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Applications and Future Prospects of Near-Infrared Light Technology in the Beauty and Skincare Field: A Comprehensive Review

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Abstract

This review aims to explore the effects and applications of near-infrared (NIR) light in the beauty and skincare field, with a focus on the advantages of combining long-wave and short-wave NIR technologies. It also presents the development and application of an innovative home beauty device. Firstly, the paper introduces the definition and classification of NIR light, explaining its biological effects and broad applications in medical, industrial, scientific research, and beauty fields. Next, it provides a detailed analysis of the current use of NIR light in skincare, including its physiological effects on the skin and the benefits and performance of existing technologies and devices. Despite its significant advantages in beauty and skincare, NIR light has limitations such as limited penetration depth, single-functionality, and safety concerns. To overcome these limitations, the paper highlights the benefits of combining long-wave and short-wave NIR technologies, such as enhancing skin absorption, improving treatment efficacy, and reducing side effects. The review includes a case study of a home beauty device to illustrate these benefits. Finally, the paper summarizes the key findings of combined NIR technologies and explores the market potential of home beauty devices. It also discusses future research directions and prospects in the skincare field, providing valuable insights for the further development of efficient and safe skincare technologies. The review shows that NIR light has a promising future in the beauty and skincare industry.

Keywords

Hairdressing, Skincare, Home beauty device

1. Introduction

In recent years, the application of near-infrared (NIR) light has become increasingly widespread across various fields, garnering more attention and importance. NIR light is notable for its unique optical properties, such as high tissue penetration and low photodamage. Exposure to NIR light causes water molecules in the substrate to vibrate. This technology is widely used in the food processing industry to inhibit bacteria, spores, yeasts, and molds (Horton et al., 2020). It is also employed in medical diagnostics, spectral analysis, and biomedical research, and is commonly used for disinfecting non-heat-sensitive equipment in medical settings (Damit, Lee, & Wu, 2011). On the other hand, as the demand for non-invasive skin care technologies grows, phototherapy has become a favored method for beauty and treatment. In recent years, NIR light has also emerged in the beauty and skincare field, attracting widespread attention for its unique biological effects and skin improvement capabilities.

However, as NIR technology continues to develop and market demands grow, its limitations in the beauty and skincare field have become apparent. First, single-wavelength NIR light has limited effectiveness in addressing complex skin issues. Different skin problems require specific wavelengths and energy densities for optimal treatment outcomes. Additionally, some skin conditions may be difficult to significantly improve with single-wavelength NIR light. To overcome these limitations, the combination of NIR long and short wavelengths has emerged, bringing new possibilities to the beauty and skincare field. This combined technology carefully integrates different wavelengths of NIR light to work synergistically during the same treatment process. The key to this technique lies in combining the advantages of long and short wavelengths, ensuring both depth and effectiveness of treatment while targeting different types of skin problems.

In this review, we will briefly discuss the characteristics and working principles of NIR technology, as well as its applications in various fields, with a focus on its use in beauty and skincare. In addition, this article will explain the combined technology of NIR long and short wavelengths, exploring their multiple advantages in skin care and aesthetics, and provide a comprehensive overview of how these wavelengths work together to enhance skin health and appearance. Finally, we will conduct a case analysis of the JMOON beauty device. This analysis will demonstrate how this equipment can provide users with a convenient and powerful tool to maintain skin health and improve beauty results in the comfort of their own homes.

2. Overview and Applications of Near-Infrared Light

2.1 Overview of Near-Infrared Light

Infrared radiation (IR) (700 nm–1 mm) is a part of the electromagnetic spectrum situated between visible light (VL) and microwave regions. It accounts for approximately 40% of solar radiation. According to ISO 20473:

Near infrared, NIR, 0.78-3 microns

Medium infrared, MIR, 3-50 microns

Far infrared, FIR, 50-1,000 microns

According to the International Commission on Lighting, NIR is further divided into:

Infrared-A (IR-A) : 700nm-1,400nm (0.7micron -1.4 micron)

Infrared-B (IR-B) : 1,400nm-3,000nm (1.4 micron -3 micron)

Infrared-C (IR-C) : 3,000nm-1mm (3 microns -1,000 microns)

Compared to visible light, infrared light is invisible to the human eye, has a broad spectral range, strong penetration ability, and high resistance to interference (Horton et al., 2023). In 1800, British physicist Herschel first discovered the infrared spectrum, marking the earliest detection of near-infrared light. Almost a century later, British astronomers Abney and Festing found that the absorption bands in the near-infrared spectrum were related to hydrogen-containing groups, laying the foundation for subsequent research (Cozzolino, 2009). Infrared light, being a form of electromagnetic wave, primarily originates from the radiation of objects. According to Wien's displacement law, objects with temperatures below 3800K emit electromagnetic waves with peak wavelengths in the infrared range. Infrared light has a strong penetration capability, allowing it to pass through obstacles such as clouds and smoke, making it useful for long-distance detection (Wu & Boyer, 2023). Additionally, infrared light exhibits a notable thermal effect, which can provide a sensation of warmth and is used in heating and drying processes (Ren & Sun, 2023).

2.2 Applications of Near-Infrared Light

Infrared light technology has demonstrated extensive applications across various fields, with its unique physical properties and functions making it indispensable in many industries. In the military sector, infrared light technology plays a crucial role. Infrared-guided missiles use infrared detectors to capture the infrared radiation emitted by targets, enabling precise targeting. The core technologies include automatic target recognition, infrared focal plane arrays, and uncooled infrared guidance systems (Zhang, Gao, Zhang, et al., 2016; Sun, Ji, Shi, et al., 2019). Additionally, infrared night vision devices are essential in the military, providing clear images in nighttime or low-light conditions and enhancing the army's nighttime combat capabilities (Bai, 2011). In the medical field, infrared light technology also has wide applications. Infrared thermometry allows for quick and accurate temperature measurements. In experimental research by Hiroyuki Kurahashi and others (2024), $NaYF^{4+}/Yb^{3+}$ was used as a fluorescent thermometer, measuring body temperature based on the temperature dependence of the fluorescence lifetime at 980 nm under 808 nm excitation. Furthermore, infrared thermal imaging is commonly used to assess wound healing. Rafaela Pedrosa's meta-analysis found that infrared thermal imaging is a relatively accurate method for identifying burn depth and healing potential (Pedrosa et al., 2024). In the industrial sector, infrared imaging technology can detect the thermal distribution of equipment, helping engineers identify anomalies and malfunctions in a timely manner. Infrared spectroscopy is also widely used in material analysis and quality control, improving the efficiency and quality of industrial production. The new pH and viscosity dual-responsive fluorescent probe (Rh-TR), showing two emission signals at 510nm and 660 nm, is extensively used in industrial detection (Chen et al., 2024). In the agricultural and food sectors, infrared light technology has shown great potential. Near-infrared technology can detect moisture, nutrients, and hardness in fruits and vegetables. In research by Zhenjie Wang and others, near-infrared light was used to visualize changes in apple hardness. Visualisation of apple hardness changes using near-infrared light by Zhenjie Wang et al. (2024). In another study, infrared light was employed to predict soil electrical conductivity (EC) and sodium absorption ratio (SAR), delineating hazardous soil areas for better management (Zhao et al., 2024).

Near infrared is a type of electromagnetic radiation with a wavelength between 780 nanometers and 2,500 nanometers, which has a wide range of applications in the medical and health fields. Near infrared rays can penetrate the surface of the skin, enter the body tissue, and produce biological effects on the human body. The role of near infrared on the human body is mainly manifested in the following aspects:

1. Improve blood circulation: Near infrared can promote blood circulation, increase the activity of vascular endothelial cells, reduce blood viscosity, and prevent cardiovascular diseases.
2. Relieve pain and reduce inflammation: Near infrared can promote cell metabolism, enhance immunity, relieve pain, reduce inflammation and relieve pain.
3. Promote wound healing: Near infrared can promote cell division and tissue repair, accelerate wound healing.
4. Improve skin quality: Near infrared can stimulate the production of collagen, increase skin elasticity and luster.

In short, near infrared ray has a wide range of application prospects in the field of medical health. However, a large amount of near infrared radiation may cause adverse effects on the human body and should be used rationally.

In summary, with its unique physical properties and wide-ranging applications, infrared light technology plays an indispensable role in the military, medical, industrial, agricultural, and everyday life sectors, bringing innovation and convenience to society's development.

3. Applications of Near-Infrared Light in the Field of Beauty and Skin Care

3.1 Overview of the Principle of Action

NIR is widely used in the biomedical field due to its unique mechanisms of action. The primary principle behind its effects is photobiomodulation (PBM), which brings about beneficial biological effects by influencing cellular metabolism, enhancing tissue repair, and regulating physiological functions (Da Silva et al., 2025).

Photobiomodulation (PBM), formerly known as low-level laser therapy, refers to the impact of light or near-infrared wavelength electromagnetic waves on cells (Amaroli et al., 2024). The main participants in PBM are mitochondria, which contain several photoreceptors like cytochromes that can respond to near-infrared wavelengths and capture energy. Studies by Andrea Amaroli et al. have shown that cytochrome c oxidase in mitochondrial complex IV is activated by visible and near-infrared light spectra (635, 808, 980, 1064 nm). Other articles indicate that complex III responds to 808, 980, and

1064 nm wavelengths, and complex I responds to 1064 nm wavelengths (Amaroli et al., 2016, 2021; Ravera et al., 2019). Near-infrared light activates these pigments in the mitochondria, leading to an overproduction of adenosine triphosphate (ATP) via the electron transport chain, which in turn increases mitochondrial membrane potential (MMP) (Amaroli et al., 2022).

Moreover, research has shown that several PBM targets are associated with the endogenous release of reactive oxygen species (ROS) and nitric oxide (NO), as well as the regulation of Ca2+ flux and redox homeostasis. ATP, as the cell's energy currency, promotes cell proliferation, migration, and repair, while an appropriate amount of ROS can trigger the cell's antioxidant mechanisms, enhancing its antioxidant capacity. These factors play crucial roles in cell proliferation, growth, and apoptosis (Whitaker & Patel, 1990; Ravera et al., 2021). Additionally, the longer wavelengths of near-infrared light possess strong tissue penetration abilities, capable of reaching the skin's epidermis and dermis, and even the subcutaneous tissue. This deep penetration enables NIR light to effectively act on the collagen and elastic fibers deep within the skin, promoting their synthesis and restructuring, thereby improving skin elasticity and texture.

NIR light also exhibits significant anti-inflammatory and antioxidant effects. Studies on wound healing, particularly for chronic wounds, show that photodynamic therapy (PDT) can trigger an acute inflammatory response primarily associated with immune system activation (Ravera et al., 2019). Research indicates that NIR light can modulate the release of inflammatory mediators, reduce cytokine production, and thereby alleviate inflammation (Amaroli et al., 2016). Corsi et al. (2016) found that PDT not only leads to the diversification of new fibroblasts (effector cells) but also promotes a close relationship between these cells and mast cells, which are attracted and stimulated to release their granules into the dermis in response to treatment. Additionally, NO, the smallest signaling molecule that can freely cross membranes, plays a role in wound healing. Preliminary experimental results suggest that the expression of NO-related enzymes increases under photodynamic therapy, promoting vasodilation and antibacterial activity. On another note, NIR light reduces oxidative stress levels in the skin by activating antioxidant enzyme systems (such as superoxide dismutase, SOD), protecting skin cells from oxidative damage (Lee et al., 2017).

Many studies on the mechanism of photobiological effects of NIR agree that the mechanism of action is attributed at the cellular level cytochrome C oxidase (cytochrome C) on mitochondrial aerobic respiratory chain.

The absorption of NIR in oxidase COX provided electrons for aerobic respiration and generated more ATP, thus enhancing cell activity. Meanwhile, many data showed: PBM can also increase the production of reactive oxygen species (ROS), enhance cell reoxidation-reduction activity, and activate some transcription factors, which can inhibit cell apoptosis, promote cell proliferation, migration and adhesion, promote collagen fibrin synthesis, and promote neurovascular regeneration. Based on the above mechanism, NIR is not easily absorbed by tissues, and can even penetrate the skin and skull to reach the physical characteristics of brain tissue and is used in the medical field.

3.2 Current Status of the Application of Near-infrared Light in the Field of Beauty and Skin Care

NIR is increasingly becoming a key technology in the field of beauty and skincare due to its unique photobiomodulation effects. Its applications in beauty and skincare primarily focus on anti-aging, improving skin texture, correcting pigmentation issues, and treating skin inflammation and lesions.

Anti-Aging Treatments. Common manifestations of skin aging include wrinkles, furrows, and dilated capillaries. During phototherapy, photoreceptor molecules absorb specific wavelengths of light, generating singlet oxygen and initiating a series of cellular responses. These responses include the regulation of cellular functions, cell proliferation, and the repair of damaged cells (Russell, Kellett, & Reilly, 2005). Studies have shown that 830 nm radiation can accelerate the transformation of fibroblasts into myofibroblasts and promote mast cell degranulation. Additionally, NIR can enhance blood circulation and nutrient supply to the skin, promoting skin regeneration and repair, thereby improving skin elasticity and resilience. The thermal effect of NIR also stimulates skin hydration, increasing the softness and smoothness of the skin. Furthermore, the stimulation of cells at this wavelength enhances the chemotaxis and phagocytic activity of leukocytes and macrophages. According to B. A. Russell et al. (2005), 51.6% of the study population showed a 25%-50% improvement in photoaging scores at a 12-week follow-up, and 12.9% showed an improvement in the 50%-75% range. Another study on phototherapy for skin rejuvenation indicated that after using 830 nm light, the R3 value, which measures the severity of wrinkles, significantly decreased. Three months post-treatment, patients exhibited a 33% improvement in skin smoothness (Lee et al., 2007). Another study showed similar trends, with 91% of participants experiencing an improvement in complexion and 82% seeing improvements in skin smoothness and evenness after treatment with 830 nm NIR (Baez & Reilly, 2007).

Collagen Synthesis. Collagen is a protein produced by dermal fibroblasts and is crucial for the skin as it provides structural support. As people age, collagen gradually diminishes, leading to reduced skin firmness and elasticity. Phototherapy is a favorable method for promoting collagen production. One of the mechanisms is fractional photothermolysis, during which a series of microscopic thermal damage zones are created in the skin. These thermal damage zones cause localized dermal wounds while preserving the surrounding tissue, thus triggering the repair of dermal wounds and promoting the generation of new dermal collagen (Hernández-Bule et al., 2024). Phototherapy often utilizes near-infrared long waves because they are well absorbed by the skin's chromophores and penetrate deeply into the collagen layer. They also target the moisture in the skin to some extent, which can increase the safety of the phototherapy process (Woolery-Lloyd, Viera, & Valins, 2011). One study demonstrated that the interaction of 1927 nm wavelength infrared light with the skin preserves the structure of the stratum corneum, while causing subdermal cleaving and thermal changes in the dermal collagen (Hernández-Bule et al., 2024).

Treating skin inflammation and disorders. Especially acne, rosacea, and other inflammatory skin diseases, has shown significant efficacy. Acne is a common skin condition with a multifactorial pathogenesis that includes excessive sebum production, over-colonization by *Cutibacterium acnes* (formerly known as *Propionibacterium acnes*), abnormal follicular hyperkeratinization, and inflammation (Layton & Ravenscroft, 2023). *C. acnes* and other bacteria reside in the sebaceous glands of all individuals as part of the skin microbiome, helping to maintain skin balance. When one or more microorganisms become dominant, this balance is disrupted, leading to inflammation and excessive sebum production (Vasam, Korutla, & Bohara, 2023). On one hand, photobiomodulation (PBM) can inhibit the proliferation of acne-causing bacteria, thereby exerting an antibacterial effect. The mechanism involves porphyrins acting as photosensitizers that, under near-infrared (NIR) light, undergo photochemical reactions to produce a large amount of reactive oxygen species (ROS) and free radicals, leading to a strong antibacterial effect (Szymańska, Budzisz, & Erkiert-Polguj, 2021). On the other hand, phototherapy can regulate sebaceous gland activity, reducing lipid production (Hernández-Bule et al., 2024). In a study by Anna Szymańska et al., it was found that after 3 and 6 treatments with 785 nm light, the lipid levels on patients' cheeks decreased from 160.1 to 140 and 121.1, respectively, and there was a noticeable improvement in pustules and papules (Figure 1) (Park et al., 2014). Additionally, phototherapy has cytokine-mediated anti-inflammatory effects. Red light and NIR can reduce the production of pro-inflammatory cytokines and inhibit the activity of inflammatory mediators. In a study by Kui Young Park et al. (2014), it was found that after three treatments with 1550 nm light for acne, 91% of the treated areas showed significant improvement. Another study also noted that using 1064 nm light to treat inflammatory acne significantly reduced the average count of inflammatory acne lesions, acne erythema grade, and erythema index (Chalermsuwiwattanakan et al., 2021).

Figure 1. (a) Comparison before the Start of the Treatment and Two Weeks after the Completion of the Treatment

Figure 1. (b) Comparison before the Start of the Treatment and Two Weeks after the Completion of the Treatment

3.3 Analysis of Limitations

Despite the wide potential and significant effectiveness of NIR in the field of beauty and skincare, its practical application faces several technical and equipment limitations. These constraints hinder the comprehensive use and widespread adoption of NIR technology.

On one hand, NIR light possesses strong tissue penetration capabilities, but its penetration depth in practical applications is still limited. Typically, NIR light can only penetrate into the dermis or shallow subcutaneous tissue of the skin, making it difficult to reach deeper tissue layers. This limitation reduces the effectiveness of NIR light in treating deep skin issues such as deep fat deposits or deep scars, where satisfactory results may not be achieved. Additionally, NIR light exhibits different scattering and absorption characteristics at various skin levels, making precise control of its depth and range of action challenging.

On the other hand, existing NIR light devices are often designed for specific skincare issues like anti-aging or pigmentation treatment, leading to limitations in meeting diverse user needs. Although some advanced devices attempt to integrate multiple light sources (such as red, blue, and NIR light) to expand their functionalities and applications, these devices are typically costly and complex to operate, limiting their widespread use among ordinary users. Therefore, developing multifunctional, user-friendly, and cost-effective NIR light devices remains a significant technological challenge.

Furthermore, current NIR light technologies often use long-wave and short-wave NIR separately, each targeting different layers of the skin with varying effects. Long-wave NIR is suitable for deep skin issues, while short-wave NIR is primarily used for superficial skin problems. Using a single wavelength of NIR light alone makes it difficult to simultaneously address both superficial and deep skin issues comprehensively, resulting in incomplete or inadequate treatment outcomes.

4. Combined Near-infrared Long-wave and Short-wave Technologies

Developing a new light modulation device (with new wavelengths or different colors of light) is a current hot topic in research. Optimizing the effectiveness of current devices, expanding their applications, and reducing treatment side effects are key objectives. Combinations of several wavelengths have also sparked great interest among researchers. This approach aims to utilize the synergistic effects of different wavelengths to enhance treatment outcomes.

IR-A has strong tissue penetration ability. This property allows long-wave NIR light to penetrate deep into the skin, reaching the dermis and even deeper subcutaneous tissue, making it suitable for treating deep skin problems. For example, IR-A light has shown good performance in anti-aging and deep repair by stimulating collagen regeneration and improving skin tightness and elasticity. In contrast, short-wave near-infrared light has weak tissue penetration and mainly affects the skin surface. IR-B significantly improves superficial skin problems such as improved skin tone and reduced pigmentation and superficial wrinkles. Shortwave NIR can effectively promote the renewal and repair of epidermal cells and accelerate wound healing.

Combining long-wave and short-wave NIR light optimizes the absorption and utilization of light energy, thereby enhancing overall treatment effectiveness. Additionally, this combination reduces potential side effects and risks associated with single-wavelength exposure. Long-wave NIR light delivers energy deep into the skin layers, while short-wave NIR light produces rapid effects on the surface. This multi-level energy absorption significantly enhances the skin's responsiveness to treatment light, achieving more pronounced therapeutic effects in a shorter time. For example, in skin whitening treatments, short-wave NIR light effectively reduces superficial pigmentation, while long-wave NIR light enhances overall skin radiance by boosting deep blood circulation. NIR light devices that utilize combined wavelengths distribute light energy more evenly, reducing the risk of overheating and thermal damage to the skin. Furthermore, this combined technology allows for flexible adjustment of wavelength and intensity according to different skin issues, providing personalized treatment plans and minimizing adverse reactions.

5. Case Study of the Application of the Jmoon Transdermal Collagen Light Home Beauty Device

The transdermal collagen light was taught by the chief scientist of Jmoon, Nobel Laureate in physics Theodor W. Hansch leading the development of cutting-edge anti-aging technology, which uses near infrared short wave (760-1400nm) and near infrared long wave (1400-1940nm).

The combination of light waves can penetrate into the skin 4.5mm, comprehensively promote the formation of shallow, middle and deep collagen in the dermis, so as to achieve strong anti-aging and anti-aging ,full face light line effect.

Transdermal Collagen Light is an advanced anti-aging technology that leverages the penetrating properties of NIR light to deeply reach the dermis layer of the skin. By using specific wavelengths of light, it activates fibroblasts in the skin, promoting collagen synthesis. This phototherapy method not only enhances skin elasticity and firmness but also reduces fine lines and wrinkles, rejuvenating the skin effectively. The process is gentle and does not damage the epidermis. As a leading domestic beauty device brand, on one hand, compared to traditional radiofrequency (RF) beauty devices, the Jmoon Transdermal Collagen Light Beauty Device offers significant advantages. Firstly, its penetration depth is greater: traditional home-use RF devices typically have a penetration depth of around 3.5 mm, reaching only the shallow to mid-dermis. In contrast, transdermal collagen light can penetrate up to 4.5 mm, promoting collagen in the superficial, middle, and deep dermis, resulting in superior anti-aging effects compared to RF technology. Secondly, it covers a larger area: RF beauty devices are limited by the number and size of electrode heads, creating a small, point-based thermal field typically around 3 cm^2. Transdermal collagen light, however, uses light technology to form a gap-free, focused, planar thermal field of 7 cm^2, doubling the treatment area. Additionally, it has higher thermal efficiency: RF requires heat absorption starting from the epidermis and moving to the dermis, resulting in energy loss through heat conduction. Transdermal collagen light technology, utilizing the targeted effect of light energy, precisely acts on the dermis layer, providing efficient, deep heating with increasing warmth the deeper it penetrates. Finally, it offers multiple anti-aging mechanisms: RF beauty devices usually stimulate collagen production through physical heating, whereas transdermal collagen light not only provides quick heating but also leverages the biological effects of light energy to promote ATP production and fibroblast regeneration, achieving dual anti-aging effects.

On the other hand, the Jmoon Transdermal Collagen Light Beauty Device features two professional modes, offering comprehensive anti-aging solutions. The Collagen Regeneration Mode employs advanced anti-aging technology—transdermal collagen Percutaneous collagen light is a combination of two wavelengths, IRA and IRB this technology, with its excellent penetration and high thermal efficiency, creates a large-area focused photothermal field, uniformly and continuously penetrating the skin from the epidermis to deeper layers, stimulating collagen regeneration to restore skin elasticity and firmness. The V-Lift Mode utilizes tri-frequency respiratory microcurrent technology to counteract skin aging and lift the fascia, instantly firming and creating a V-shaped face. This technology works from the surface to deeper layers, tightening the skin comprehensively and sculpting the V-shaped contour. According to product efficacy reports, users can noticeably experience a lifting and firming effect after just one use; continuous use for seven sessions significantly reduces wrinkles across the entire face (Figure 2). The product efficacy report demonstrates its ability to provide "one-time lifting, seven-time full-face wrinkle reduction," offering consumers a thorough and effective anti-aging solution (Table 1).

Figure 2. Before and after Using Jmoon Transdermal Collagen Light for Home Cosmetic Treatment

Table 1. Product Efficacy Report

Evaluation Metric	Time point	Rate of change	Conclusions of the analysis	Metric description
Chin angle	3 minutes	-1.75%	significant differences	The smaller the test value, the smaller the chin angle
	14 day	-1.34%	significant differences	
	28 day	-2.39%	significant differences	
The moisture content of the stratum corneum of the skin	7 day	25.52%	significant differences	The higher the test value, the higher the moisture content of the stratum corneum of the skin
	14 day	31.26%	significant differences	
	28 day	39.82%	significant differences	
Skin oil content	7 day	-10.12%	significant differences	The lower the test value, the lower the amount of skin oil
	14 day	-8.13%	significant differences	
	28 day	-22.24%	significant differences	
Skin ITA	7 day	3.64%	significant differences	The higher the test value, the
	14 day	4.40%	significant differences	

	28 day	4.29%	significant differences	whiter the skin
Skin melanin	7 day	-1.37%	significant differences	The lower the test value, the less melanin the skin has
	14 day	-2.02%	significant differences	
	28 day	-2.66%	significant differences	
Skin redness value	7 day	2.70%	significant differences	The lower the test value, the lower the red value of the skin
	14 day	-4.59%	significant differences	
	28 day	-7.26%	significant differences	
Skin elasticity	7 day	6.48%	significant differences	The higher the test value, the better the skin elasticity
	14 day	10.65%	significant differences	
	28 day	17.74%	significant differences	
Skin firmness	7 day	-5.67%	significant differences	The lower the test value, the better the skin firmness
Skin firmness	14 day	-10.67%	significant differences	
	28 day	-10.43%	significant differences	
Skin thickness	7 day	0.80%	significant differences	The higher the test value, the greater the dermal thickness of the skin
	14 day	2.80%	significant differences	
	28 day	3.28%	significant differences	
Skin density	7 day	1.48%	significant differences	The higher the test value, the greater the density of the dermal layer of the skin
	14 day	2.22%	significant differences	
	28 day	5.93%	significant differences	
Skin radiance	7 day	7.05%	significant differences	The higher the test value, the better the skin radiance
	14 day	9.99%	significant differences	
	28 day	15.27%	significant differences	

6. Conclusion and Outlook

In the field of skincare and beauty, near-infrared (NIR) technology stands out due to its unique photothermal effects and biological stimulation capabilities. Through a detailed examination of NIR technology, it becomes evident that it has strong potential to promote collagen production, accelerate metabolism, improve microcirculation, and reduce inflammation. These mechanisms can effectively combat skin laxity, diminish wrinkles, enhance skin quality, and promote blood circulation, offering comprehensive skin care. However, despite the significant achievements of NIR technology in skincare, there is still room for further exploration and development. Firstly, with advancements in technology, we can expect the emergence of more advanced NIR devices and techniques that provide more efficient, safe, and convenient skincare solutions. Secondly, future research could explore the combined use of NIR technology with other skincare treatments to achieve better synergistic effects and more noticeable results. In conclusion, NIR technology has broad application prospects and great potential for development in the skincare field. As technology continues to progress and innovate, we have reason to believe that NIR technology will bring more surprises and possibilities to the skincare and beauty industry.

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