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# Studying the effects of wavelengths (565, 810) NM used in-home cosmetic laser on native rabbits

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**Abstract**

A contemporary method for cosmetic treatment, especially hair removal, is at-home laser technology. The properties of the light wave and how it affects the target tissues determine how successful it is. In order to ensure the safety and effectiveness of at-home lasers, it is necessary to assess the biological and histological impacts of various wavelengths. In order to determine how much each laser wavelength affects deep and superficial tissues, this study will examine the histological and biological effects of two laser wavelengths (565 nm and 810 nm) used in at-home laser hair removal devices on the dermal and tissue tissues of European rabbits (Rabbits). Twenty-four domestic female rabbits were utilized, and they were split into three groups at random: a control group that received no treatment, a group that was exposed to a wavelength of 565 nm, and a group that was subjected to a wavelength of 810 nm. The animals were subjected to the wavelengths for three to six weeks, during which time they underwent routine microscopic and histological evaluations. Histological and microscopic imaging methods were used to examine changes in skin structure, collagen, hair follicles, and inflammation. According to the study's findings, the 565 nm wavelength had little effect on deeper tissues but produced a few restricted superficial effects, such as enhanced collagen deposition and skin regeneration, especially in thin epidermal areas. As a result of its capacity to reach deeper layers of the skin, the 810 nm wavelength, on the other hand, produced more severe effects, including visible heat impacts and substantial alterations in hair follicles and surrounding tissues. The study's findings, which take into account the effects of time and dose, demonstrate that the skin's biological reaction to laser irradiation is significantly influenced by wavelength characteristics in terms of penetration and efficacy. These results highlight the necessity to take into account the variations in different wavelengths and their possible clinical consequences while offering a scientific foundation for creating safe and efficient at-home laser applications in cosmetic care.

**Keywords:** Laser wavelength, Biological tissues, Dermis, Thermal changes

## 1.Introduction

Even while laser technology has many benefits, improper application could have negative biological and environmental repercussions. The physical characteristics of the light employed, particularly its wavelength and duration of exposure, have a significant impact on the outcomes and effects of lasers on tissues [1, 2]. This emphasizes how important it is to have a thorough grasp of how lasers interact with human tissue in order to maintain a balance between safety and effectiveness [3, 4]. Due to the extensive usage of laser devices by non-professionals at home, recent research assessing the effects of lasers on tissues, especially those used in home applications, are becoming more and more important [5,18]. If their efficacy and safety are not sufficiently evaluated, this could be dangerous. Additionally, the majority of earlier studies have used large animals or direct human models to examine the efficacy of lasers in treating skin diseases or removing hair. The specific histological effects of the various wavelengths employed in home laser systems, particularly on appropriate animal tissues as an alternative model, are still poorly understood [6, 7].

Therefore, in order to ascertain the safety and efficacy of these devices in home usage, comprehensive experimental studies are required to assess the histological and biological changes occurring from exposure to various light wavelengths [8]. Analyzing tissue penetration, alterations in tissue structure, collagen levels, and hair follicle cell activity offers crucial scientific information for enhancing laser technology research and design to make it safer while still producing the intended effects. In order to comprehend the impact of each wavelength on superficial and deep tissues, as well as to assess the safety and efficacy of these wavelengths in home cosmetic treatment, this study will assess the histological and structural effects resulting from the use of two laser wavelengths (565 nm and 810 nm) in home cosmetic laser devices on the tissues of domestic rabbit animals.

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## 2. Study Methodology

### 2.1. Study design

The histological effects of two-wavelength lasers (565 nm and 810 nm) on the tissues of domestic rabbits were assessed in this cross-sectional experimental study [9]. The study employed twenty-four female domestic rabbits that were chosen at random to reduce bias and guarantee individual variations [10,19]. The rabbits weighed between 1900 and 2400 g and were between 6 and 8 months old. To guarantee a fair distribution of samples among the groups, their weights were precisely measured using a sensitive scale.

To provide a clean and infection-free environment, the bunnies were put in individually equipped containers that were pre-sterilized and disinfected with certified disinfectants. To meet their nutritional demands and promote their general health, they were given clean water, a balanced, manufactured food, and some fresh veggies like carrots, cucumbers, and leafy greens every day. In order to maximize tissue responsiveness and rabbit behavior, stable environmental conditions were supplied, such as an ambient temperature between 22 and 25°C and a natural light cycle of 12 hours of light followed by 12 hours of darkness. Before the studies started, the rabbits were given 14 days to get used to the lab environment.

### 2.2. Ethical approval

The Ethics Committee for the Use of Animals in Scientific Research at the University of Thi-Qar's College of Education for Basic Sciences examined and approved the experimental procedure (Committee Approval No. 3612/2025). In order to guarantee the safety and welfare of the animals, all local and international ethical requirements were followed. This included reducing pain and suffering, giving the required medical attention, and using suitable scientific techniques to use as few animals as feasible.

### 2.3. Animal division and experimental design

Following the acclimation phase, the rabbits were split into three groups of eight animals each at random. Control Group, this group was used as a reference group for comparison and was not exposed to any kind of laser. A home laser device was used to expose Experimental Group 1 (565 nm) to a 565 nm laser wavelength. Using the identical apparatus, Experimental Group 2 (810 nm) was exposed to an 810 nm laser wavelength.

### 2.4. Procedures for laser exposure

The instrument utilized in this study was a Philips Lumea, a home-use laser device based on Intense Pulsed Light (IPL) technology, which is commonly employed for hair removal applications. To ensure the accuracy and reliability of the results, the device specifications were consistent with scientific standards. The device was adjusted to the designated wavelengths for each experimental group, while maintaining controlled energy intensity and exposure duration to ensure fair variation between experimental conditions.

The device produces a broad light spectrum ranging from 565 to 1400 nm, with an energy density ranging from 2.4 to 6.5 J/cm$^2$, depending on the selected operating level. It features five adjustable energy levels to accommodate different tissue sensitivities. Each light pulse lasts 1–2.5 milliseconds, with an inter-pulse interval of 1–3.5 seconds, depending on the operating mode. The device operates at a power output of 12 V/3 A (36 W).

The face, neck, underarms, abdomen, and hips were selected as the exposed body regions. Each exposure area was precisely defined as 2.5 cm$^2$ using specialized measuring tools to guarantee repeatability and reliability. The exposure time for each site ranged between 15 and 20 seconds, with the energy level automatically adjusted and limited according to the device's standard settings, ensuring that recommended safety limits were not exceeded. During all exposure procedures, the rabbits were securely restrained to prevent movement that could affect application accuracy, and all procedures were performed with great care to avoid causing stress to the animals.

### 2.5. Study length and assessment times

To ensure a thorough assessment of the laser's effects on tissues, the eight-week study period was split into

several phases.

### A. *First exposure stage*:

The first day that the rabbits in the two experimental groups received laser treatment marked the start of this phase. To guarantee the recurrence of the effects and validate their stability over time, all exposure sessions were repeated in accordance with a schedule established for each group (once weekly).

### B. *Evaluation and follow-up tests*:

- Clinical Examinations: Every day, clinical examinations were carried out to keep an eye on the rabbits' overall health, including any indications of malnourishment, revolt, or illness brought on by stress or laser exposure.

- Laboratory Examinations: To quantify inflammation, oxidative stress, and target enzyme levels, blood samples were taken from each rabbit before to the commencement of the trial (Day 0) and following each week of treatment. Certified biochemical analyzers were used to examine these samples. Imaging and Histological Modeling: To evaluate structural alterations in the tissues, MRI and X-rays were taken at the conclusion of weeks 4 and 8. In order to assess damage, impacted cells, and inflammatory patterns, histological biopsies were also obtained from the exposed areas for additional microscopic examination.

### C. *Data analysis:*

Following the time period, data were gathered and statistically analyzed using statistical software (such as SPSS or R). The level of statistical significance was set at $p<0.05$, and the appropriate tests were applied to analyze differences between groups (such as One-way ANOVA followed by Interference Analysis).

## 3. Results and Discussion

The results show the values of the study groups and the control group. (Figure.1) shows a skin section from the control group containing intact epidermis, along with normal skin components such as collagen fibers, hair follicles, and sebaceous glands, and a skin section stained with hematocrit and estrogen.

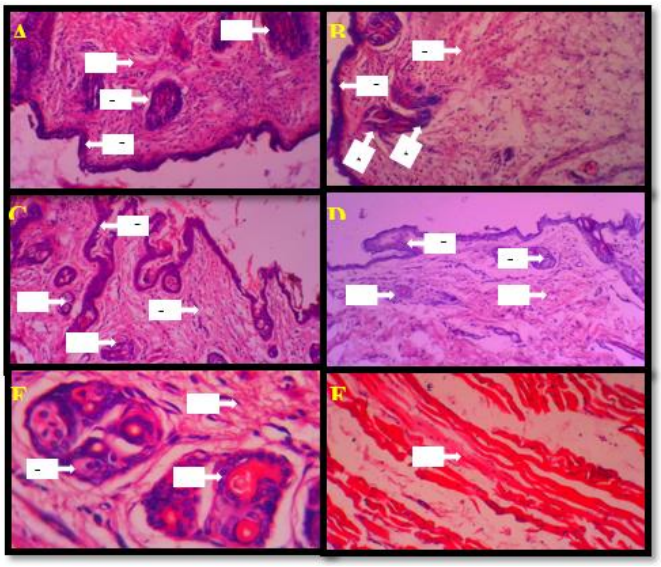

**Figure (1):** Skin section from the control group: Arrow (I) intact epidermis, Arrow (II) normal skin components such as collagen fibers, Arrow (III) hair follicles, Arrow (IV) sebaceous glands. Skin section stained with hematocrit and estrogen: (a) facial skin, (b) neck skin, (c) axillary skin, (d) abdominal skin, magnified 10x, (e) thigh skin, magnified 40x, (f) normal muscle fibers

### 3.1. Effects of 565 nm light on histology

The findings demonstrated that rabbits exposed to a focused light pulse (565 nm) for three and six weeks had only minor surface alterations, mostly in the dermis' deeper layers. Under a microscope, the tissues showed a significant increase in collagen accumulation in the dermis, which improved markers of tissue regeneration and repair. This was especially true in areas with thin skin, like the face and neck, where there was a slight improvement in skin elasticity and a slight increase in tissue thickness.

There were little tissue alterations and no obvious indications of extensive inflammation or profound injury. This implies that the 565 nm wave reacts safely with superficial and intermediate tissues and has a limited effect on underlying tissues, particularly when the exposure time is not exceeded. Unlike those seen with the 810 nm wave, no damage to blood vessel pockets, death of hair follicle cells, or alterations to nerve cells were noted, as shown in (Figures. 2,3).

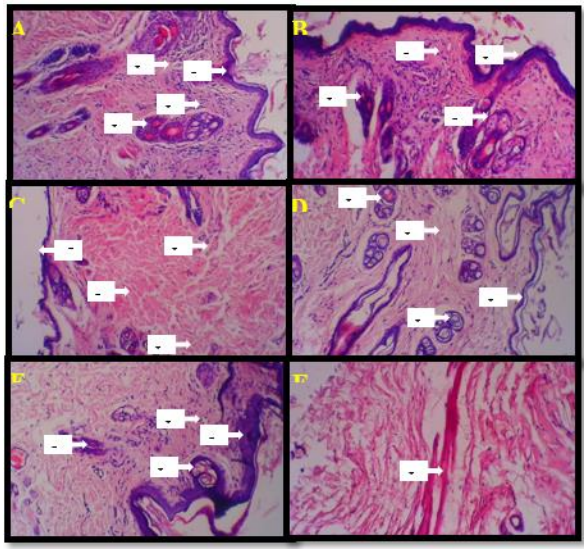

**Figure (2):** Skin sections exposed to 565 nm laser for 3 weeks: Arrow (I) Normal epidermis; Arrow (II) Dense collagen fibers in the dermis; Arrow (III) Normal hair follicles; Arrow (IV) Normal sebaceous glands in facial and neck skin (A and B); (C, D, E) Decrease and atrophy of both hair follicles and sebaceous glands in the dermis of the axillary, abdominal, and thigh skin; Arrow (V) Normal muscle fibers: (A) Facial skin; (B) Neck skin; (C) Axillary skin; (D) Abdominal skin at 10x magnification; (E) Thigh skin at 40x magnification; (F) Normal muscle fibers (hematocrit and isomer staining)

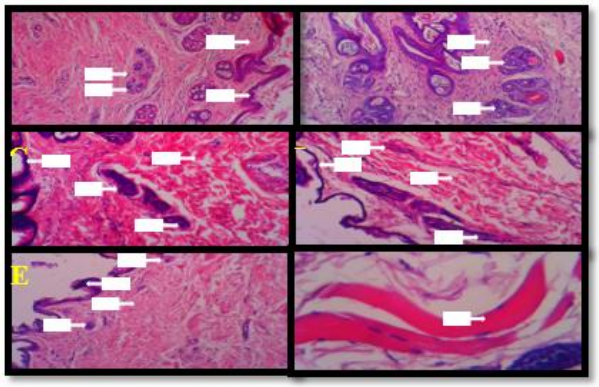

**Figure (3):** Skin sections exposed to a 565 nm laser for 6 weeks: Arrow (I) shows normal skin in all groups; Arrow (II) shows dense collagen fibers in the dermis; Arrow (III) shows a decrease in the number and atrophy of both hair follicles and sebaceous glands; Arrow (IV) shows normal muscle fibers; Arrow (V) shows normal muscle fibers: (A) facial skin, (B) neck skin, (C) axillary skin, (D) abdominal skin at 10x magnification; (E) Thigh skin (4x magnification); and (F) representative muscle fibers from all groups at 10x magnification (hematocrit and isopropylene staining)

### 3.2. Impact of the 810 nm wavelength on histology

The 810 nm wavelength, on the other hand, was shown to be more penetrating, bypassing the top layers and reaching deeper tissues. At three and six weeks after treatment, there were noticeable alterations in the structure of the hair follicles, including a considerable reduction in the surrounding tissue and damage to the hair follicle cells. Researchers found evidence of resistance in the tissue surrounding the follicles, as well as damage to nearby structures and surrounding cells that was connected to the inflammatory response and cell regeneration.

Two weeks after treatment, exposure to the 810 nm wavelength also significantly boosted the production of connective tissue, with larger collagen fibers, especially in places with thicker epidermis like the thighs and back. Along with vascular hyperplasia and alterations in nearby nerve cells, which indicated a deeper thermal influence in the inner layers of the dermis, these tissue alterations were suggestive of an ongoing inflammatory response and tissue repair processes. As shown in (Figures. 4,5).

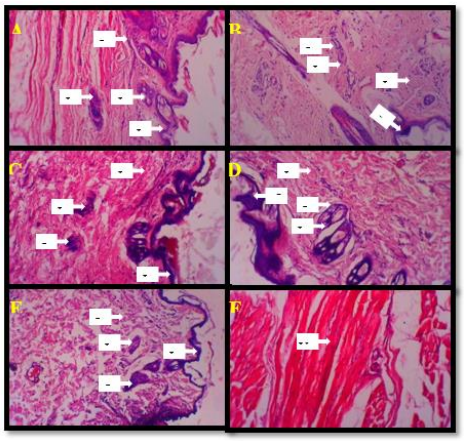

**Figure (4):** Skin sections exposed to 810 nm laser for 3 weeks: Arrow (I) Normal epidermal layer; Arrow (II) Dense collagen fibers in the dermis; Decrease in the number and atrophy of both hair follicles; Arrow (III) and sebaceous glands; Arrow (IV); Arrow (V) Normal muscle fibers: (A) Facial skin; (B) Neck skin; (C) Axillary skin; (D) Abdominal skin at 10x magnification; (E) Thigh skin (4x magnification); (F) Representative muscle fibers of all groups at 10x magnification (hematocrit and isopropylene staining).

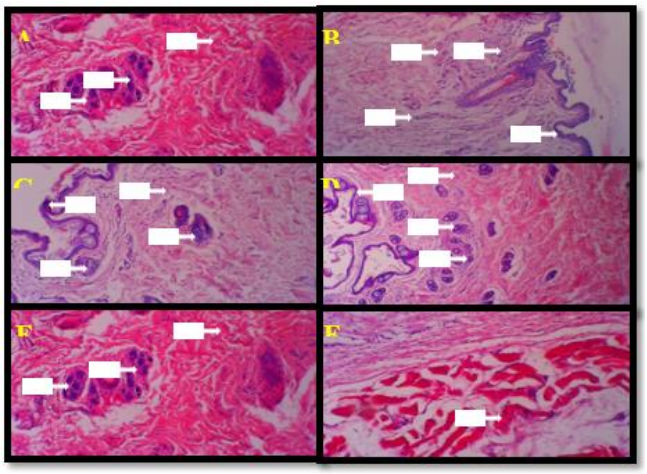

**Figure (5):** Skin section exposed to 810 nm laser wavelength for 6 weeks, Arrow (I) normal epidermis in all groups, Arrow (II) dense collagen fibers in the dermis, marked decrease in the number of hair follicles and their atrophy, Arrow (III), and absence of sebaceous glands, Arrow (IV), Arrow (V) normal muscle fibers: (a) facial skin, (b) neck skin, (c) armpit skin, (d) abdominal skin at 10x magnification, (e) thigh skin (4x magnification); (f) representative muscle fibers of all groups at 10x magnification (hematocrit and isopropylene stain)

### 3.3. Comparative analysis of the two wavelengths during two times

The effects of the 565 nm wavelength were found to be limited and showed only a modest increase with prolonged exposure when comparing the three-week and six-week treatment schedules. In contrast, the 810 nm wavelength demonstrated more pronounced and progressive effects over time, characterized by deeper and more substantial tissue alterations. Notably, tissue regions exposed for extended durations exhibited increased fibrosis and collagen stretching, indicating that exposure duration is a critical factor influencing the extent of wavelength-induced tissue effects.The observed differences between the effects of the 565 nm and 810 nm wavelengths can be attributed to wavelength-dependent tissue interactions and penetration depth, as supported by the present findings and previously published studies [11,12].

The 565 nm wavelength, operating within the visible spectrum, predominantly affects superficial tissue layers, where it promotes collagen formation and collagen fiber reorganization without causing significant structural damage. These characteristics make it particularly suitable for non-invasive dermatological applications aimed at improving skin firmness and elasticity, which is consistent with reports demonstrating that shorter wavelengths safely enhance collagen synthesis and support skin regeneration.

Conversely, the 810 nm wavelength exhibits significantly greater penetration depth, enabling effective interaction with deeper tissue layers and hair follicles. Comparative analysis with diode laser studies confirms its superior ability to penetrate tissue and induce follicular disruption, thereby enhancing its therapeutic effectiveness in procedures requiring deeper cellular damage, such as hair removal and targeted tissue modification [13,14]. However, the increased thermal penetration associated with this wavelength also elevates the risk of unintended tissue injury, underscoring the necessity for precise control of exposure duration and energy delivery.Collectively, these findings reinforce the importance of appropriate wavelength selection and exposure optimization to achieve optimal therapeutic outcomes while maintaining a balance between efficacy and safety. This highlights the need to tailor laser treatment parameters according to specific clinical objectives—whether enhancing superficial skin characteristics or targeting deeper tissue structures—while considering tissue response and physiological variability [15]. Based on the present study, the 810 nm wavelength is more suitable for deeper tissue targeting when exposure parameters are carefully regulated, whereas the 565 nm wavelength remains advantageous for non-invasive applications focused on improving skin texture and appearance [16, 17].

## 4. Conclusion

The study's findings demonstrated that the use of a 565 nm wavelength in at-home laser technology produces limited superficial effects, resulting in a notable increase in collagen accumulation and dermal regeneration, especially in areas with thin skin, without significantly affecting deeper tissues or causing irritation. The 810 nm wavelength, however, reached deeper layers, inducing changes in hair follicles and surrounding tissues, while also enhancing thermal effects that triggered various biological responses, including improvement of

complex skin structures. These findings emphasize the importance of selecting the appropriate wavelength according to treatment goals: the 810 nm wavelength is more effective for deeper tissues, whereas 565 nm is suitable for surface cosmetic applications and safe management of skin conditions. Following safety guidelines and proper exposure durations remains essential to achieve intended effects while minimizing risk.

Notably, the effects of the 565 nm wavelength increased only modestly with prolonged exposure, while the 810 nm wavelength produced progressively stronger tissue alterations over time. Extended exposure led to increased fibrosis and collagen stretching, highlighting the critical role of exposure duration in determining tissue response. These differences reflect wavelength-dependent tissue interactions and penetration depth, as supported by both the current findings and previous studies [11,12]. The 565 nm wavelength predominantly affects superficial layers, promoting collagen formation and fiber reorganization without structural damage, making it ideal for non-invasive dermatological applications. Conversely, the 810 nm wavelength penetrates deeper, effectively interacting with hair follicles and deeper tissues, enhancing its therapeutic potential in procedures requiring cellular modification, such as hair removal [13,14]. However, its greater thermal effect also increases the risk of unintended tissue injury, underscoring the need for careful control of exposure time and energy. Overall, these results reinforce the importance of careful wavelength selection and exposure optimization to achieve effective and safe therapeutic outcomes. The study provides a strong basis for designing personalized treatment protocols, maximizing benefits while minimizing risks, and highlights the potential of at-home laser devices for both cosmetic and medical use. In summary, selecting the right wavelength and exposure duration can improve performance, reduce hazards, and expand the safe use of at-home laser technology, calling for further research to fully realize and enhance its potential.

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