



## EVALUATION OF THE SAFETY AND EFFICACY OF THE LED TEETH WHITENING SYSTEM

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### Abstract:

In this clinical evaluation, the primary focus was to assess the safety, efficacy, and patient satisfaction with a Light Emitting Diode (LED) teeth whitening system designed to whiten teeth by utilizing photochemical reactions activated by LED light. Two patients presenting with mild to moderate tooth discoloration were treated using this system. In the first case, the patient exhibited mild pale-yellow discoloration. In the second case, the patient had yellow discoloration accompanied by minor sensitivity. Both patients underwent multiple treatment sessions utilizing a whitening gel activated by LED light. The LED teeth whitening system functions by utilizing a specially formulated whitening gel that is applied directly to the surface of the teeth. This gel is then activated through exposure to a precise wavelength of light emitted by an advanced LED device. The interaction between the gel and the light initiates a photochemical reaction that effectively breaks down stains on the enamel and dentin layers, leading to a visibly whiter smile. In comparison to conventional whitening techniques, the LED-based system offers a significantly enhanced patient experience. It is designed to be safer and more comfortable, minimizing common side effects such as tooth sensitivity and gum irritation. The controlled light emission and gel composition ensure that the whitening process is both gentle and effective, making it suitable for patients with varying degrees of discoloration. As a result, there was a significant improvement in tooth color after treatment with minimal sensitivity or side effects. It shows that LED teeth whitening is a non-invasive, safe, and effective alternative to traditional whitening methods, offering faster results with reduced discomfort.

**Key Words:** Light Emitting Diode (LED), Teeth Whitening, Whitening Gel, Photochemical Reaction, Clinical Evaluation

### Introduction:

Teeth discoloration is a most common aesthetic concern that can affect an individual's self-esteem and confidence. This condition can be caused by intrinsic factors, such as aging, trauma, genetic predispositions, or disease, and extrinsic factors, including food, beverages, smoking, and certain medications. Discoloration often presents as yellow, brown, gray, or white stains, depending on the underlying cause, such as yellow from dark foods or poor hygiene, brown from smoking or tobacco use, purple from red wine, gray from nerve damage, white flecks from dental fluorosis.

Some unavoidable teeth discoloration causes includes genetic factor, Dental trauma, Aging, Dental treatment some dental material like silver amalgam used to metal fillings may cause teeth discoloration also the tooth canal therapy can sometime result in discoloration.

Additionally, some health conditions cause teeth discoloration including liver disease, celiac disease, calcium deficiency while some medication are cause the discoloration likewise; antihistamines, drug for high blood pressure, especially adults who took tetracycline or doxycycline during childhood are may cause the teeth discoloration.



Figure 1: Types of Teeth Discoloration

To address this condition, various traditional methods of teeth whitening are available including bleaching agents (e.g., hydrogen peroxide and carbamide peroxide), whitening strips, and over-the-counter gels, offer some relief but each technique has its benefits and limitations [Cleveland Clinic. 2023] (Choudhary Ekta et al 2024) (Dr Richard et al 2024) (Noorsaed et al 2021), (Bersezio et al 2021) (Kahler et al 2022) (Kwon et al 2015)].

Bleaching agents are used in both vital tooth bleaching and non-vital bleaching procedures. There are various adverse effects of tooth bleaching like gingival irritation is a common and mild form of gum disease causes irritation, redness, swelling and bleeding of gingival, tooth sensitivity, cervical root resorption is a condition where the root of a tooth starts to break down

near the gum line it can be caused by trauma, inflammation or orthodontic treatment, damage to enamel; damage to restorative materials, chemical burns [Noorsaeed et al 2021, Patil, G et al 2022, Mounika et al 2018].

Among these, a new innovation technique LED teeth whitening has emerged as a recent advancement in the field of cosmetic dentistry. LED teeth whitening produces a specific wavelength of LED emits that activates the whitening agent in the gel, enhancing the bleaching process. The whitening gel, usually containing carbamide peroxide, hydrogen peroxide and sodium pebarate breaks down when it comes to contact with LED light, allowing oxygen to penetrate the teeth and break down stains and specific wavelengths, light intensities are crucial in optimizing the whitening process, ensuring efficient and safe treatment outcomes. The combination of light and whitening gel its offers long-lasting effect with minimal sensitivity which are main advantages of LED teeth whitening is that it delivers faster results than traditional whitening methods methods [Choudhary Ekta et al 2024), (Noorsaeed et al 2021), (Bussadori SK et al 2017), (Zhao X et al 2023), ( Kiryk, Jan et al 2024), (Panhoca, Vitor et al 2024), (Oommen Taniya et al 2024,( Brugneraet al 2020)].

Recent advancements in teeth whitening technology have introduced LED-based systems that use light to activate whitening gels more effectively than traditional methods. LED teeth whitening involves a photochemical reaction where specific wavelengths of light activate whitening agents, enhancing stain removal with faster results and reduced side effects.

This clinical assessment aims to examine the efficacy and safety of a professional LED teeth whitening system, comparing it to traditional whitening treatments and exploring patient outcomes. [(Bussadori SK et al 2017), (Zhao X et al 2023), (Kiryk, Jan et al 2024)]

**Device Description:**

The LED teeth whitening system utilized in this assessment is designed for professional application within dental clinics and hospitals. It features a high-powered LED light source with customizable settings to accommodate different patient needs. The system operates by emitting specific wavelengths of light (blue, red, and purple) that activate a whitening gel applied to the tooth surface.

**Technical Specifications:**

- Broad Spectrum: 450nm-510nm (Blue light), 620nm-640nm (Red light), 380nm-420nm (Purple light).
- Voltage: AC: 100V-240V
- Light Source: 4-5W/pc (Blue light), 2-3W/pc (Red light), 1W/pc (Purple light).
- Display: 5-inch high-sensitivity LCD touch screen with customizable settings.

Table 1: Benefits of Multi-light LED whitening

Light Color	Purpose	Benefits
Blue Light	Activates whitening gel on teeth surface	Breaks down stains effectively and quickly.
Red Light	Improve blood circulation in gums	Promotes gum health and reduces sensitivity.
Purple Light	Combines blue & red wavelengths	Targets stains and supports oral hygiene.
Red + Blue	Dual action whitening and gum care	Enhances whitening while soothing gums

**Main Screen Function**

A main screen-functional high sensitivity, 5-inch touch electronic display with easy to operation, sleek LCD screen and advanced LED technology, this teeth whitening machine offers a truly immersive experience. The vibrant display allows for effortless navigation and control ensuring a seamless and personalized treatment for each user.

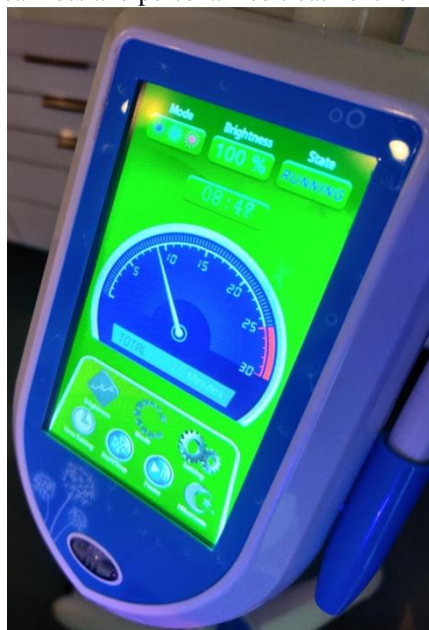


Figure 2: 5 inch LED Display

**Product Features:**

- Adjustable light intensity (low, medium, high) to tailor treatment according to patient needs.
- Time setting range from 1 to 30 minutes per session.
- Enclosed disposable sheaths to prevent cross-infection.
- Automatic sleep functions after 60 seconds of inactivity to conserve energy.

**Clinical Relevance:**

The LED system is effective and safe, with studies showing minimal discomfort and reduced risk of enamel damage compared to traditional bleaching techniques. The system's ability to accelerate the whitening process with minimal sensitivity makes it a suitable alternative for patients seeking faster results.

**Clinical Evaluation Methodology:**

**Patient Selection:**

This clinical assessment involved two patients, both of whom reported dissatisfaction with their teeth discoloration.

**Case 1:** A 28-year-old female, presented with mild pale yellow discoloration on her upper and lower incisors. The patient had no significant medical history likewise allergies or oral diseases and maintained good oral hygiene. On the clinical examination patient had mild discoloration in teeth, but no plaque, cavities, gum recession was observed then case was completed into two sessions.

**Treatment Protocol:**

Patient underwent two sessions of whitening treatment with the LED system:

**Session 1:** Blue light (480nm wavelength) was used to activate a 35% carbamide peroxide gel to break stain molecules on the tooth surface and blue light helped to activate the whitening gel on the tooth surface and breakdown stain effectively resulting in faster and noticeable whitening observed on the teeth. The treatment duration was 15 minutes.

**Session 2:** A combination of blue (460nm), red (620nm), and purple (380nm) lights was used in conjunction with the same whitening gel. This multi-light treatment aimed to enhance whitening efficacy, overall oral hygiene while promoting gum health and reducing sensitivity and the medications prescribe for the whitening and sensitivity of teeth.



3.a: Image before the teeth whitening process

3.b: Image After the teeth whitening process

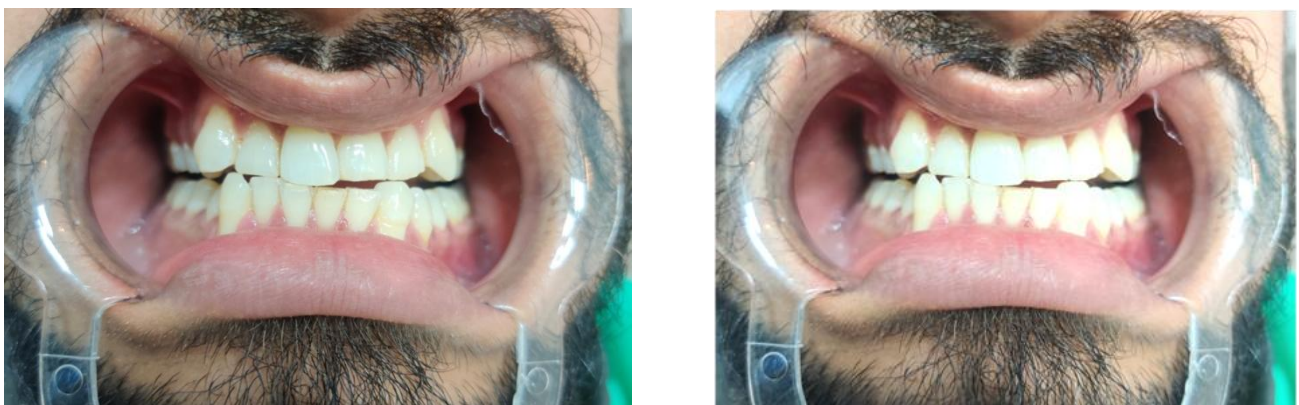
Figure 3: LED teeth whitening procedure showing noticeable whitening results

**Case 2:** A 25-year-old male, experienced yellow discoloration primarily on his lower incisor on anterior teeth and slight extension to the posterior with minor sensitivity on teeth. On clinical examination patient had yellow discoloration in teeth, but no plaque, cavities, gum recession was observed. Before teeth whitening treatment scaling was done on teeth for enhance result.

**Treatment Protocol:**

Patient underwent one sessions of whitening treatment with the LED system:

**Session 1:** Three light sources are use which is Blue light about (480nm wavelength) was used to activate a 35% carbamide peroxide gel to break stain molecules on the tooth surface. Red light with wavelength 620nm; blue light with about 450nm wavelength and purple light with wavelength 380nm were used during the treatment. The treatment duration was 30 minutes. These LED lights interact with Carbamide peroxide resulting breakdown the stain quickly whereas red light enhance blood circulation in the gums and reduced sensitivity of the teeth and also Medications prescribe for the whitening and sensitivity of teeth.



4.A: Image before the teeth whitening process

4.B: Image After the teeth whitening process

Figure 4: LED teeth whitening procedure showing noticeable whitening results

**Results:**

**Case 1: Female Patient**

- Initial Condition: Mild pale yellow discoloration, no plaque, cavities, or gum recession.

- Follow-Up and Monitoring: Post-treatment follow-up occurred after 1 week to assess color change and sensitivity. The results were documented through visual assessment and shade comparison using a standardized color scale.
- Results: After two sessions, significant improvement in tooth color was observed, with a noticeable whitening of approximately 3-4 shades on the shade guide. The patient reported minimal sensitivity post-treatment.

#### **Case 2: Male Patient**

- Initial Condition: Yellow discoloration with mild sensitivity, primarily affecting lower incisors.
- Follow-Up and Monitoring: After the procedure patients were instructed to refrain from eating or drinking foodstuffs rich in color for the first 48 hours after the LED bleaching stage. Medications prescribe for the whitening and sensitivity of teeth to the patient. Once the treatment completed, the patient visited hospital for follow-up to evaluate the shade change and any post-operative sensitivity. The follow up revealed reduced sensitivity and a stain on the teeth.
- Results: After completing the treatment patient visited hospital for follow-up to evaluate the shade change and any post operative sensitivity. The examination revealed a noticeable improvement in the overall shade of the teeth. The patient expressed high satisfaction with the significant results increase in lightness as well as reductions in redness and yellowness after the completion of the whitening treatment and the follow up revealed reduced sensitivity and a stain on the teeth.

#### **Discussion:**

Teeth discoloration can result from a combination of intrinsic and extrinsic factors. Traditional whitening methods, including bleaching agents, have long been the standard treatment; however, they come with side effects such as gingival irritation, tooth sensitivity, cervical root resorption, damage to enamel, damage to restorative materials, chemical burns. LED teeth whitening offers a safer and more efficient alternative, with studies indicating it can produce quicker results and reduce patient discomfort compared to conventional methods.

In this evaluation, both patients experienced significant improvements in tooth color after two sessions with minimal sensitivity. The use of blue, red, and purple light wavelengths worked synergistically to activate the whitening gel and promote gum health. The red light enhanced blood circulation, while the purple light combined the benefits of blue and red wavelengths to target stains and improves overall oral hygiene.

The clinical evaluation shows that noticeable improvement in teeth color after the few sessions. Primary benefit of LED teeth whitening is its non-invasive nature, this method offers more effective and low complications. The LED exposure is not harmful and there is no significant risk of damage to the enamel over the traditional methods.

Compared to laser-assisted whitening, which can require more intensive sessions and may increase the risk of enamel damage, LED whitening provides a gentler approach with comparable outcomes. This method also reduces the risk of side effects like chemical burns or enamel erosion, making it a more patient-friendly option.

The successful whitening outcomes achieved in clinical use underscore the potential of this advanced LED technology as a powerful tool in modern cosmetic dentistry. Its ability to deliver significant improvements in tooth color, with minimal discomfort, positions it as a preferred option for both dental professionals and patients seeking effective aesthetic enhancement.

#### **Limitations:**

- Sample Size: This clinical assessment was limited to two patients. Larger studies are necessary to confirm the generalizability of these results.
- Follow-Up Duration: The follow-up period was limited to one week. Long-term studies assessing the durability of whitening effects are needed.
- Patient Factors: The results may vary based on individual patient characteristics, such as age, severity of discoloration, and oral health.

#### **Conclusion:**

LED teeth whitening systems represent a significant advancement in dental aesthetics. This innovative, non-invasive, efficient, and safe technique provides quicker results with minimal sensitivity compared to traditional whitening methods. This non-invasive technique utilizes light-emitting diodes (LED) to activate whitening agents, typically hydrogen peroxide or carbamide peroxide, accelerating the whitening process.

The clinical evaluation demonstrates the potential of LED whitening to effectively treat teeth discoloration, offering patients a comfortable and affordable option for brightening their smiles.

However, the initial findings are encouraging further research is necessary to establish the long term safety and efficacy of LED whitening. In future study should include larger, more diverse populations and extended follow-up periods to better understand treatment durability, enamel health, and optimal usage intervals. This evidence will be crucial for developing standardized guidelines and ensuring that LED whitening remains a reliable and sustainable option for dental care.

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