Annals of Pharmacy Practice and Pharmacotherapy
ISSN: 3062-4436
2023, Volume 3, Page No: 21-27

Available online at: www.galaxypub.co/page/journals

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Comparative Effectiveness and Safety of Low- vs High-Concentration Carbamide Peroxide for Dental Bleaching: A Systematic Review

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Received: 03 February 2023; **Revised:** 11 April 2023; **Accepted:** 16 April 2023

ABSTRACT

Tooth bleaching is a less intrusive option than procedures linked to aesthetics. However, some are concerned about bleaching's possible negative consequences, even though it is harmless when used on teeth and surrounding tissues. Based on this statement, the bleaching process must be utilized following a specific diagnostic, considering several elements, such as the kind of discolouration, the state of the teeth caused by food, the amount of reagents used, the patient's age, the type of reactions to the chemical compounds used, and the application time. This systematic review aimed to compare the effectiveness and adverse effects of 10–16% versus 30–37% carbamide oxide. A comprehensive review of the literature from 2012–2022 was conducted utilizing databases including ScienceDirect, Medline, and PubMed. "Carbamide peroxide," "bleaching," "10% carbamide peroxide," and "30% carbamide peroxide" were the keywords that were utilized. According to some studies, effective concentrations of carbamide peroxide ranged from 10 to 16%. Based on the results of certain studies, using 35% CP bleaching gels did not affect the composite resin's surface roughness. According to the results, in a single treatment week, concentrations of 10 and 16% are more beneficial than 37%. Without running the danger of any negative consequences, a low concentration is sufficient to generate positive benefits. The color changed for both carbamide peroxide concentration levels. However, high concentrations often caused surface roughness that may facilitate the deposition of S. mutans. A sufficient focus is sufficient to yield positive outcomes without the possibility of negative consequences.

Keywords: Bleaching, Carbamide peroxide, 10% carbamide peroxide, 30% carbamide peroxide

How to Cite This Article: Khashashneh M, Ratnayake J, Jung Eun Choi J, Mei L, Lyons K, Brunton P. Comparative Effectiveness and Safety of Low- vs High-Concentration Carbamide Peroxide for Dental Bleaching: A Systematic Review. Ann Pharm Pract Pharmacother. 2023;3:21-7. https://doi.org/10.51847/hE26QqCyuQ

Introduction

Straight, white teeth are seen as beautiful in today's environment, when individuals are more conscious of their looks and more focused on their entire appearance. Tooth discoloration is becoming an increasing concern for those who appreciate the appearance of their smile [1–3]. Due to the negative effects on their self-esteem, patients with discolored or misaligned front teeth typically avoid smiling. By fixing this problem, the patient's appearance, mental health, and social relationships will all improve. Most patients find that whitening teeth with antioxidants improves their appearance while having few side effects, making it a conservative option to direct restorations, ceramic veneers, or enamel discoloration [4, 5].

A less intrusive option to having cosmetic treatment done is to bleach your teeth. Even though bleaching is safe for teeth and surrounding tissues, some people are nonetheless concerned about possible negative consequences. The majority of people who get their teeth whitened have already had some sort of dental work done, such as a crown or filling. Teeth whitening procedures can involve chemical treatments that might damage tooth tissues and

the restorative materials already present in teeth, depending on the method used. In recent years, researchers have looked at how bleaching agents affect tooth and restoration materials. One major concern is that the chemical softening caused by bleaching agents may make composite fillings in teeth less clinically durable than they otherwise would be [6, 7].

Based on the statement, the bleaching process must be utilized following a specific diagnostic, considering several elements, such as the kind of discolouration, the state of the teeth caused by food, the amount of reagents employed, the patient's age, the type of reactions to the chemical compounds employed, and the application time. It was demonstrated that employing the highest possible focus of the whitening agent or employing tooth-whitening procedures improperly might seriously damage the pulp tissue [8, 9].

This systematic review aimed to compare the effectiveness and adverse effects of 10–16% versus 30–37% carbamide oxide.

Materials and Methods

A thorough assessment of the literature from 2012 to 2022 was carried out utilizing databases including ScienceDirect, Medline, and PubMed. The main phrases used were bleaching, carbamide oxide, 10% carbamide oxide, and 30% carbamide oxide (**Table 1**). A PRISMA flowchart was used to illustrate the selection process for the articles that were searched (**Figure 1**).

Table 1. Inclusion and exclusion criteria

№	Inclusion criteria	Exclusion criteria
1.	Case-control and randomized control studies	Systematic reviews or meta-analyses or expert opinions, or narrative reviews
2.	Published between 2012 and 2022	Out of the specified time range
3.	Studies including 10-16% and 30-37% carbamide oxide	Bleaching agent other than Carbamide oxide
4.	The English language of publication	Language other than English
7.	In vivo (humans)	In vitro

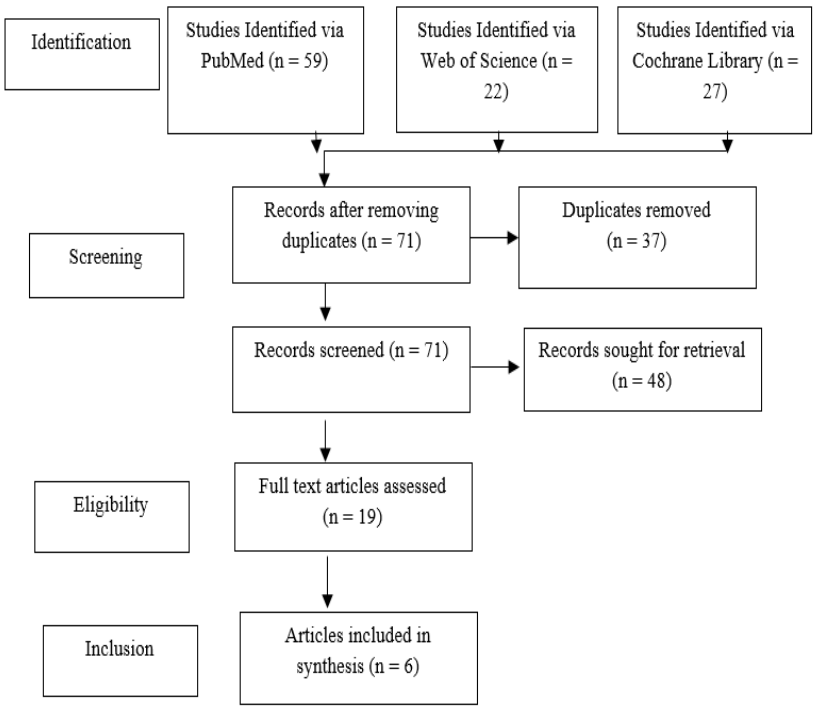

Figure 1. PRISMA flow diagram

Risk of Bias Assessment

The quality of the included research was evaluated using the Cochrane risk of bias evaluation technique (Table 2).

Table 2. Summary of Cochrane risk of bias assessment

Study	Selection bias/appropriate control selection/baseline characteristics similarity	Selection bias in randomization	Selection bias in allocation concealment	Performance-related bias in blinding	Reporting bias/Selective reporting of outcomes	Detection bias blinding outcome assessors	Accounting for confounding bias
Nathan *et al*. [10]	+	+	+	+	+	+	-
Sutil *et al*. [11]	+	+	+	+	-	+	-
Anggakusuma *et al*. [12]	+	+	+	+	+	_	+
Meireles *et al*. [13]	+	+	+	+	+	+	-
Sadeghloo *et al*. [14]	+	-	+	+	+	+	+
Knežević *et al*. [15]	+	+	+	-	+	+	+

Results and Discussion

The various carbamide concentrations were examined in the Nathan *et al.* investigation [10]. According to the results, 35% CP had the highest peroxide leakage among the carbamide peroxide concentrations, followed by 15% and 10%. To ascertain which two groups had a statistically significant distinction, the Mann-Whitney test was employed. Comparing each group to the others revealed a statistically significant distinction. Fifty single-rooted premolars from young, healthy people have been employed in the present research. The number of large and small teeth in each group was then used to split the specimens into five groups. The amount of peroxide was calculated utilizing an optical density assessment made using a UV-visible spectrophotometer calibrated to 480 nm. Peroxide leakage was shown to be decreased at CP 10% and 15% concentrations in the present research.

Eighty patients were selected for clinical examinations at the college's dental clinics for the research by Sutil *et al.* [11]. Participants needed to be at least eighteen years old, in good dental and general health, with all of their natural teeth, free of frontal carious and non-carious lesions, and without any indications of periodontal disease. One common negative effect of at-home teeth whitening is gingival irritation. It was determined that gingival inflammation would rise with the administration of 37% CP. Nevertheless, shorter (37% CP) than longer (10% CP) consumption may lessen gingival damage, similar to tooth sensitivity. Lastly, it is significant that both 10% and 37% of CP showed comparable whitening results following three weeks of therapy. The daily at-home bleaching regimen was supposed to more than compensate for the decreased concentration of the 10% CP gels. When compared to utilizing 10% carbamide peroxide for four hours a day for teeth whitening, 37% CP for 30 minutes a day did not increase gingival irritation or tooth sensitivity. Thus, utilizing 37% CP for 30 minutes a day can reduce the amount of time you need to utilize the trays for at-home teeth whitening.

Anggakusuma *et al*. [12] did a further investigation in which they discovered that substantial numbers of S. mutans stuck to the surface of the teeth following carbamide peroxide treatment, as evidenced by turbidimetry and the TPC test. After being treated with 35% carbamide peroxide, *S. mutans* was detected in large amounts on the surface of the teeth (3,034,000 CFU/ml, OD: 0.06). These results indicated that carbamide peroxide altered the surface structure of enamel, increasing roughness and promoting *S. mutans* adherence. When exposed to carbamide peroxide, the surface enamel of teeth exhibited structural changes, with greater changes noted at higher carbamide peroxide concentrations in terms of surface roughness.

Meireles *et al.* [13] found that varying doses of carbamide peroxide (10%, 16%, and 37%) were efficacious. After a week of therapy, the results show that concentrations of 10 and 16% are more beneficial than 37%. Following treatment, the color enhancement was comparable whether the bleaching was done in-office (37%) or at home (10 or 16% carbamide bleaching chemicals). The average tooth shade of the CP37-treated group was substantially lighter than that of the other bleaching techniques tested during the same period ($P < 0.01$). The tooth color of the CI10, CI16, and CI37 groups did not change statistically significantly one week following bleaching (T2).

All of the teeth in each treatment group got lighter (L*), less red (a*), and less yellow (b*) when comparing their before and after conditions ($P < 0.001$). During both evaluation periods, the CI37 group's rise in lightness (L*) was less pronounced than that of the CP10 and CP16 groups ($P < 0.001$). Regarding the decrease in a* values at T2, there was no statistically significant distinction between the CP10, CP16, CP37, and control groups. The reduction in b* values for CI37 was much less than those of the other treatment groups ($P < 0.001$).

The impact of 10% and 35% CP and the control group on microleakage was noted in the research done by Sadeghloo *et al.* [14]. It is evident from the results that the bleached group differs significantly from the control group. Additionally, the results indicate that the microleakage score did not considerably change among the three CP concentrations (10% to 35%). Every one of the ten tests (100) was immune to the bleaching impacts of carbamide peroxide at a concentration of 16%. After the second treatment, the weight of six teeth (60%) decreased. Nevertheless, following the third treatment, none of the six teeth that were inspected had any color change (four teeth were disqualified from the third operation since their shade remained the same following the first two treatments). There was no noticeable difference between the first and third bleaching treatments, but we did observe a significant and statistically significant distinction ($P < 0.05$) between the second and third treatments. Following the first treatment, 10% of teeth in a group bleached with 30% carbamide peroxide did not brighten. The exact binomial test was used to demonstrate the statistically significant distinction ($P < 0.05$) in this subset. After bleaching with 16% carbamide peroxide, one shade lightened six teeth (86.67%), whereas two colors lightened just one tooth (16.67%).

Knežević *et al.*'s study [15] examined the utilization of 24 human premolars and molars that had just been extracted from healthy people. To determine if there were any statistically significant differences in the groups' microleakage scores, the test was employed. The findings showed that the group of teeth bleached with a higher carbamide peroxide concentration (30%) and a shorter exposure period (roughly 15 minutes) experienced a more significant change in tooth color than the group of teeth bleached with a lower carbamide peroxide concentration (16%) and a longer exposure period (**Table 3**).

Table 3. Summary of results.

Study	Objectives	Material used	Outcome
Nathan *et al*. [10]	Radicular peroxide penetration from different concentrations of carbamide peroxide gel during intracorneal bleaching	10%, 15%, and 35% carbamide peroxide.	CP (35%) most peroxide leakage at 15 and 10%.
Sutil *et al*. [11]	Effectiveness and adverse effects of at-home dental bleaching with 37% versus 10% carbamide peroxide	10%, and 37% carbamide peroxide.	Comparing 37% CP for 30 minutes daily to 10% CP for 4 hours daily, there was no rise in gingival irritation or tooth sensitivity.
Anggakusuma *et al*. [12]	Effect of carbamide peroxide on surface enamel structural changes	high quantities on the surface of the teeth after treatment with carbamide peroxide 35% (3,034,000 CFU/ml, OD: 0.06)	These results showed that carbamide peroxide altered the enamel's surface structure and that the increased roughness promoted the adherence of *S. mutans*.
Meireles *et al*. [13]	Effectiveness of different carbamide peroxide concentrations used for tooth bleaching	10%, 16%, and 37% carbamide peroxide.	These results showed that, after a week of therapy, carbamide peroxide concentrations of 10 and 16% are more efficient than those of 37%.
Sadeghloo *et al*. [14]	The effect of various effect of different concentrations of carbamide peroxide on the marginal seal of composite	10%, 22%, and 35% carbamide peroxides	The findings also showed that the focus of CP (10%, 22%, and 35%) was not a substantial variation in microleakage score.
Knežević *et al*. [15]	The degree of tooth color change using different concentrations of carbamide peroxide	16% and 30% carbamide peroxides	The findings revealed that teeth bleached with a greater concentration of carbamide peroxide (30%) and a shorter exposure duration (15 minutes) had a significant degree of tooth color alteration.

The purpose of this review is to evaluate how tooth color is affected by varying concentrations of carbamide peroxide. One obvious aesthetic problem is tooth discoloration. Instead of using dental prostheses, both patients and dentists would like to have their discolored teeth returned to their original color. Because of its established safety and effectiveness, this 10% CP concentration is widely regarded as the gold standard in dentistry for at-home whitening [16].

The present meta-analysis demonstrated that irrespective of whether 10% or 35% carbamide peroxide was utilized, microleakage was statistically significantly higher in the bleached group than in the unbleached group. Although a prior study suggested that bleaching chemicals might have an impact on microleakage in Scotch-bonded composite restorations, researchers demonstrated that this was not the case. Non-vital bleaching with 10% CP exacerbated microleakage in the margins of composite restorations, according to Moosavi and colleagues. Microleakage in the dentin margins of composite restorations may be boosted by bleaching with CP after restoration, according to Moosavi *et al.* [17]. Dentin protein and enamel, which are both firmly rooted in inorganic materials, have been linked to denaturation when CP is used. Modifications to the mechanical details may result in a decrease in microhardness, which might weaken the resin's bond with the teeth.

There are several tooth-whitening products available, and the amount of carbamide peroxide in each one affects how effective it is. The effectiveness of carbamide peroxide for home use (10% and 16%) was tested by the researchers using the application technique and period suggested by the manufacturer for each group. The outcomes of using at-home bleaching solutions (10 or 16% carbamide) are probably going to be similar to those of salon-grade bleaching procedures. This experiment demonstrated that contact time with the bleaching chemical was more significant than gel concentration once the 37% concentration reached its maximum effectiveness. Unexpectedly, extended treatment durations increased tooth color in a comparable way, independent of the peroxide concentration. Prior research has indicated that while deciding whether to have your teeth whitened, there are two important factors to take into account. Some individuals think that whitening solutions with larger bleaching chemical concentrations will work faster and more effectively [18]. According to a review of 25 teeth-whitening procedures and nine clinical trials, the success rate of dental whitening was increased when the bleaching agent was placed in trays.

Tooth enamel treated with 35% carbamide peroxide exhibited the most pronounced structural alterations in comparison to samples treated with 10% and 15% carbamide peroxide. The results demonstrate that carbamide peroxide alters the structure of the enamel on the surface of teeth, with surface roughness serving as a measure of the degree of change as the concentration of carbamide peroxide (up to 35%) rises. Additionally, Goldberg *et al.* [19] demonstrated that employing a higher carbamide peroxide concentration caused structural alterations in dental enamel. The results, however, contradict those of earlier studies.

The groups that were bleached with a higher carbamide peroxide focus (30%) and shorter exposition time (two applications lasting 15 minutes each) and the groups that were bleached with a lower carbamide peroxide focus (16%) and longer exposition time (four applications lasting 30 minutes each) did not vary statistically significantly in the extent of tooth color change (three applications lasting 30 minutes each). For best effects, the teeth-whitening solution has to be used at the right moment. For the optimum result, the amount of time spent in therapy should be proportionate to the degree of tooth color change. The same bleaching effects as a high concentration can be obtained by applying a mild concentration of a bleaching agent to a tooth over an extended period. Meireles *et al.* [13] demonstrated that the duration of contact with the bleaching agent was more significant than the gel concentration. The high quantity of carbamide peroxide did not prevent the teeth from being effectively whitened after several treatments. The American Dental Association's (ADA) recommendation to whiten teeth with modest quantities of carbamide peroxide is in line with the authors' strategy in this instance.

Comparing the results of at-home teeth whitening with 10% and 37% carbamide peroxide, colorimetric studies show differences. Compared to 10% CP (4 hours per day), they found that 37% CP (30 minutes per day) was more beneficial. It was anticipated that the outcomes would be the same because whitening teeth with 15–20% CP gels after two weeks of use was shown to be more effective than with 10% CP gels. At larger concentrations, CP may oxidize the substrate and cause it to react with the organic component of dentin more quickly because it produces more free radicals. To achieve the same level of whitening, though, it will take longer since less focus produces fewer free radicals and interacts with the dentin substrate more slowly.

10% and 15% CP concentrations considerably reduced peroxide leakage, according to the research. For impaired teeth with cervical dental abnormalities, where the risk of external root resorption is highest, it may be tried in place of conventional therapy. The CP concentration was increased to 37% by Sharafeddin and Jamalipour [20]

to alter the walking bleach technique. The tooth color was assessed using four clinical visits spread out over a month. It was worth the four weeks it took to get what was needed, which included the teeth looking more natural. A clinical and radiological assessment conducted ten months following treatment confirmed the absence of external cervical root resorption and the lighter tooth shade. Sharafeddin and Jamalipour [20] demonstrated that the surface roughness of composite resin was unaffected by the use of 35% CP bleaching gels.

Lim *et al.* [21] discovered no discernible disparity in the effectiveness of two of the most widely used bleaching chemicals, 35% CP gel and 35% HP gel. After seven days, they were far more appealing than sodium perborate. Because CP gel 35% has a larger free radical discharge, it was recommended as the best intracorneal bleaching agent and substrate to start a quicker reaction with the organic component of dentin. Nevertheless, it will take longer to attain the same amount of whitening since the lower concentration produces fewer free radicals because it reacts with the dentin substrate more slowly. This explains the reason why 10% CP produces a lesser initial degree of whitening than 37% CP.

Conclusion

- A color shift was seen at both carbamide peroxide concentration levels.
- On the other hand, a great deal of focus frequently produced surface roughness that might facilitate the deposition of *S. mutans*.
- Good outcomes can be obtained with low concentration without running the danger of negative side effects.

Acknowledgments: We would like to thank the Riyadh Elm University Research Center for its assistance.

Conflict of Interest: None

Financial Support: None

Ethics Statement: This study fulfils the ethical requirements of Riyadh Elm University.

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