water, and signed a free and informed consent form. This research was approved by COEP number 2.338.349.

Controlled clinical trial, randomized, triple-blinded and parallel. The study was carried out at the dental clinic of UNIPAR Francisco Beltrão, PR.

The patients to be included in this clinical study should be at least 18 years old, good general and oral health, being recruited through local advertising. All volunteers were examined by two dentist-surgeons, with more than 3 years of clinical experience, to check that would fulfill the inclusion criteria to participate in the study, as described in Table 1. In total, 40 patients were evaluated, of which only 30 were selected.

**Table 1** - Inclusion and exclusion criteria for patients selection

Inclusion Criteria	Exclusion Criteria
1-Candidates should have at least all upper and lower anterior teeth, without manifestations of caries, restorations, and exposed dentine and spontaneous dental sensitivity. 2-Apt to sign an informed consent form 3- Be between 18 and 30 years. 4-Undertake to use the dentifrice at least 3 times a day for 60 days and attend periodic examinations. 5- Have good oral and general health. 6 Canines with color A2 or darker, comparing with the color scale Vita Classical (Vita Zahnfabrik, Bad Säckingen, Germany).	1. Pregnant or lactating women. 2- Smokers 3- Patients who had stains caused by tetracycline (grade I, II, III or IV), dental fluorosis or endodontic treatment. 4- Bruxers with severe periodontitis.

Source: Research data.

The participants were randomly divided into 3 groups (n=10): GA - Colgate® Maximum Anti-Caries Protection (negative control), GB - Colgate® Luminous White, GC - Colgate® Luminous White Advanced. The randomization was performed by means of tables on a computer by a person not involved in the research, and the numbers were

randomized through the site [www.sealedenvelope.com](http://www.sealedenvelope.com). Then, that same person put the groups allocated on cards numbered sequentially and stored in opaque and sealed envelopes which were opened only at the time of the procedure. Thi0 aims at the effective blinding of the operator and the participant.

Two operators with clinical experience, and who have not participated in the screening and randomization process, were responsible for the implementation of the study.

40 patients were evaluated and 10 were excluded for the following reasons: have the canines color less than A2 in Color Scale Vita Classical (Vita Zahnfabrik, Bad Säckingen, Germany), or because they had already performed whitening procedure previously. Thus, the 30 patients who met the inclusion criteria, were duly informed of how the research would be conducted, being able to sign the informed consent form (ANNEX A). The dentifrices were allocated in identical tubes and duly identified as GA (Colgate® Maximum Anti-Caries Protection), GB (Colgate® Luminous White) and CG (Colgate® Luminous White Advanced), and then the opening of the envelope was performed corresponding to each patient and the delivery of the corresponding dentifrice. Afterward, the patient was instructed to brush his or her teeth at least 3 times a day during certain periods of time, and that returned within the deadlines set forth for the evaluations.

The study occurred in 60 days, being that the colors evaluations were carried out initially to use (baseline), at 7, 15, 30 and 60 days.

For the evaluation with a spectrophotometer, a preliminary molding of the upper arch from canine to canine was carried out with polyvinyl siloxane Adsil (Vigodent, Rio de Janeiro, RJ, Brazil). The mold has served as a guide for the measurement of color, where it was created a window in the middle third of the canines buccal surface. The spectrophotometer used was the VITA Easyshade Compact (VITA Zahnfabrik, Bad Säckingen, Germany).

Two calibrated examiners made the evaluation of the initial color through the reflectance spectrophotometry, which conducts the color measurement by means of the corresponding values at scale CIE L\*a\*b\*. In this system L\* indicates the brightness where the average varies from 0 (black) to 100 (white) and a\*b\* the hue, being that a\* represents the saturation in the red- green shaft- and b\* in the blue-yellow shaft. The comparison of the initial color and after each period of time was given by the difference of color or ΔE, represented by the equation:

$$\Delta E^*_{ab} = [(\Delta L^*)^2 + (\Delta a^*)^2 + (\Delta b^*)^2]^{0.5}, \text{ where:}$$

$$\Delta L^* = L^*_1 - L^*_0 \text{ (reading after a certain period of time less reading of initial color)}$$

$$\Delta a^* = a^*_1 - a^*_0 \text{ (reading after a certain period of time less reading of initial color)}$$

$$\Delta b^* = b^*_1 - b^*_0 \text{ (reading after a certain period of time less reading of initial color)}$$

The same calibrated evaluators also made the subjective evaluation of color through the color scale Vita Classical (Vita Zahnfabrik, Bad Säckingen, Germany), organized into 16 vanes, which were on the order from the highest (B1) to the lowest value (C4). The Vita Classical scale (Vita Zahnfabrik, Bad Säckingen, Germany) presents statistical values corresponding to each color, causing the minimum color required for the study to be A2, being that in accordance with the statistical value present in the scale, the color A2 represents respectively the number 5 of the scale. The color measurement was performed in the middle third of the canines buccal surface. The color scale Vita Bleachedguide 3D-MASTER (Vita Zahnfabrik, Bad Säckingen, Germany), organized into 15 vanes of color scale, which were exhibited from the highest (0M1) to the lowest value (5M3), was also used. The color scale Vita Bleachedguide is indicated for the evaluation of color in teeth that were subjected to whitening treatment<sup>10</sup>

It was also evaluated through a questionnaire, the patient's satisfaction in relation to the change of teeth color. The evaluated data were recorded in the respective identification sheets of each one.

The obtained results were subjected to statistical analysis, using the analysis of variance of a criterion ANOVA and Tukey test with  $\alpha=0.05$ .

### 3 Results and Discussion

The first results correspond to the objective color assessment. In Table 2 are shown the results obtained from the measurement of initial color through the VITA Easyshade Compact®, where no significant difference in color was observed.

**Table 2** - Average and standard deviation of the initial color, according to values corresponding to scale CIE L\* a\*b\*, for each experimental group.

Dentifrices	L	C	H	A	B
<b>GA</b>	79.36 (±1.42)	23.66 (±1.86)	88.26 (±1.99)	0.8 (±1.99)	23.6 (±1.8)
<b>GB</b>	78.88 (±1.84)	22.82 (±2.66)	88.87 (±2.65)	0.9 (±1.29)	25.05 (±2.59)
<b>GC</b>	77.95 (±1.86)	22.12 (±1.88)	88.4 (±1.76)	0.49 (±0.86)	22.11 (±1.87)

ANOVA - Tukey.  $p=0.6443$ .

Source: Research data.

In Table 3 it is possible to observe the average of whitening obtained after 7 and 15 days of use of the respective dentifrices (GA - Colgate® Maximum Protection Anticáries, GB - Colgate® Luminous White and GC - Colgate® Luminous White Advanced), being the dentifrice GA the control group. In 7 days, for the values in L there was no significant difference in color when compared to the control group. Whereas in 15 Days it is noticed significantly higher average of whitening

in the CG group regarding the toothpaste Colgate® Luminous White Advanced when compared to the control group.

**Table 3** - Average and standard deviation after 7 and 15 days of continuous use of dentifrices, following the values corresponding to scale CIE L\* a\*b\*.

Dentifrices	GA	GB	GC
L (7 days)	79.27 (±1.65)	78.30 (±1.82)	76.32 (±2.70)
L (15 days)	80.33 (±1.82)	82.06 (±2.32)	85.98 (±2.24)
C (7 days)	24.00 (±1.97)	19.85 (±2.00)	21.06 (±2.43)
C (15 days)	22.86 (±1.54)	22.02 (±1.97)	21.68 (±1.86)
H (7 days)	87.40 (±1.63)	87.08 (±1.17)	87.50 (±1.51)
H (15 days)	87.92 (±1.49)	87.90 (±1.57)	88.38 (±1.90)
A (7 days)	0.97 (±0.87)	0.61 (±1.06)	0.47 (±0.94)
A (15 days)	0.87 (±0.56)	0.49 (±0.96)	0.41 (±0.87)
B (7 days)	23.93 (±1.93)	19.83 (±2.00)	20.38 (±2.00)
B (15 days)	22.84 (±1.54)	21.98 (±1.93)	21.65 (±1.83)

7 days: ANOVA - Tukey.  $p=0.6443$ .

15 days: ANOVA - Tukey  $P<0.0001$ .

Source: Research data.

In Table 4 it is possible to observe the average of lightening obtained after 30 and 60 days of use of the respective dentifrices. In 30 days, it is noted significantly higher average of whitening in the GB group regarding the dentifrice Colgate® Luminous White when compared to the control group and in 60 days there was no significant difference in color when compared to the control group.

**Table 4** - Average and standard deviation after 30 and 60 days of continuous use of dentifrices, following the values corresponding to scale CIE L\* a\*b\*.

Dentifrices	GA	GB	GC
L (30 days)	79.03 (±1.74)	82.16 (±2.15)	80.54 (±2.57)
L (60 days)	79.91 (±1.23)	81.68 (±2.09)	78.00 (±2.58)
C (30 days)	22.52 (±1.91)	19.96 (±2.32)	20.83 (±2.05)
C (60 days)	21.02 (±1.45)	23.12 (±2.09)	15.09 (±1.87)
H (30 days)	87.61 (±0.97)	72.54 (±2.65)	89.35 (±2.65)
H (60 days)	87.18 (±1.79)	87.33 (±1.15)	87.70 (±1.79)
A (30 days)	1.05 (±0.86)	0.59 (±1.12)	0.46 (±0.80)
A (60 days)	1.09 (±0.77)	0.4 (±1.13)	0.53 (±0.87)
B (30 days)	22.51 (±1.94)	19.58 (±2.60)	20.76 (±2.07)
B (60 days)	21.45 (±1.91)	23.06 (±2.09)	15.85 (±1.89)

30 days: ANOVA - Tukey  $P<0.0001$

60 days: ANOVA - Tukey  $p=0.6443$ .

Source: Research data.

In Table 5 the results illustrated show statistical values corresponding to each color of scales VITA Classical and Bleachedguide Vita 3D MASTER.

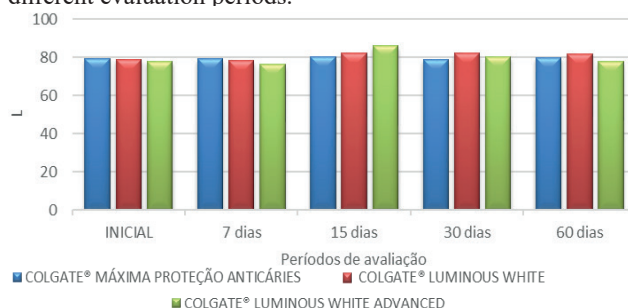
**Table 5 - Changes of color in the scale VITA Classical and Bleachedguide Vita 3D MASTER.**

		GA			GB		GC	
VITA Classical	Initial	7.3	C2	6.3	C1	6.2	C1	
VITA Bleached	Initial	8.5	2.5 M2	10.1	3.5 M2	9.8	3.5 M2	
VITA Classical	7 days	7.2	C2	5.7	C1	6.6	C1	
VITA Bleached	7 days	8.1	2.5 M2	7.8	2.5 M2	7.8	2.5 M2	
VITA Classical	15 days	6	C1	5	A2	6.4	C1	
VITA Bleached	15 days	8.1	2.5 M2	7.3	2 M2	7.1	2 M2	
VITA Classical	30 days	6	C1	4.4	D2	4	D2	
VITA Bleached	30 days	7.7	2 M2	7.8	2.5 M2	7.1	2 M2	
VITA Classical	60 days	7	C2	4.5	D2	3.6	B2	
VITA Bleached	60 days	8.1	2.5 M2	7.8	2.5 M2	7.2	2 M2	

Source: Research data.

The graphical representation (Figure 1) confirms that the whitening toothpaste GB - Colgate® Luminous White and the GC - Colgate® Luminous White Advanced presented whitening (L- level of clarity-value) significant after 15 and 30 days of continuous use (P<0,001) when compared to the control group (GA - Colgate® Maximum Anti-Caries Protection).

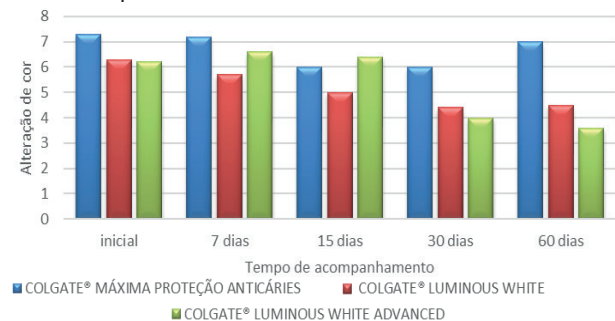
**Figure 1 - Mean values of L (chromatic space CIEL\*a\*b) in different evaluation periods.**



Source: Research data.

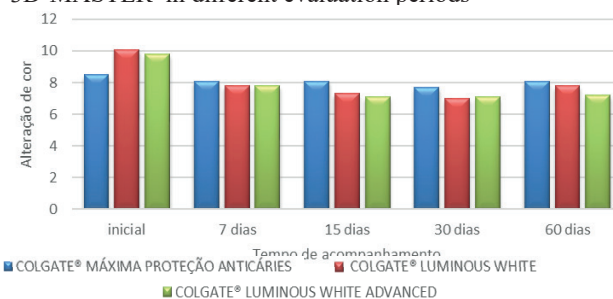
In the graphic in Figure 2 it is possible to observe the results after the subjective evaluation of color, carried out through the color scale Vita Classical (Vita Zahnfabrik, Bad Säckingen, Germany). After the period of 15 days the dentifrices GB - Colgate toothpaste® Luminous White and GC - Colgate® Luminous White Advanced showed significant difference of color, it can be observed that the toothpaste GB presented alteration of color in relation to the period of 7 and 15 days, remaining unchanged in the period of 60 days when compared with the other periods of time, on the other hand the toothpaste GC indicated change of color in all the analyzed time periods.

**Figure 2 - Mean Color changing Vita Classical in different evaluation periods**



The graphic in Figure 3 shows that the whitening toothpaste GB - Colgate® Luminous White and the GC - Colgate® Luminous White Advanced showed significant color change after 7 days of continuous use. After 60 days the dentifrice GB presented the same change color in relation to the period of 7 days.

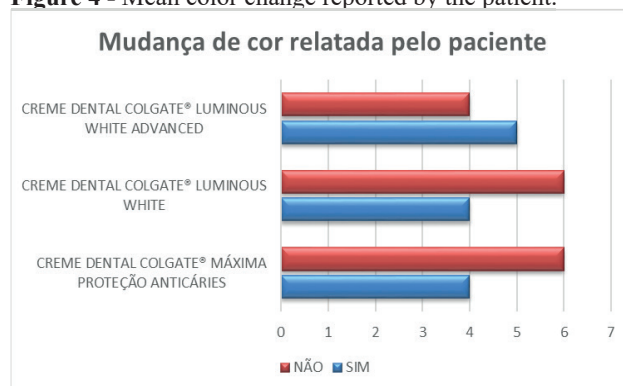
**Figure 3 - Mean Color changing scale Vita Bleachedguide 3D-MASTER in different evaluation periods**



Source: Research data.

In the graph in Figure 4 it is possible to observe the change of color reported by the patient, which was the best result for the GC - Colgate toothpaste® Luminous White Advanced when compared to the other dentifrices.

**Figure 4 - Mean color change reported by the patient.**



The growing appreciation of aesthetics has led the market to launch the Products OTC (*over-the-counter*), which are low cost and promise whitening action. The toothpaste is one of the forms of presentation<sup>10,11</sup>, among them that promise whitening action if used often and for a certain period of time. However, upon analyzing the composition of dentifrices, in some it is



possible to observe the existence of substances responsible for whitening action and in others the whitening agent in low concentrations<sup>12</sup> which leads us to believe that the whitening result, if present, is due to the frequency and period of use of the same.

The results obtained with this study showed that two whitening dentifrices (GB - Colgate® Luminous White and GC - Colgate® Luminous White Advanced) showed statistically a whitening action, being that the toothpaste GB showed a better outcome when compared to toothpaste GC, this result may be related to its abrasiveness.

The ability of removing stains is related to the number of abrasive particles in its composition, among them, are the alumina, dihydrate dicalcium phosphate and silica. The contact between the dentifrice and the dental structure, these particles are responsible for the breaking of extrinsic organic molecules of pigments, causing thus the removal of stains and a possible whitening effect observed by patients<sup>6,7,13</sup>.

For the toothpaste GC, which presents in its composition the hydrogen peroxide, during the realization of the readings in the period of 15 and 30 days, it can be noted that presented whitening (L- brightness level-value), i.e., demonstrated effectiveness, even if limited, in the whitening process. Antón et al.<sup>14</sup>, evaluating the readings taken after 14 days of bleaching procedures for the control group and 28 days for groups tests, and the results showed limited effectiveness of hydrogen peroxide present in dentifrice test, noting that there was a significant increase in luminosity (L\*) and reduction of red shade (a\*). Thus, the toothpaste containing hydrogen peroxide, even if have efficacy after 14 days of use, is not capable of reducing the yellow pigmentation (parameter b\*).

Silva et al.<sup>8</sup> evaluated *in vitro* the effectiveness of dentifrices with whitening action in 36 healthy dental elements, stored in artificial saliva for 21 days. The result obtained for parameter of luminosity (L\*) indicated that the toothpaste Colgate® Luminous White showed no significant change. Whereas in relation to the result of the present study, the same dentifrice (GB) showed a significant change in the parameter of luminosity (L\*). The results proved to be different from what was reported, which can be justified due to the time of the research, the number of daily brushings and also, because it is a study in humans, being that habits such as diet also can influence the results.

Silva et al.<sup>15</sup> evaluated the efficacy of whitening toothpastes with associated use or not of special toothbrush where Colgate® Branqueadora, Malvatricin Branqueadora and manipulated whitening toothpaste were used, and verified that there was no significant difference for whitening action in none of the materials tested. In contrast with the results obtained in this study, it was observed that there was a significant difference, by the fact that the guidelines which the patients were subjected to the beginning of the study, the use of toothpaste, and also in larger size of the sample used

(64 patients).

Horn et al.<sup>11</sup> assessed the composition of whitening action dentifrices and observed that none of the dentifrices analyzed presented hydrogen peroxide and did not present whitening action. In the present study, the dentifrice GC - Colgate® Luminous White Advanced has in its composition 1% hydrogen peroxide that when assessing the change of color showed a statistically significant change of color. In another study, carried out by Araújo et al.<sup>16</sup> It was observed that the dentifrices that have whitening = agents in their composition may lighten independently and effectively the dental enamel, even with the fact that the concentration of hydrogen peroxide in the whitening dentifrice is much smaller than in the homemade whitening (4 to 10%)<sup>17</sup> and/or clinic (35%)<sup>17</sup>, also in these cases the gel remains in contact with the dental enamel for long periods of time, which does not happen with the dentifrices, which have contact quickly with the dental enamel, only during brushing.

In relation to the results of color change observed by the patient, it was noticed that for the dentifrice GC - Colgate® Luminous White Advanced, patients observed color change, whereas for the toothpaste GB - Colgate® Luminous White and GA - Colgate® Maximum Anti-Caries Protection, the patients did not notice any change. This result may be due to the fact that during the research the canine teeth were used as reference knowing that patients usually observe changes in central incisors, besides the fact that GA and GB do not have hydrogen peroxide in their composition<sup>18</sup>, or even to the fact that patients may not have properly followed the guidelines for use of the dentifrices.

Within this context, it was observed that there were statistically significant changes related to change color in whitening dentifrices GB - Colgate® Luminous White and GC - Colgate® Luminous White Advanced, being in the CG group more effective, according to the patients' reports. However, due to the limitations of the work and a lack of studies regarding the real effectiveness of whitening dentifrices, in particular those that contain hydrogen peroxide in their composition, it is impossible to say with precision the whitening effectiveness, as well as their longevity.

#### 4 Conclusion

Based on the results obtained, it was observed that the dentifrices GB - Colgate toothpaste® Luminous White and GC - Colgate® Luminous White Advanced presented a similar whitening effect. Regarding the patients' perception, they only observed color change in CG and not in the GB group.

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