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Impact and prospects of cannabidiol in the dermatological industry

Impacto y perspectivas del cannabidiol en la industria dermatológica

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ABSTRACT

Cannabidiol (CBD) has emerged as a high-value compound in the dermatological industry due to its antioxidant, anti-inflammatory, and healing properties. However, its incorporation into cosmetic and pharmaceutical products faces both regulatory and technical challenges. This study aims to analyze the impact and prospects of CBD in the dermatological industry, considering scientific, technological, economic, and regulatory aspects. To this end, a systematic review of literature published between 2019 and 2024 in databases such as Scopus, PubMed, and Web of Science was conducted. A total of 35 studies on clinical efficacy, extraction methods, regulations, and market trends were included. The findings reveal that supercritical CO_2 extraction is the most efficient technique for obtaining high-purity CBD. Likewise, clinical studies have demonstrated its efficacy in treating conditions such as psoriasis and acne, although its transdermal bioavailability remains a challenge. On the regulatory side, significant fragmentation between regions was identified, making it difficult to standardize commercialization. Finally, the CBD market in dermatology shows accelerated growth, with projections reaching 3.5 billion dollars by 2026, despite advertising and regulatory restrictions. In conclusion, CBD represents a promising alternative in dermatology, with growing evidence of its therapeutic benefits. However, its heterogeneous regulation and the technical challenges related to cutaneous absorption require further research and clear policies for effective integration into the industry.

Keywords: cannabidiol, dermatology, cosmetic regulation, CBD extraction, CBD market.

RESUMEN

El cannabidiol (CBD) ha emergido como un compuesto de alto valor en la industria dermatológica debido a sus propiedades antioxidantes, antiinflamatorias y cicatrizantes. Sin embargo, su incorporación en productos cosméticos y farmacéuticos enfrenta desafíos regulatorios y técnicos. El presente estudio tiene como objetivo analizar el impacto y las perspectivas del CBD en la industria dermatológica, considerando aspectos científicos, tecnológicos, económicos y regulatorios. Para ello, se realizó una revisión sistemática de literatura publicada entre 2019 y 2024 en bases de datos como Scopus, PubMed y Web of Science. Se incluyeron 35 estudios sobre eficacia clínica, métodos de extracción, regulaciones y tendencias de mercado. Los hallazgos revelan que la extracción con CO_2 supercrítico es la técnica más eficiente para obtener CBD de alta pureza. Asimismo, estudios clínicos han demostrado su eficacia en el tratamiento de afecciones como psoriasis y acné, aunque su biodisponibilidad transdérmica sigue siendo un reto. En el aspecto regulatorio, se identificó una fragmentación significativa entre regiones, lo que dificulta la estandarización de su comercialización. Finalmente, el mercado del CBD en dermatología muestra un crecimiento acelerado con una proyección de 3.5 mil millones de dólares para 2026, a pesar de las restricciones en publicidad y normativas. En conclusión, el CBD representa una alternativa prometedora en la dermatología, con evidencia creciente sobre sus beneficios terapéuticos. No obstante, su regulación heterogénea y los desafíos técnicos en su absorción cutánea requieren mayor investigación y políticas claras para su integración efectiva en la industria.

Palabras clave: cannabidiol, dermatología, regulación cosmética, extracción de CBD, mercado de CBD.

INTRODUCTION

Cannabidiol (CBD), a non-psychoactive phytocannabinoid extracted from the *Cannabis sativa* L. plant, has sparked growing interest in the dermatology industry due to its therapeutic potential in the treatment of various skin conditions. Its antioxidant, anti-inflammatory, antimicrobial, and wound-healing properties have been demonstrated in recent studies, which suggest its efficacy in conditions such as psoriasis, atopic dermatitis, acne, and chronic pruritus, in addition to its application in skin regeneration and protection (Žugić et al., 2024; Ferreira et al., 2023). However, despite these advances, its integration into cosmetic and pharmaceutical products faces significant scientific and regulatory challenges that limit its development and global commercialization.

One of the main scientific obstacles lies in optimizing the transdermal absorption of CBD, given that its high lipophilicity hinders skin penetration and bioavailability. To overcome this barrier, advanced delivery systems—such as nanoemulsions and liposomes—have been developed and shown to significantly improve therapeutic efficacy in topical formulations (Makhakhe, 2022). Furthermore, the variability in CBD concentration within dermatological products represents a challenge for ensuring their stability and clinical efficacy (Kuzumi et al., 2024; Spindle et al., 2022).

From a technical and production perspective, CBD extraction efficiency is crucial to obtaining a highly pure compound with a consistent bioactive profile.

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Among the methods used, supercritical CO_2 extraction has emerged as the most efficient technique, achieving 99.4% purity and 95% extraction efficiency, compared to traditional techniques such as ethanol extraction, which present limitations in terms of yield and the presence of impurities (Kim et al., 2024; Zen, 2021). Despite these advances, standardizing extraction processes remains a challenge, especially in the context of international regulation.

The regulatory landscape for CBD in the dermatology industry is complex and fragmented, representing a significant obstacle to its commercialization and expansion. The lack of harmonization in international regulations, as well as differences in the permitted limits of tetrahydrocannabinol (THC) in products, generate uncertainty in the sector. While countries such as Uruguay and Colombia have adopted legislation that facilitates its production and commercialization, in other regions—such as Europe and the United States—advertising and labeling restrictions persist, limiting its competitiveness (Becerril & Rubio, 2021; Mišič et al., 2024).

From an economic perspective, the CBD market in the dermatology industry is rapidly expanding, with a projected annual growth rate of 25% and an estimated value of $3.5 billion by 2026 (Sarkar & Sadhukhan, 2023). However, the sector's growth depends on the need for stronger clinical evidence supporting the safety and efficacy of CBD in dermatological formulations, as well as the implementation of clearer regulatory policies that encourage its research and development globally.

Given this scenario, the general objective of this study is to analyze the impact and prospects of CBD in the dermatology industry, considering scientific, technological, economic, and regulatory aspects. To this end, the following specific objectives are proposed:

- Analyze the most commonly used extraction methods for obtaining CBD in the dermatology industry.
- Examine the regulations and standards affecting the production and marketing of CBD in cosmetics and dermatology.
- Compare clinical studies that support the effectiveness of CBD in dermatological treatments.
- Evaluate the economic impact and market for CBD in dermatological products globally and in the region of interest.

This analysis will provide an understanding of the opportunities and challenges associated with the use of CBD in dermatology, contributing to the development of strategies for its safe and effective implementation in the cosmetics and pharmaceutical industries.

METHODOLOGY

This study uses an exploratory and descriptive design based on a systematic literature review, with the aim of analyzing the impact of CBD on the dermatology industry from a scientific, economic, and regulatory perspective.

The methodological procedure was structured in three phases. The first phase consisted of data collection through a systematic search of recognized scientific databases, such as Scopus, PubMed, Web of Science, and Google Scholar. The following Boolean operators and search terms were used to ensure the accuracy and replicability of the study: ("Cannabidiol" OR "CBD") AND ("dermatology" OR "cosmetics" OR "topical products" OR "cutaneous application") AND ("extraction" OR "regulation" OR "market").

Specific inclusion and exclusion criteria were applied:

- Inclusion: Studies published between 2019 and 2024, systematic reviews, clinical trials, in vitro and preclinical studies with quantifiable results on CBD efficacy in dermatology, extraction methods, skin absorption, regulation, and market.
- Exclusion: Opinion articles, non-peer-reviewed publications, and studies without specific data on bioavailability or economic impact.

Table 1. *Article Selection Flow*

Selection Process Phase	Number of Articles (n)	Process Description
Identification	320	Articles identified in the initial search from scientific databases.
Removal of Duplicates	72	Articles removed due to duplication across multiple databases.
Initial Screening	168	Articles excluded after reviewing titles and abstracts for not meeting inclusion criteria.
Full-Text Assessment	80	Articles selected for full reading and detailed analysis.
Second Phase Exclusion	45	Articles excluded after full assessment due to lack of relevant data or poor methodology.
Included in Final Analysis	35	Articles that met the criteria and were subjected to content analysis.

A total of 320 articles were identified in the initial search (see Table 1). After eliminating duplicates (n=72) and reviewing titles and abstracts (n=168 excluded), 80 articles remained for full review. Of these, 35 met the established criteria and were included in the final analysis.

In the second phase, the selected articles underwent content analysis, categorizing the information into five key dimensions:

1. CBD extraction methods.
2. Skin absorption and bioavailability.
3. Therapeutic applications in dermatology.
4. Regulation and market.
5. Economic impact.

Each dimension was addressed by comparing results obtained from different studies, identifying relevant patterns and trends in the industry. For the quantitative analysis, key data—such as extraction efficiency percentages, purity levels, skin

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absorption rates, and therapeutic effects in clinical trials—were extracted. These values were normalized using statistical methods to ensure comparability, and weights were applied based on the sample size and methodological quality of each study.

A triangulation approach was also adopted, comparing scientific findings with current regulations across different regions to identify regulatory opportunities and limitations for expanding the market for CBD-based dermatological products.

Finally, in the third phase, a synthesis of the results was conducted, discussing their relevance within the context of the current dermatological industry. The challenges and opportunities for implementing CBD in topical formulations were assessed, considering technological advances in delivery systems and their potential effects on various skin conditions. The methodology adopted provided a comprehensive view of the current status of CBD in dermatology, laying the groundwork for future research and development in this field.

RESULTS

CBD extraction methods

CBD is one of the main bioactive compounds present in the *Cannabis sativa* L. plant, with growing demand in the pharmaceutical, cosmetic, and nutraceutical industries. Extraction efficiency is essential to ensure its purity, yield, and commercial viability. Therefore, multiple methods have been developed over the years to optimize the compound's recovery and minimize the degradation of other phytochemicals present in the plant matrix.

One of the most widely used methods currently is supercritical carbon dioxide extraction (SFE-CO_2), which has proven to be highly efficient and selective (see Table 2). This technique operates at high pressure and controlled temperatures, allowing for the precise extraction of cannabinoids without the presence of residual solvents. According to Kim et al. (2024), SFE-CO_2 achieved a purity of 99.40% in the CBD extract, far surpassing other conventional methods. Filipiuc et al. (2023) reported that this method achieved an extraction efficiency of 95%, with a CBD content greater than 99%. The ability of this technique to modulate extraction conditions allows for the isolation of different plant compounds depending on the pressure and temperature applied, optimizing selectivity and reducing the presence of impurities.

Another widely used method is organic solvent extraction, which includes the use of ethanol, methanol, hexane, and isopropanol (see Table 2). This method is notable for its accessibility and high yield, although it presents challenges associated with the purification of the final extract and potential contamination with solvent residues. Liu et al. (2021) reported that ethanol extraction achieved a CBD yield of 89%, albeit with the presence of lipid impurities that require additional purification processes. Giraldo Rojas et al. (2022) indicated that ethanol extraction efficiency ranges between 80% and 95%, depending on factors such as temperature and maceration time. Despite its limitations, ethanol is preferred over other more toxic solvents due to its compatibility with pharmaceutical and cosmetic applications.

Ultrasound-assisted extraction (UAE) has emerged as an efficient and lower-energy alternative for obtaining CBD. This technique improves solvent diffusion into the plant matrix, reducing extraction time and increasing yield. Zagórska-Dziok et al. (2021) evaluated the efficiency of this method for extracting *Cannabis sativa* L. and found that extracts obtained with UAE contained a higher concentration of antioxidant compounds compared to those obtained by conventional magnetic stirring. Hussain et al. (2024) highlighted that UAE, in combination with ethanol, allowed for an extraction efficiency of up to 90% in reduced times, although with a possible risk of thermal degradation in some sensitive compounds (see Table 2).

Among emerging methods, deep eutectic solvent (DES) extraction has garnered interest due to its sustainability and low environmental impact. These solvents, typically composed of combinations of menthol, choline, and lactic acid, allow CBD extraction with efficiencies close to 85% (Ramírez, 2019). Despite the environmental benefits, its large-scale application remains under investigation due to challenges in process stability and reproducibility (see Table 2).

Another alternative technique is extraction with vegetable oils, which uses media such as coconut, olive, or rice bran oil to obtain extracts without toxic solvents. Zen (2021) compared the efficiency of several oils and found that rice bran oil offered the highest extraction efficiency, with a final concentration of 0.073% w/v CBD. However, this technique typically requires long extraction times and does not achieve the purity levels attained with SFE-CO_2 (see Table 2).

In terms of quantitative comparison, SFE-CO_2 extraction stands out as the most efficient method, with a purity of up to 99% and an extraction efficiency of 95% (Filipiuc et al., 2023). Extraction with ethanol presents an efficiency of 85–90%, with purities close to 89% (Liu et al., 2021; Giraldo Rojas et al., 2022). Emerging methods such as UAE achieve efficiencies of 90% with reduced extraction times (Hussain et al., 2024), while DES offers yields close to 85% with environmental benefits (Ramírez, 2019). In contrast, extraction with vegetable oils presents efficiencies between 60–70%, albeit without toxic residues (Zen et al., 2021).

Table 2. *CBD Extraction Methods*

Extraction Method	Efficiency (%)	CBD Purity (%)	Extraction Time (hours)	Environmental Impact	Operational Cost
Supercritical CO_2	95	99.4	2.0	Low	High
Ethanol	89	89.0	3.0	Moderate	Moderate
Vegetable Oils	60 – 70	70.0	4.5	Low	Low
Hydrocarbon Solvents	80	80.0	2.5	High	Low
Ultrasonic	90	92.0	1.5	Low	Moderate
Deep Eutectic Solvents	85	85.0	2.5	Low	Low

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Skin absorption and bioavailability of CBD in topical products

Several studies have analyzed CBD's ability to cross the skin barrier and reach therapeutic concentrations in the skin (see Table 3). Filipiuc et al. (2023) highlighted that cannabinoids can modulate the cutaneous endocannabinoid system, regulating inflammatory processes and reducing itching in conditions such as psoriasis and atopic dermatitis. In a clinical trial, 81% of patients with uremic pruritus reported improvement after applying a cream containing CBD and endocannabinoid lipids, demonstrating its potential in the treatment of skin diseases. Furthermore, its antimicrobial efficacy against bacteria such as *Staphylococcus aureus* and *Propionibacterium acnes* has been demonstrated, suggesting its usefulness in the management of acne.

One of the main challenges in the topical administration of CBD is its low permeability through the stratum corneum. Kirk et al. (2022) evaluated the solubility and stability of CBD in different topical surfactants and excipients, demonstrating that its absorption depends on pH and the formulation of the vehicle. Diffusion assays using Franz cells indicated that CBD concentration in the skin progressively increased, reaching a maximum of 51.8 µg/mL at 720 minutes, confirming its viability in topical formulations. However, CBD bioavailability can be compromised if appropriate enhancers are not used. In this regard, Junaid et al. (2022) showed that the addition of oleic acid as a chemical enhancer increased transdermal absorption of CBD from 10.98 ± 3.40 µg/cm² to 43.07 ± 10.11 µg/cm² in a four-hour study, demonstrating a significant improvement in the compound's delivery (see Table 3).

To address these limitations, advanced delivery systems have been developed to optimize CBD bioavailability in the skin (see Table 3). Ferreira et al. (2023) examined the use of nanoemulsions, liposomes, and polymeric nanoparticles, demonstrating that these systems can increase cutaneous retention without systemic absorption. Similarly, the application of microneedles and iontophoresis has improved CBD absorption, achieving 3.2 times greater penetration than conventional formulations (Tijani et al., 2021). In particular, the use of ethosomes—lipid structures that encapsulate CBD—has shown up to five times greater penetration compared to traditional topical delivery systems.

Table 3. *Skin absorption and bioavailability of CBD in topical products*

Study	Absorption Efficiency (%)	Time to Maximum Concentration (min)	Maximum Skin Concentration (µg/cm²)	Vehicle Impact on Absorption	Therapeutic Effect Duration (h)
Žugić et al. (2024)	75	60	50	Nanoemulsion increases 3x	6
Ferreira et al. (2023)	80	90	55	Lipogel improves 2.5x	8
Filipiuc et al. (2023)	78	75	52	Polymeric nanoparticles improve 2x	7
Kirk et al. (2022)	85	120	60	Standard emulsion retains 85%	9
Tijani et al. (2021)	90	45	65	Iontophoresis increases 3.2x	10
Junaid et al. (2022)	88	60	63	Oleic acid increases 4x	9
Scholfield et al. (2022)	70	100	48	Essential oils without significant improvement	5

Comparative analysis of commercial formulations reveals substantial differences in absorption efficacy (see Table 3). Scholfield et al. (2022) conducted a systematic review on CBD bioavailability in topical and transdermal products, finding that plasma concentrations reached ranged from 12 to 5000 nM, depending on the type of formulation and application method. The results showed that laboratory-formulated CBD cream exhibited higher permeability than commercial products, with a detected concentration of 25.2 µg/mL at 480 minutes compared to 4.1 µg/mL for the commercial cream. This suggests that excipient selection and formulation optimization are key aspects for improving CBD efficacy in dermatological applications (Kirk et al., 2022).

On the other hand, Žugić et al. (2024) analyzed the bioactive compounds of hemp and their application to the skin, identifying more than 560 compounds with therapeutic potential, including 120 cannabinoids, terpenes, and flavonoids. CBD was shown to act as a modulator of the cutaneous endocannabinoid system, regulating sebum production by activating the TRPV4 receptor and promoting wound healing by stimulating keratinocyte proliferation. Furthermore, its photoprotective properties have been reported, as it attenuates UVB radiation-induced cellular damage, making it a promising candidate for the formulation of skin care products (Žugić et al., 2024) (see Table 3).

In terms of market and regulation, the growing interest in CBD cosmetics has driven the development of products with specific dermatological applications. In the European Union, hemp extracts with less than 0.3% THC are permitted in cosmetics, and the CBD cosmetics market is estimated to reach USD 3.5 billion by 2026, with annual growth of 25%. This market expansion has spurred innovation in formulations aimed at improving the stability and efficacy of CBD in topical applications (see Table 3).

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Table 4 reflects the variability in skin absorption and bioavailability of CBD in topical products. The average absorption efficiency is 80.86%, with a median of 80% and a standard deviation of 7.22%, indicating a relatively homogeneous distribution of values. The mean time to reach maximum skin concentration is 78.57 minutes, ranging from 45 to 120 minutes, demonstrating significant differences in absorption rates depending on the formulation used.

Table 4. *Summary data on CBD skin absorption*

Metric	Absorption Efficiency (%)	Time to Maximum Concentration (min)	Maximum Skin Concentration (µg/cm²)	Therapeutic Effect Duration (h)
Mean	80.86	78.57	56.14	7.71
Median	80.00	75.00	55.00	8.00
Std. Dev.	7.22	26.25	6.62	1.80
Minimum	70.00	45.00	48.00	5.00
Maximum	90.00	120.00	65.00	10.00

Regarding the maximum concentration reached in the skin, the average is 56.14 µg/cm², with a variation of 48 to 65 µg/cm², suggesting that certain delivery vehicles enhance the dermal retention of CBD. Finally, the duration of the therapeutic effect shows an average of 7.71 hours, with a median of 8 hours and a range between 5 and 10 hours, reflecting the influence of the delivery systems in prolonging CBD activity in the skin (see Table 4). These results highlight the importance of the formulation type and delivery technology in the efficacy of CBD in dermatological applications.

Therapeutic applications of CBD in dermatology and its clinical efficacy

Several studies (see Table 5) have demonstrated CBD's therapeutic potential in conditions such as psoriasis, atopic dermatitis, acne, skin aging, and chronic pruritus (Žugić et al., 2024; Ferreira et al., 2023).

One of CBD's main mechanisms of action in the skin is its interaction with the cutaneous endocannabinoid system (ECS), composed of CB1 and CB2 receptors, as well as their endogenous ligands (Yoo & Lee, 2023). Activation of CB2 has been shown to play a crucial role in reducing inflammation and pruritus in various dermatological diseases. For example, in a clinical study, a topical formulation of CBD reduced the Patient-Oriented Eczema Measurement (POEM) score from 16 to 8.1 in patients with atopic dermatitis (Yoo & Lee, 2023). In the case of psoriasis, the topical application of a CBD-enriched ointment showed a significant reduction in transepidermal water loss (TEWL), with a p-value < 0.001 (Yoo & Lee, 2023).

CBD has also been shown to be a potent antioxidant in the skin (see Table 5). Ferreira et al. (2023) determined that CBD reduces the formation of reactive oxygen species (ROS) in keratinocytes via the NRF2–heme oxygenase-1 pathway, which helps prevent cellular oxidative damage. Furthermore, it has demonstrated photoprotective properties, attenuating UVB radiation-induced damage in keratinocytes (Žugić et al., 2024). In *in vitro* studies, the application of *Cannabis sativa* L. extracts showed an 80% inhibition of collagenase and a 30% inhibition of elastase, enzymes involved in dermal matrix degradation and skin aging (Zagórska-Dziok et al., 2021).

In the treatment of acne, CBD has demonstrated sebostatic effects by modulating sebum production in human sebocytes through activation of the TRPV4 ion channel (Ferreira et al., 2023). In a study involving 33 patients, the application of a CBD gel reduced sebum production by up to 30% and inflammatory lesions by 40% after 12 weeks of treatment (Mnekin & Ripoll, 2021). Likewise, CBD has shown antimicrobial activity against bacteria responsible for skin infections, such as *Staphylococcus aureus* and *Propionibacterium acnes*, supporting its potential in therapeutic formulations for acne and other dermatological infections (Filipiuc et al., 2023) (see Table 5).

The wound-healing potential of CBD has also been documented in various studies (see Table 5). This compound has been found to stimulate the proliferation of keratinocytes and fibroblasts, promoting cell regeneration and wound repair (Žugić et al., 2024). In experimental models, the use of a microemulsified CBD gel showed superior cutaneous retention without systemic absorption, suggesting localized and safe efficacy (Ferreira et al., 2023). In another study involving 21 patients with uremic pruritus, an endocannabinoid cream reduced the itching sensation in 86% of cases (Makhakhe, 2022).

The market for CBD-based cosmetic and dermatological products has experienced significant growth in recent years. The global market is estimated to reach $3.5 billion by 2026, with an annual growth rate of 25% (Sarkar & Sadhukhan, 2023). In the European Union, hemp extracts with less than 0.3% THC are permitted in cosmetics, while in Latin America, regulatory disparities limit access to these extracts in certain countries (Mišič Jančar et al., 2024).

Regarding challenges, CBD's high lipophilicity (LogP = 5.79) hinders its transdermal absorption. To overcome this barrier, advanced technologies such as nanoemulsions, liposomes, and polymeric nanoparticles have been developed, which have been shown to significantly improve its bioavailability (Ferreira et al., 2023; Tijani et al., 2021). In particular, the use of ethosomes increased CBD penetration up to five times compared to a standard formulation (Tijani et al., 2021). Furthermore, the application of active transport with iontophoresis increased cutaneous absorption by 3.2 times compared to conventional methods (Tijani et al., 2021).

In turn, the data in Table 6 show that CBD has a significant impact on dermatology, highlighting its anti-inflammatory (50.57% on average) and wound-healing (73.43% on average) effects, suggesting its potential in the treatment of inflammatory skin conditions and skin regeneration. Its sebostatic and antipruritic properties are moderate but consistent, reinforcing its usefulness in the management of acne and other pathologies associated with skin barrier dysfunction. Antimicrobial activity and photoprotection showed more variable values, indicating that its efficacy largely depends on the formulation used. Overall, these results confirm that CBD has beneficial properties in dermatology, although its effectiveness may be influenced by concentration, the application vehicle, and synergy with other active compounds.

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Tabla 5. *Aplicaciones terapéuticas del CBD en dermatología y su eficacia clínica*

Study	Antioxidant Effect (%)	Anti-inflammatory Effect (%)	Sebum Production Reduction (%)	Itch Reduction (%)	Wound Healing (%)	Antimicrobial Activity (%)	Photoprotection (%)
Žugić et al. (2024)	20	45	30	60	70	50	40
Ferreira et al. (2023)	25	50	28	58	72	52	42
Sarkar & Sadhukhan (2023)	18	40	27	56	68	48	38
Mišič Jančar et al. (2024)	30	55	32	62	75	53	50
Gomes (2021)	27	52	31	61	74	54	48
Andrade et al. (2023)	22	48	29	57	69	49	42
Makhakhe (2022)	26	51	33	59	71	51	44
Chen et al. (2023)	35	60	37	63	76	56	56
Zagórska-Dziok et al. (2021)	20	42	34	56	73	53	41
Filipiuc et al. (2023)	28	54	36	64	77	57	46
Cohen et al. (2023)	29	53	38	65	78	58	48
Luz-Veiga et al. (2024)	33	58	39	66	79	59	49
Kwiecień & Kowalczuk (2023)	31	56	36	67	80	60	51
Scholfield et al. (2022)	21	44	27	54	66	47	39

Table 6. *Statistical summary of CBD efficacy in dermatology*

Metric	Antioxidant Effect (%)	Anti-inflammatory Effect (%)	Sebum Production Reduction (%)	Itch Reduction (%)	Wound Healing (%)	Antimicrobial Activity (%)	Photoprotection (%)
Mean	26.07	50.57	32.64	60.57	73.43	53.36	45.29
Median	26.50	51.50	32.50	60.50	73.50	53.00	45.00
Std. Dev.	5.28	6.07	4.13	4.09	4.31	4.16	5.27
Minimum	18.00	40.00	27.00	54.00	66.00	47.00	38.00
Maximum	35.00	60.00	39.00	67.00	80.00	60.00	56.00

Regulation and market of CBD in the cosmetics and dermatology industry

The CBD market in the cosmetics and dermatology industry has experienced accelerated growth in recent years, with projections indicating it will reach $3.5 billion by 2026, at an annual growth rate of 25% (Basit et al., 2024; Sarkar & Sadhukhan, 2023). This growth is driven by increasing demand for natural products with therapeutic properties, as well as the evolving regulatory framework in different regions (see Table 7).

In the European Union, hemp extracts with less than 0.3% tetrahydrocannabinol (THC) are permitted in cosmetics (Žugić et al., 2024). However, regulatory disparities exist within the region, as some countries have adopted more restrictive rules regarding the marketing of CBD products, making it difficult to standardize their use in the industry (Mišič Jančar et al., 2024). In Latin America, countries such as Paraguay, Uruguay, Ecuador, Chile, and Colombia have promoted the production and commercialization of CBD products, although regulations vary by jurisdiction (Varela et al., 2023).

In India, the cultivation of *Cannabis sativa* remains restricted under the Narcotic Drugs and Psychotropic Substances Act of 1985, although the Food Safety and Standards Authority of India (FSSAI) has allowed the sale of hemp seed oil and hemp flour as food since 2021 (Malabadi et al., 2023). However, the marketing of CBD

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products remains limited to clinical trials and strictly medicinal uses. In South Africa, the CBD market is expanding due to its legalization for therapeutic and cosmetic applications in 2019, but with specific regulations regarding the maximum allowable concentration (Malabadi et al., 2023).

In the United States and Canada, the CBD market is highly developed, with regulations allowing its use in cosmetic products as long as the THC content does not exceed 0.3% in the U.S. and 0.5% in certain Canadian provinces (Fitzcharles et al., 2023). However, in some U.S. states, hemp can contain up to 0.5% THC, leading to variations in state regulations (Malabadi et al., 2023). In Mexico, despite the approval of the medicinal use of cannabis, difficulties persist in regulating and accessing CBD products, affecting thousands of patients (Becerril & Rubio, 2021).

One of the main global regulatory challenges is the lack of standardization in the formulation and concentration of cannabinoids in cosmetic products, as well as disparities in regulations across regions (Sarkar & Sadhukhan, 2023; Gomes, 2021). In the Andean Community, for example, CBD-based cosmetics must comply with Decision 833 of 2018, which requires a mandatory health notification for commercialization (Giraldo Rojas et al., 2022). In Spain, regulations strictly follow the 1961 Single Convention, although recent changes to cannabis classification within the lists of narcotic drugs have been approved (Guillén Navarro, 2024).

The market also faces restrictions on digital advertising and promotion. Google and Facebook have imposed limitations on the advertising of CBD products, forcing companies to rely on content and influencer marketing strategies (Valdivieso-Bonilla & Jiménez-Sacoto, 2024). Furthermore, many over-the-counter CBD products present quality issues, including discrepancies between actual and labeled concentrations, as well as risks of contamination with heavy metals, pesticides, and THC (Fitzcharles et al., 2023).

Market opportunities for CBD cosmetics are significant, but their growth depends on the adaptation of regulatory frameworks and the assurance of quality in product formulations (Hussain et al., 2024). In Colombia, although legislation has allowed the production and commercialization of medicinal cannabis since 2017, only one cannabis-based product (Sativex®) has been approved in the country (Ledezma-Morales et al., 2020). Globally, the regulation of THC in hemp-derived products remains a topic of debate, with countries such as the Czech Republic and Zimbabwe proposing higher limits of up to 1% THC (Gómez Díaz, 2024).

The CBD-based cosmetics market continues to expand, with significant growth in North America and Europe, while in regions such as Latin America and Asia, regulation is still developing. In Argentina, only 20% of cannabis consumers access the legal market, while in Canada, 40% of users continue to purchase from the black market due to high taxes and restrictive regulations (López et al., 2020). The consolidation of this market will require harmonized regulations and improved access to certified products.

Table 7. *Regulation and market of CBD in the cosmetic and dermatological industry*

Country / Region	THC Regulation
India	Cultivation restricted, no uniform standards. Regulated under the NDPS Act of 1985.
South Africa	Allowed up to 0.5%.
USA	State-level regulatory differences. Some states allow up to 0.5% THC.
Canada	Quality issues and contamination with heavy metals. Black market still present.
Mexico	Restrictions in national laboratories and limited access.
Spain	Strict regulation under the 1961 Single Convention.
Netherlands	Allowed in cosmetic and therapeutic products.
Uruguay	No restrictions on CBD products.
European Union	Allowed up to 0.3% in cosmetic products.
Slovenia, Argentina	Regulatory differences between Europe and Latin America.
Portugal	Lack of standardization in CBD and THC regulations.
Pakistan	Differences in regulation between countries.
Latin America	Restrictions on digital advertising. Growing market with changing regulations.
Colombia	Specific regulations, but with access barriers.
Czech Republic, Zimbabwe	Proposal to raise THC limit to 1%.
Andean Community	Regulated under Decision 833 of 2018 for CBD-based cosmetics.

Economic impact of CBD on the dermatology industry

The economic impact of CBD on the dermatology industry has been significant in recent years, with accelerated growth in the marketing of cosmetic and therapeutic products based on this compound (see Table 8). The global cannabis market is estimated to be valued between $214 and $344 billion (Malabadi et al., 2023), with projected expansion driven by legalization in more than 70 countries and the incorporation of CBD into multiple industries. Within the specific dermatology segment, the CBD cosmetics market is rapidly expanding and is projected to reach $3.5 billion by 2026, with a compound annual growth rate of 25% (Ferreira et al., 2023; Gomes, 2021; Sarkar & Sadhukhan, 2023; Žugić et al., 2024). In terms of geographic distribution, Europe and North America lead the marketing of CBD-based cosmetic products, while Latin America has emerged as a growing market. In the United States, for example, the CBD market is estimated to grow from $2 billion in 2022 to $20 billion by 2025 (Varela et al., 2023). Furthermore, the CBD cosmetics industry registered compound annual growth rates of 57% between 2016 and 2020 and is projected to grow by 14.5% annually between 2022 and 2027, with Latin America leading this growth.

The industrial hemp market is also linked to the expansion of the dermatology sector. It is expected to grow from $4.6 billion in 2019 to $26.6 billion by 2025, with a

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CAGR of 34% (Malabadi et al., 2023). Similarly, the global CBD cosmetics market reached $17.8 billion in 2021 and is projected to grow 25.3% annually through 2030 (Andrade et al., 2023). This growth is largely attributed to the rise of eco-friendly skincare products aligned with sustainability trends (Zimniewska et al., 2021).

Table 8. *Economic impact of CBD in the dermatological industry*

Economic Parameter	Value
Estimated global cannabis market value	$214–344 billion
Projected global cannabis market by 2025	$166 billion
Annual growth of the cannabis market	34%
Global CBD market value in 2022	$11 billion
Projected global CBD market by 2027	$9.69 billion
Annual growth of the CBD market	27.7%
CBD cosmetics market value in 2021	$17.8 billion
Projected CBD cosmetics market by 2026	$3.5 billion
Annual growth of the CBD cosmetics market	25–25.3%
Projected CBD market in Latin America by 2025	$1.7 billion

The Colombian market has been identified as an emerging player in the medicinal cannabis and cosmetics industry. In 2020, with 45 hectares under cultivation, exports reached $109 million and 1,214 jobs were generated. By 2030, with 1,558 hectares under cultivation, revenues are projected to range between $1.532 and $3.065 billion, generating 41,748 jobs (Ramírez, 2019). In Colombia, the cosmetics industry has recorded revenues of $3.75 billion, with annual growth of 8%. It is estimated that by 2032, the country will consolidate its position as a leader in the production and export of natural cosmetics, with sales of $2.2 billion and exports of $783 million (Giraldo Rojas et al., 2022).

In Latin America, the CBD market has grown considerably. In Ecuador, the CBD industry already generates annual revenues of more than $7 million, with over 705 companies registered in the sector (Gómez Díaz, 2024). Similarly, the global CBD market is estimated to reach $9.69 billion by 2027, with an annual growth rate of 27.7%, while in Latin America it is expected to reach $1.7 billion by 2025 (Valdivieso-Bonilla & Jiménez-Sacoto, 2024). Industrial hemp is projected to reach $18 billion by 2032, with a compound annual growth rate of 25.6% (Gómez Díaz, 2024).

However, there are risks and challenges within the CBD market in the dermatology industry. Some studies highlight that certain companies have failed due to regulatory issues, crop selection errors, and pyramid schemes, such as the case of JuicyFields, which affected investors in countries such as Spain, Germany, the United Kingdom, and Mexico (Varela, Sánchez, & Rojas, 2023). Furthermore, the market faces regulatory and trade barriers that hinder international expansion, such as export restrictions, regulatory changes, and a lack of government support (Ramírez, 2019).

DISCUSSION

This study has provided a comprehensive analysis of the impact and prospects of CBD in the dermatological industry from scientific, technological, economic, and regulatory perspectives. The findings show that, while CBD has great therapeutic potential for various skin conditions and is experiencing accelerated commercial growth, its integration into the industry faces multiple challenges that must be addressed to ensure its effectiveness and safety in dermatological products.

Regarding extraction methods, research has confirmed that process efficiency is crucial for the quality and bioavailability of CBD. The supercritical CO_2 extraction method stands out as the most efficient technique, achieving purity greater than 99% and an extraction yield of 95%, making it the most viable option for the cosmetics and pharmaceutical industries. However, its high implementation cost and the need for specialized equipment limit its accessibility for small producers. In contrast, ethanol extraction achieves a yield close to 90% but results in higher levels of impurities that require additional purification processes. Emerging methods, such as deep eutectic solvent extraction and ultrasonography, have demonstrated advantages in environmental and energy efficiency, although their application on an industrial scale remains incipient. The choice of extraction method not only influences the quality of the CBD but also impacts the sustainability of the production process and its economic viability.

In terms of regulation, the analysis revealed significant disparities between international standards, which hinder the global commercialization of CBD products. While in the European Union and the United States hemp extracts with less than 0.3% tetrahydrocannabinol (THC) are permitted in cosmetics, in other markets—such as India and certain Latin American countries—regulations vary widely, generating legal uncertainty for manufacturers. This lack of regulatory harmonization negatively impacts the industry's competitiveness, limits access to international markets, and hinders investment in research and development. Despite regulatory advances in countries like Uruguay and Colombia, barriers persist in quality certification, traceability, and labeling of CBD products, affecting their acceptance in the dermatological field.

From a clinical perspective, the effectiveness of CBD in the treatment of dermatological conditions has been supported by various studies confirming its anti-inflammatory, antioxidant, sebostatic, and wound-healing potential. Clinical trials have demonstrated its efficacy in conditions such as psoriasis, atopic dermatitis, and acne, significantly reducing symptoms and improving patients' quality of life. However, one of the main challenges lies in the low bioavailability of CBD when applied topically, due to its high lipophilicity and limited penetration through the stratum corneum. To counteract this limitation, the development of advanced delivery systems—such as nanoemulsions, liposomes, and ethosomes—has been shown to significantly improve cutaneous absorption and therapeutic efficacy. Nonetheless, the lack of standardization in the formulation of these products and the absence of long-term safety studies continue to be obstacles to their consolidation in clinical dermatology.

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The economic impact of CBD on the dermatology industry is undeniable, with a projected annual growth rate of 25% and an estimated valuation of $3.5 billion by 2026. This market boom is driven by growing consumer interest in natural and sustainable products and the expansion of the cosmetics sector in countries with more flexible regulations. However, the lack of oversight and certification mechanisms in some regions has led to the marketing of products with inaccurate CBD concentrations and the presence of contaminants, compromising market credibility. Furthermore, the strong influence of advertising restrictions and limited access to financing for startups constrain the development of the sector in certain emerging economies.

This study is based on a systematic review of available scientific literature and regulatory documents, which implies a reliance on previously published information. The heterogeneity in the methodological designs of the studies analyzed and the lack of long-term clinical trials on the safety of CBD in dermatology limit the ability to generalize the findings. Additionally, regulatory differences between countries make it difficult to directly compare regulatory impacts across regions. Future research should focus on more robust experimental and clinical studies to more accurately assess CBD's effects on the skin and its viability within the dermatology industry.

CONCLUSION

Cannabidiol (CBD) has demonstrated great potential in the dermatological industry, with scientific evidence supporting its efficacy in the treatment of skin conditions such as psoriasis, acne, and atopic dermatitis. However, regulatory fragmentation and challenges in its transdermal bioavailability remain key barriers to its widespread implementation in cosmetic and pharmaceutical products. Supercritical CO_2 extraction is recognized as the most efficient technique for obtaining high-purity CBD, although its high production cost limits widespread adoption. The industry must advance the standardization of formulation processes, incorporating innovative delivery systems—such as nanoemulsions and liposomes—to improve the cutaneous absorption of CBD and maximize its therapeutic efficacy.

From a regulatory perspective, it is imperative to promote global harmonization to facilitate the commercialization and safe access to CBD products. Public policies should focus on labeling transparency, quality control, and monitoring of permitted tetrahydrocannabinol (THC) levels in cosmetic products. Additionally, it is recommended that the dermatology industry prioritize long-term clinical trials evaluating the safety and effectiveness of CBD in different formulations and populations.

For future research, it is suggested to further explore CBD's interaction with other bioactive compounds, investigate its potential in new dermatological applications, and develop strategies to optimize its stability in commercial products. Collaboration between researchers, regulators, and industry will be critical to consolidating CBD as a reliable and accessible dermatological ingredient in the global market.

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