cosmetics

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Review

Harnessing the Potential of *Helinus integrifolius* in Cosmeceutical Research: Toward Sustainable Natural Cosmetics

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Abstract: The growing demand for natural and sustainable ingredients in cosmetic formulations has driven scientists to explore a wide range of botanical resources. *Helinus integrifolius*, a lesser-known botanical entity, has recently emerged as a formidable contender in this field. This review explores the possibility of incorporating *Helinus integrifolius* in the cosmetics industry, synthesizing data from the literature on pharmacological, botanical, and cosmetic research. Additionally, this highlights the versatility and multipurpose nature of this botanical resource in cosmetic applications. Furthermore, concerns regarding the safety of contemporary cosmetic products, formulation compatibility, and regulatory aspects are addressed to accelerate its integration into cosmetic products. Ultimately, this review highlights the untapped potential of *Helinus integrifolius* as a treasured resource for the cosmetics industry, emphasizing its ability to meet the growing consumer demand for eco-friendly, effective, and naturally inspired cosmetic solutions. Through thorough exploration and analysis, this paper aims to stimulate further research and development initiatives aimed at harnessing the cosmetic capabilities of *Helinus integrifolius*, thus contributing to the advancement of innovation in natural cosmetics.

Keywords: botanical resources; cosmeceutical; *Helinus integrifolius*; pharmacological properties; natural

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1. Introduction

The concept of beauty is deeply ingrained in society, and a universal standard for facial beauty that is based on ideal facial proportions is being established [1]. This standard is often pursued by using cosmetics, which are subject to quality control measures that ensure products meet specific standards [2,3]. The use of cosmetics, particularly for enhancing appearance, has been prevalent throughout history and is linked to the desire for ideal beauty and social competition [4]. Cosmetics play a significant role in enhancing appearance, protecting from harmful rays, and boosting confidence, hence the medicalization of female beauty [5]. The increasing popularity of cosmetic procedures further reflects the influence of societal beauty standards [5]. The global beauty industry, which includes cosmetics, is currently valued at $532 billion [6]; however, it is anticipated to increase to $758.05 billion by the year 2032, revealing a CAGR of 9.8% over the forecast period [7]. These figures indicate substantial growth and increased revenue for the cosmetics industry. However, there is a global shift towards more eco-friendly, sustainable, and green products that is driven by a growing awareness of the environmental impact of synthetic chemicals. The shift has led to a recent surge in consumer demand for natural and sustainable ingredients in cosmetics [8–12]. The global green cosmetics market is anticipated to increase at a CAGR of 5.1% from 2024 to 2029 [13]. Consequently, the focus is largely on botanical resources, with cosmetic scientists and formulators increasingly leveraging the potency of natural compounds in skincare formulations [14,15]. Despite this trend, concerns about their safety have led to calls for more stringent regulations [9]. To address some of the concerns, over 60 amendments have been revised by Regulation 1223/2009. The Regulation 1223/2009 is a European Union regulation that governs the safety and labeling of cosmetic products sold within the EU market. It establishes a comprehensive framework for ensuring the safety of cosmetic products to protect consumer health [16].

The potential effectiveness of many botanical ingredients in skincare products is still being researched, with a need for more clinical trials to assess their biological effects [17]. Hence, leveraging the inherent potency of natural compounds in skincare formulations will provide a competitive edge. The use of medicinal plants in skincare formulations is gaining popularity due to their natural and beneficial properties [18]. Plant extracts in skincare products have been reported to have antioxidant, antimicrobial, and other biological effects, further supporting their potential in skincare formulations [19–21]. Among these botanical resources, *Helinus integrifolius* (Lam.) Kuntze, also known as Soap Bush, is a valuable botanical resource with significant potential in skincare due to its rich repository of bioactive compounds [22]. This plant has been traditionally used by indigenous African communities for its medicinal properties, particularly in treating dermatological conditions and enhancing skin health [23].

H. integrifolius is identified as a medicinal plant that is used by Xhosa communities in South Africa to manage skin disorders [24]. This is consistent with the use of herbal oils and natural emulsifiers in topical applications [25]. The potential of *Helianthus tuberosus* in treating atopic dermatitis, which is a chronic inflammatory skin disease, has also been explored [26]. These studies collectively accentuate the plant's therapeutic value, which is further highlighted by its diverse skincare benefits [27]. The potential of *H. integrifolius* in skincare is a promising area for further research and development. The use of *H. integrifolius* in natural cosmetics is in line with the growing demand for botanical-based solutions that prioritize efficacy, safety, eco-friendliness, and sustainability. This review seeks to unveil the rich potential of *H. integrifolius* as a natural, eco-friendly, and sustainable ingredient or product in cosmetic formulation innovations, regulatory considerations, and future prospects.

2. Botanical Characteristics

Helinus integrifolius (Lam.) Kuntze is a perennial climbing shrub that belongs to the family Rhamnaceae [28]. It is native to the tropical and subtropical regions of Africa and Asia. It is commonly found in thickets (along riverbanks and gassy areas), forest margins, woodlands, bushlands, dry savannah, rocky places, and elevated areas [29]. The common names of this plant include Soap Bush, Soap Creeper in English; Seepbos or Seepbossie in Afrikaans; Ubulawu Obude, Ukumbuqwekwe or ithyolo in isiXhosa; and uPhuphuphu, Uxuphukwekwe, or uBhubhubhu in isiZulu [28]. The genus name *Helinus* means tendril and refers to the fact that the shrub has climbing tendrils [29]. It is known for its distinct botanical characteristics. It has a hairless stem with coiled tendrils that help it climb to other plants for support [29]. *H. integrifolius* has simple, alternate, large oval leaves. They are elliptical to lanceolate in shape, with entire margins that are smooth with no indentations or serrations pressed with silky pubescence. (Hence, the specific epithet "integrifolius", meaning "with entire leaves"). *H. integrifolius* produces small, white, yellowish star-shaped flowers with five petals [30] as shown in Figure 1. They are born in pendulate umbels with a long peduncle and a short, slender pedicel that lacks showy petals but is nonetheless important for the plant's reproductive cycle. The fruits are three-lobed, with the calyx remaining on the tips. The seeds are small, black, and triangular [31]. Understanding the botanical characteristics of *H. integrifolius* is essential for both botanical enthusiasts and those interested in utilizing this plant for various purposes, including landscaping, conservation, and botanical as well as cosmeceutical research.

Figure 1. The botanical morphology of *Helinus integrifolius* (Photo by Mike Bingham) [32].

3. Sustainability in Cosmetics

There is a growing global need for natural resources to produce cosmeceuticals [33]. In many cultures around the world, using natural resources, especially plant material, for skin conditions and cosmetic purposes is a long-standing custom [34]. Natural treatments are not just for cosmetic purposes but also for therapeutic purposes aimed at curing different skin conditions [35]. Statistics South Africa states that while seeking treatment for common ailments, such as skin conditions, South Africans turn to both traditional healers and public health institutions [36]. Despite the ongoing disregard for traditional cosmeceuticals in favor of synthetic ones, many rural communities still use natural resources for skin health [33,37–39]. Alshammari et al. [40] state that "the move away from synthetic flavors and fragrances towards plant extracts, particularly for the food, drink, and cosmetic industries", is one reason why the usage of natural product extraction has grown in popularity recently. The market is expected to rise at a compound annual growth rate of 6.0% from 2021 to 2026, where it is expected to reach $55.3 billion [41]. The cosmetics industry is placing a greater emphasis on sustainability due to the increase in the need for natural ingredients derived from medicinal plants. Sustainability has become a cornerstone of the cosmetic industry, driven by increasing consumer awareness of environmental issues and a desire for eco-friendly products. Natural ingredients, such as those derived from *H. integrifolius*, play a pivotal role in advancing sustainability initiatives within the industry [42]. Therefore, *H. integrifolius* sustainability in cosmetics is a crucial aspect that aligns with the global trend towards sustainable practices in the cosmetics industry [43]. However, some businesses might find it difficult to adopt sustainability practices because of a lack of long-term planning, hierarchies, and investor overvaluation [44,45], although other businesses in the industry are progressively embracing long-term sustainable strategies, integrating green chemistry principles, and concentrating on sustainable supplier selection [46–48]. Rapid changes in environmental and socioeconomic conditions may result in the extinction of targeted plant species and the indigenous knowledge that goes along with them [35]. In this context, evaluating the ecological footprint becomes paramount.

3.1. Ecological Footprint

The harvesting and subsequent depletion of natural resources for human consumption is a global conservation and sustainability issue [49,50]. The depletion of natural resources not only negatively impacts biodiversity and water availability but also exacerbates the effects of climate change on the environment [49,50]. The increased use of medicinal plants such as *H. integrifolius* in the cosmetics industry has been shown to have a significant ecological footprint, spanning from the harvesting of the plant, the extraction of bioactive compounds, the production and manufacturing of the cosmetic to the consumer pre and post use [51–54]. The unregulated harvesting of natural resources depletes the resource from the environment, thereby reducing biodiversity as well as the amount of plant material available for the absorption of carbon dioxide from the atmosphere. Information on the commercial cultivation and harvesting of *H. integrifolious* is limited, although numerous studies report on the harvesting of the plant from its natural environment in the wild [35,55,56]. To produce and manufacture cosmetic products from harvested medicinal plants, saponins are extracted from plant parts and, in the case of *H. integrifolius*, the entire plant is utilized [51,55,56]. The extraction process requires extensive electricity and water usage, thereby contributing to an electricity indirect greenhouse gas emission, which increases the carbon and water footprint [51,54,57]. Greenhouse gas emissions are further exacerbated during the transportation of the finished product due to emissions from transportation vehicles [57]. In addition to greenhouse gas emissions, chemical spills during the production process, and effluents deposited in water during use by consumers, further pollute the environment. This reduces the quality of ground and river water, thereby affecting access to safe and clean drinking water for humans. Polluted water may also lead to eutrophication, thereby affecting aquatic life [51,54,57].

3.2. Sustainable Practices

Numerous studies make reference to sustainability practices being employed in the entire process of product formulation, that is, from harvesting, manufacture, and packaging, to distribution, as shown in the case of the L'Oreal group of companies [50,52,57,58]. Although this is the case, emphasis is placed largely on sustainable production, manufacturing, distribution, consumer use and after-use practices, while research on sustainable harvesting is limited [51,57]. In addressing the biodiversity conservation concern, which impacts the carbon footprint, emphasis needs to be placed on regulating the sourcing of natural resources. Although *H. intergrifolius* and most of the medicinal plants that are used in the cosmetics industry are placed in the Least Concern category of the threatened and endangered species red list by the International Union for Conservation (IUCN; [56]), the continued use of these plants needs to be monitored to prevent overexploitation, given their demand in the quest for "green cosmetics". The harvesting of a portion of the plant for tissue culture and propagation, rather than the whole plant as in the case of *H. integrifolius*, should be explored. This would ensure that wild populations of these plants continue to thrive.

To limit energy consumption and reduce the carbon and water footprint, reports in the literature include the use of renewable energy, a reduction in greenhouse gas emissions, the recycling and reuse of water in a loop, the use of biobased ingredients and packaging materials from sustainable sources, the use of biobased formula ingredients derived from minerals or circular processes, the recycling of packaging plastic, and the recycling and re-use of generated waste, such as almond shells, orange peel and used cooking oil [52,53,58]. However, Rocca et al. [50] argue that looking at these aspects does not consider the social and economic standing of consumers, nor does it highlight standardized and precise regulations that pertain to sustainability. Table 1 emphasizes the sustainable qualities of *Helinus integrifolius*, making it an ideal candidate for use in natural cosmetics formulations.

Table 1. Sustainability attributes of *Helinus integrifolius* for natural cosmetics.

Sustainable Sourcing	Indigenous to tropical and subtropical regions, promoting local biodiversity—cultivated by indigenous communities using sustainable practices
Organic Certification	Traditionally grown without synthetic pesticides or fertilizers, ensuring purity and naturalness
Biodegradable Ingredients	Plant-derived compounds naturally degrade, minimizing environmental impact and waste
Eco-Friendly Formulations	Abundant in antioxidants and bioactive compounds, ideal for natural skincare formulations Cultivated using environmentally friendly agricultural practices
Renewable Resources	Utilizes renewable plant resources, reducing reliance on finite resources and supporting ecosystem health
Packaging	Plant-derived extracts can be incorporated into biodegradable packaging materials, reducing plastic waste
Certifications and Standards	*Helinus integrifolius*-derived ingredients can meet organic and natural cosmetic standards, ensuring quality and authenticity
Environmental Impact Assessment	Low environmental footprint due to sustainable sourcing and minimal processing, minimizing ecological harm
Transparency and Communication	Ingredient transparency through clear labeling and communication fosters consumer trust and informed choices

4. Limitations and Drawbacks of Contemporary Cosmetic Products

Cosmetics contain organic, inorganic, or synthetic ingredients that enhance their effectiveness to meet certain social or peer-approved standards. However, some of the ingredients pose a threat to human health and the environment. The study conducted by Sheikh [59] highlighted 10,500 harmful synthetic ingredients used in cosmetics, whereas the study by Abed et al. [60] indicated 70,000 chemicals currently used in cosmetics, an extreme increase in the number of synthetic chemicals used in cosmetics over an 8-year period. In addition, an estimated 1000 new compounds are expected to be introduced every year. Surprisingly, it has been brought to our attention that about 7500 cosmetic products contain more than one ingredient that has never been evaluated or tested for safety, toxicity, or permissible allowance [59]. It is reported that in the United States, there are approximately 12,500 different compounds used in cosmetics. Among these, only 2500 are claimed to be safe for use. Still, a large number of the remaining compounds have been identified as unsafe, with only 11 of them currently being restricted [60]. Naveed [61] has mentioned that a large group of harmful ingredients persists in the cosmetics industry, which shockingly includes 100 carcinogens and 15 endocrine disruptors.

Furthermore, a number of these chemicals pose health complications, such as carcinogens, pesticides, reproductive toxins, endocrine disruptors, plasticizers, degreasers, and surfactants. While some chemical ingredients may only cause minor irritations or allergic reactions, others are associated with more severe health issues, such as cancer, hormonal disruptions, immunosuppressants, tumor promoters, and reproductive problems [60–62]. It is important to consider that in the process of manufacturing, in addition to the chemicals used, synthetic preservatives are also used, which can have negative effects on human health. These preservatives can cause chronic symptoms, such as cardiovascular disorders, hypersensitivity, an estrogenic effect, endocrine disruption, pulmonary irritation, carcinogenicity, neurotoxicity, cytotoxicity, antibiotic resistance, sensitization, and more [63].

The skin is the body's largest organ, protecting the entire body and interacting directly with cosmetics of various types. The interactions may result in the absorption of these active ingredients into the body, which may potentially cause harm and contribute to health complications. Certain cosmetics are associated with provoking negative effects on one's overall health over time or through continuous exposure. This is because the toxic chemical ingredients in these products can accumulate in the bloodstream, disrupt hormones and cell functioning structures, and increase the risk of developing chronic diseases, such as cancer [62]. The repeated application of certain cosmetic products may result in irritation or complications.

In the study conducted by Sullivan et al. [62], it was found that eye makeup can directly cause ocular surface and adnexal diseases, leading to various symptoms such as infections, inflammation, allergies, trauma, neoplasia, dysfunction, and degeneration. In a survey of 10 makeup cosmetics, prominent symptoms such as toxicity, cytotoxicity, allergens, irritants, immunosuppressants, carcinogens, endocrine disruptors, neurotoxins, meibomian gland dysfunction, and antibiotic resistance were identified. It is important to note that the above-mentioned acute disease symptoms were only collected from a survey of 10 eye cosmetics. However, it is worth considering that there are many other cosmetic products that people use every day alongside eye makeup, such as toothpaste, body lotion, perfume, hair conditioner, aftershave, lipstick, and nail polish; people that have tattoos must also be considered. All of these products contain different synthetic chemicals that could potentially lead to adverse health effects and negatively affect the environment.

As reported in many studies, including those by Sullivan et al. [62], the current cosmetic products are produced with several chemicals that endanger humans and the environment. These compounds cause chronic conditions like neurotoxicity, endocrine disruptors, meibomian gland dysfunction, and toxicity to epithelial cells. Different heavy metal ingredients have been associated with the potential to cause definite or varying acute or chronic conditions; as such, exposure to heavy metals like cobalt, mercury, beryllium, and chromium is associated with chronic health (cancer, neurological, and reproductive complications) or other non-cancerous health disorders that include impaired neurological, immunological, respiratory, and reproductive functioning [60,64].

In the past few decades, cosmetic production has invested in heavy metal ingredients that ultimately contribute to symptomatic conditions, including toxicity of different kinds, depending on the types of metals involved and the fact that they easily penetrate the skin [60]. Heavy metals such as aluminum, lead, cadmium, mercury, chromium, cobalt, manganese, copper, titanium, nickel, zinc, iron, and arsenic are classified as harmful metals that are associated with causing acute toxicity and poisoning that leads to disorders in the nervous system, blood, lungs, kidneys, and liver [60,65]. It has been observed that cosmetic products contain significantly higher levels of certain metals compared to our diet. The accumulation of metals in the skin leads to several health issues, such as cancer, allergies and neurological problems, and can cause birth defects. This, therefore, raises concerns about the safe utilization of these cosmetic products with harmful substances [65].

Recently, in a study by Abed et al. [60], cosmetic products contained heavy metals at levels that exceeded the permissible limit set by the Food and Drug Administration. Some examples of these metals include mercury at 65 ppm, lead at 10 ppm, arsenic at 3 ppm, and chromium at 50 ppm. However, the permissible limits of these metals may vary depending on the specific cosmetic product. Inorganic compounds are other elements that have generated interest for use in cosmetic production due to their broad photoprotective or UV filters that offer dual protection against UVB and UVA radiation [66]. Users are increasingly opting for cosmetic products that contain inorganic compounds instead of organic ones, despite being unaware of the potential risks involved. This, therefore, means that humans and the environment will suffer as users prefer products that offer more activity, and producers will always manufacture and introduce new chemicals to enhance effectiveness or relevance to the demand or market. The application of skincare products containing heavy metals, synthetic chemicals, or inorganic compounds can cause the generation of reactive oxygen species, which can ultimately lead to skin damage and a loss of elasticity [59,66]. Hydroquinone is a depigmenting agent in skin-lightening cosmetics that causes irritations, redness, burning, and ultimately exogenous ochronosis that is triggered by extreme cytotoxicity to melanocytes and potentially linked with mutagenic mammalian cells [65]. Other compounds, like black henna, would cause symptoms like blisters, oozing, swelling, and rashes.

The improper disposal of cosmetic products can release heavy metals into waterways and soil, leading to severe environmental impacts [60]. Numerous studies have concluded that people frequently use cosmetic products that contain complex chemical compounds that directly interact with the skin, penetrate it, and leach into the blood, causing both carcinogenic and non-carcinogenic health disorders, as well as chronic or acute conditions. Harmful ingredients are present at high levels in the soil, drinking water, and the food we consume. The combined effect of these compounds increases exposure not only to humans but also to animals and the environment. Exposure to inorganic, heavy metal, and synthetic chemicals in cosmetic products can be minimized by adjusting manufacturing and preservation techniques or toxic chemical compounds. It is highly recommended to consider using natural-based products that are safe, with chemical ingredients that are regulated and tested for safety.

5. Cosmetic Formulation Innovations (Natural Products)

H. integrifolius has been traditionally used in the treatment of stroke, leg pain, hysteria, nervous system ailments [34,67] and as a soap substitute for the treatment of hair loss and skin disorders [25,34,35,55,68]. This herb, like most soapy plants, foams when agitated in water [68]. The soapy properties are attributed to the presence of saponins [68]. Saponins are amphyillic glycosides characterized by hydrophobic aglycones attached to varying numbers of hydrophilic sugar chains [55,68]. Saponins from *H. integrifolius* are not only used as foaming agents, as they can also be utilized as natural washing and emulsifying compounds, and skin health-enhancing agents [68]. The hydrophilic sugar moieties are usually in the form of either hexose or pentoses [56]. The phytochemical studies revealed that the type of saponins in *H. integrifolius* were triterpenoid and steroidal saponin [55]. However, this depended on the type of aglycone they carried [67]. Most of these saponins accumulated in roots rather than in the other parts [55]. Both saponins have been reported to contribute to skin hydration [69,70]. They achieve this by reinforcing the skin's natural barrier and interacting with lipids in the stratum corneum or by using their hydrophilic sugar moieties to attract and retain water [69]. Steroidal and triterpenoid saponins have attracted significant attention as important anti-inflammatory compounds which inhibit pro-inflammatory mediators (e.g., IL-1β, TNF-α and COX-2) and the NF-kB pathway, thereby calming irritated skin [71,72]. Several plant-derived saponins have been reported to exhibit a collagen synthetic property, which improves skin firmness [73]. They accomplish this by stimulating fibroblasts, which are responsible for producing collagen and thereby enhancing skin firmness and elasticity [69,71]. The other way this is achieved is by inhibiting collagen-degrading enzymes [70]. These saponins also have antimicrobial activity [56,71], wound healing, and skin regeneration properties; hence, they can be used to heal eczema and psoriasis [73,74]. These saponins also have a skin lightening capability, wherein they inhibit tyrosinase and reduce melanin production, leading to a more even skin tone [69]. This is also achieved by applications such as those of antioxidants and cytotoxic activities [70]. The presence of saponins in *H. integrifolius* is a groundbreaking discovery that unequivocally demonstrates the plant's potential for cosmeceutical applications. Its multifunctionality, ranging from formulation benefits to skin health improvement, make it an attractive natural ingredient that people can use in skincare products.

This plant has other key innovations in traditional cosmetic formulation, although the literature on commercial cosmetic products derived from *H. integrifolius* is limited. Numerous chemical compounds with possible health benefits are found in the plant species *Helinus integrifolius*, which has been investigated for its medicinal qualities. According to studies conducted on *Helinus integrifolius*, the leaves contain triterpene 1, squalene, spinasterol, oleanolic acid, phytol, and lutein; the stems contain squalene and spergulagenin A, and the roots contain spinasterol [75]. The aforementioned compounds demonstrate the potential of *Helinus integrifolius* as a bioactive compound exhibiting a wide range of pharmacological activities.

Helinus integrifolius, particularly the stem bark, has been traditionally used for treating various skin infections [25,76]. In addition to stem bark, the leaves are cited as the most used plant part for traditional concoctions using *H. integrifolius*, due to ease of preparation for treatment. Leaves are crushed and mixed with water for a softer consistency [34,35], Shai et al., 2013 [35]. The entire plant, consisting of roots, stems, and leaves, is also used to form a poultice for treating acne [35]. In some instances, the whole plant is harvested, although only the leaves or roots are required [77]. Poultices are formed from mixing either roots, leaves or stem bark with water and applied as a topical [35]. In African folklore, roots and bark are used to form a spiritual connection with ancestors and to induce dreams [77]. The reason this plant is used to treat skin ailments is the fact that it is rich in antioxidants, such as phenolic compounds. The plant-derived phenolic antioxidants help neutralize free radicals, protecting the skin from oxidative stress and premature aging [70]. *H. integrifolius* was among the plant species that have been used in the treatment of skin-related issues, including wounds [35]. The bark extract of *H. integrifolius* comprises bioactive compounds (friedelin and lupeol), which have shown significant wound healing properties by reducing the wound area and enhancing keratinocyte migration [78]. Additionally, *H. integrifolius* root and leaf extracts have shown significant activity against skin disorder, inducing bacteria such as Staphylococcus typhi [79] and Staphylococcus aureus, fungi that include Candida albicans [80] as well as diabetes-inducing enzymes [81].

By using consistent manufacturing procedures and logical formulation development, formulations containing *Helinus integrifolius* can demonstrate reproducibility. A few crucial actions must be taken in order to guarantee the reproducibility of *Helinus integrifolius* formulations and produce consistent outcomes throughout manufacturing. Initially, to ensure constant concentrations of active ingredients, standardized extraction techniques and strict quality control procedures must be put in place. Standardizing active ingredient concentrations and guaranteeing the consistency of raw material sources both contribute to uniformity. Consistency and control over all aspects of production are guaranteed when Good Manufacturing Practices (GMP) are followed [82]. It is confirmed that the active ingredients continue to work overtime by performing formulation stability testing. Comparing new batches with older ones to make sure the same quality is maintained requires batch-to-batch consistency checks. Tracking any variations and taking quick corrective action is also possible by keeping complete documentation and traceability [83]. Producing consistent, high-quality *Helinus integrifolius* formulations is ensured by manufacturers in adhering to these guidelines.

Such cosmetic formulations incorporating African olive extract can, therefore, contribute to maintaining skin health and vitality. *H. integrifolius* has been implicated in the treatment of hair loss [77]. Innovative cosmetic formulations leveraging the diverse benefits of *Helinus integrifolius* are poised to revolutionize skincare routines, offering consumers effective solutions for maintaining healthy, radiant skin [25]. Similar to other plants, *Helinus integrifolius* poses certain challenges when used in formulations. These challenges include the need to ensure the quality and purity of raw materials, manage plant composition variability due to environmental factors, and standardize extraction techniques to maintain constant concentrations of active compounds [84]. There are also a lot of obstacles to overcome in terms of these compounds' stability, formulation compatibility with other ingredients, and regulatory compliance [85]. Strict quality control must be maintained throughout production in order to achieve consistent efficacy and consumer acceptance. Notwithstanding these obstacles, if they are methodically resolved, the plant's potential for secure and efficient use in supplements and cosmetics can be realized.

6. Regulatory Considerations

A body of evidence has explored regulatory frameworks and guidelines related to sustainable sourcing and the use of botanical ingredients in cosmetics. The European Union (EU) regulatory framework is cited as governing the use of botanical food supplements (BFS) and herbal medicines (HM), ensuring their safety and quality while taking into account potential interactions between botanical ingredients, HM, and traditional medicines [71–73]. Furthermore, the development of the Cosmetics Sustainable Supplier Selection (C-SSS) model, which assesses suppliers in an unbiased manner, has been driven by the need for a long-term sustainable strategy in the cosmetics industry. Although specific guidelines for sustainable sourcing and use of botanical ingredients in cosmetics are not explicitly mentioned, the EU regulatory framework and the C-SSS model provide essential considerations for promoting sustainability in this area [47].

International standards, such as ISO 16128, developed by the International Organization for Standardization (ISO), provide directives for natural and organic cosmetic ingredients, incorporating sustainability criteria [74]. In addition, certification programs like COSMOS (Cosmetic Organic and Natural Standard) ensure compliance with rigorous standards for organic and natural ingredients, as well as sustainable sourcing and manufacturing practices [86]. Regulatory bodies, such as the European Commission's Scientific Committee on Consumer Safety (SCCS) and the U.S. Food and Drug Administration (FDA), are responsible for evaluating the safety of cosmetic ingredients, including botanicals, while considering their environmental and sustainability aspects. Moreover, ethical sourcing and fair-trade practices are emphasized in certain regulatory frameworks, with certifications such as fair trade ensuring equitable remuneration for producers and adherence to environmental and social standards [87].

The regulatory landscape for saponins and other compounds in *Helinus integrifolius* involves a complex interplay of global regulatory considerations. Herbal preparations can be registered as botanical drugs or sold as dietary supplements in the United States. In contrast, the medicinal product laws of Europe have created a regulatory class known as "herbal medicinal products". Based on the therapeutic good/drug model, Australia and Canada have implemented a comprehensive approach that includes the majority of herbal and traditional medicines. Asian countries have created distinct legal frameworks to accept traditional medical practices such as traditional Chinese medicine (TCM) and Ayurveda. Certain products used in traditional medicine can be altered and sold in India thanks to hybrid categories [88].

Saponins, such as those found in *Helinus integrifolius*, have been identified as key phytotherapeutic principles with significant molecular bases for their antidiabetic, anti-obesity, and plant growth regulatory effects [89]. The global demand for herbal biomolecules underlines the importance of stringent regulatory policies to ensure quality, safety, and efficacy in the marketing of herbal drugs, including those derived from *Helinus integrifolius* [90]. The lack of standardization, the misidentification of plant species, contamination, adulteration, uneven dosages, interactions with medications, and adverse effects are among the safety issues with herbal medicines [91]. Strict quality control testing, the standardization of active ingredient concentrations, clinical trials and scientific testing to assess safety and efficacy, unambiguous labeling with details on ingredients, dosages, side effects, and drug interactions, and post-market surveillance to monitor safety after products are on the market are some of the regulatory measures used to address these problems. By following federal guidelines, these precautions help guarantee that herbal medicines are safe to use [92]. Furthermore, the need for improved methods to enhance the production and diversification of saponins in plants like *Helinus integrifolius* highlights the potential for metabolic engineering to address challenges related to limited yields and resource availability.

Furthermore, labeling requirements mandated by regulatory agencies necessitate the accurate disclosure of botanical ingredient sourcing and origins, enabling consumers to make informed decisions and support sustainable practices [93]. The importance of supply chain traceability is growing, as it is crucial for ensuring transparency and accountability in ingredient sourcing practices. This involves the comprehensive documentation of the entire supply chain, extending from procurement to production and distribution [86]. In summary, following regulations and guidelines is essential for promoting the responsible sourcing and utilization of botanical ingredients in cosmetics, which in turn supports environmental preservation, the protection of biodiversity, and ethical trade practices.

7. Comparative Analysis

As previously highlighted, cosmetic production and active ingredients include a variety of synthetic and organic chemicals, inorganic compounds, and heavy metals that negatively impact human health and the environment [62]. A body of evidence has highlighted the negative effects of using synthetic cosmetic products with various forms of reactions (internally or externally), and this raises major concerns [94,95], including alignment with the market requirements and recommendations, including the use of herbal cosmetics. Current research on *H. Integrifolius* is limited to indigenous knowledge systems in traditional cosmetics and treatments as well as spiritual significance to sangomas [35,55,67]. Although the plant has been evaluated for the presence of bioactive compounds [79] that have the potential to reduce the incidence of acne-causing bacteria and the prevalence of diabetes [75], scientific evidence on the full potential of the plant is still lacking. Additionally, no commercial cosmetic products specifically formulated from *H. integrifolius* are readily available or stipulated in the literature. This highlights the need for further biochemical research on the plant to accentuate its traditional benefits scientifically. There is a growing demand for herbal cosmetics that is triggered by vital benefits that include product safety, effectiveness, no adverse effects, or multiple benefits due to a complex package of bioactive compounds [96]. Bioactive compounds in herbal products are hypoallergenic and compatible with sensitive skin. Additional benefits include an improvement in sleep, endurance, emotional and physical health, as well as boosting the immune system, aiding in digestion, and reduced weariness [97–99]. The literature sources demonstrate that synthetic cosmetics have ingredients that are not sustainable and pose a threat to cosmetic society or users, and their non-sustainability also poses a threat to the health environment [63,96,98]. Figure 2 highlights the various adverse effects of synthetic cosmetics and organizes them into distinct categories related to skin and overall health.

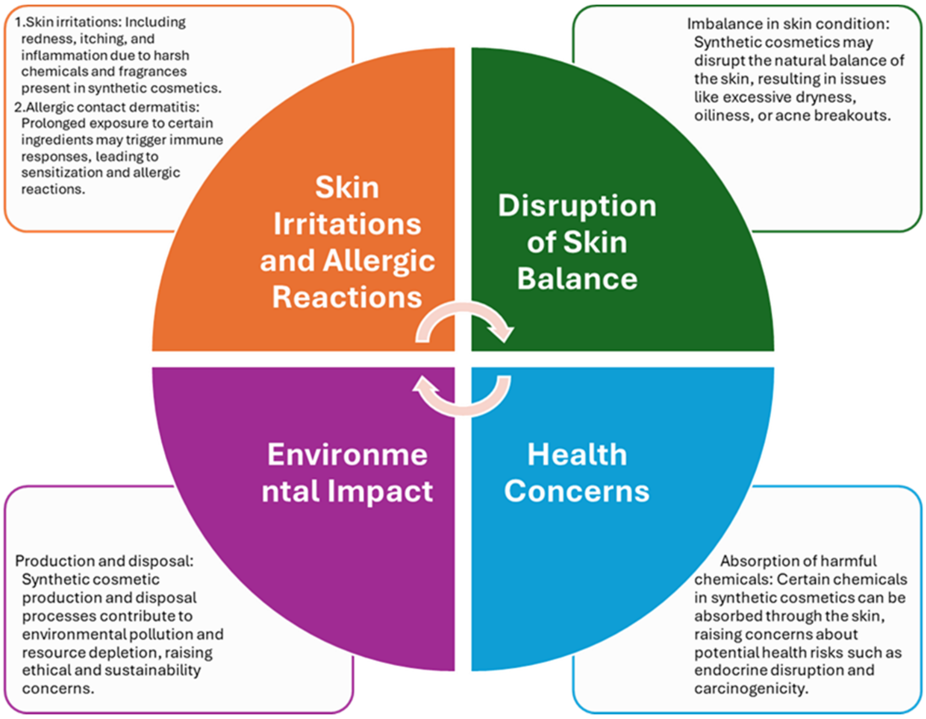

Figure 2. Negative effects of synthetic cosmetic products: categorized impacts on skin and health.

Alternatively, herbal cosmetics have been revealed to have beneficial contributions to developing countries and poor people. In essence, herbal cosmetics offer an eco-friendly, pure, stable, and renewable form compared to synthetic cosmetics [99]. However, there are limited studies conducted to test or evaluate the cosmetic efficiency and the application of the active compounds identified in *H. integrifolius*. Moreover, the plant's bioactive compounds are worth investigating, as there is a growing demand for herbal cosmetics. This, therefore, requires an evaluation of the bioactive compounds of *Helinus integrifolius*, as the cosmetics industry requires an increasing amount of new and evolving bioactive compounds to address safety concerns in the application of cosmetics, especially herbal cosmetics, as shown in Table 2.

Table 2. Summary of various skin treatments offered by *Helinus integrifolius*.

Active or Bioactive Ingredients	Skin Conditions or Disorders	References
Friedelin Lupeol	Treatment against hair loss	[25]
	Soap application (skin issues)	[35]
	Hair loss and skin infections	[83]
	Treat sandworm infections Used as an emetic and soap substitute	[100]
	Inflammation, antioxidants and pains	[101]
	Various skin conditions Canine demodicosis treatment	[102]

8. Future Prospects

Current research on medicinal plants in cosmeceutical research has made significant strides in highlighting the therapeutic benefits of plants in natural cosmetics [103]. However, gaps exist in the field, including a lack of standardized methods for quality control and consistency in active ingredients [104], an insufficient understanding of the biological mechanisms of action, and limited long-term safety and efficacy studies [105]. Additionally, research on the bioavailability and skin absorption rates of active compounds is inadequate, and interactions between medicinal plant extracts and other ingredients are not well studied [106,107].

In order to progress the application of *Helinus integrifolius* in cosmetics, it is imperative to support investigations that tackle open-ended issues and establish a stronger scientific basis. Given its enormous biological potential, *Helinus integrifolius* is an excellent option for eco-friendly cosmetics that are both sustainable and suitable. To guarantee that the active ingredient concentrations in *Helinus integrifolius* extracts are constant, research should concentrate on standardizing quality control procedures. In-depth research on the biological processes that this plant uses to improve skin health is required in order to create cosmetic formulas that are more precise and potent [108]. Long-term safety and efficacy research will also offer important insights into the long-term advantages and possible drawbacks of *Helinus integrifolius* in cosmetic products. Product performance can be improved by maximizing the bioavailability and absorption rates of its active ingredients through sophisticated formulation techniques [109]. Furthermore, developing safe and effective formulations will be made easier by knowing how *Helinus integrifolius* extracts interact with other cosmetic ingredients. To ensure environmental responsibility, a focus on sustainable cultivation, harvesting, and processing techniques is necessary [110]. Finally, carrying out carefully planned clinical trials will produce strong proof of *Helinus integrifolius*'s safety and effectiveness, encouraging regulatory approval and consumer confidence. Taking up these research topics will be important.

As sustainability becomes increasingly integral to the cosmetic industry, the exploration of botanical resources like *Helinus integrifolius* for eco-friendly formulations presents promising avenues for future development. It is crucial that, while using non-crop plant species, conservation is taken into consideration. Training on how to use fruits and leaves should be part of these methods [57]. The attainment of effective biodiversity protection necessitates the persistent efforts of all parties involved, particularly rural communities, whose livelihoods are directly dependent on the local biodiversity [111]. A study by Chigor [112] emphasizes the significance of protecting our native plant resources from extinction, since some of them may be pharmacologically active or have unique chemicals with biological activity against specific ailments. The intensive harvesting and overexploitation of these plants have resulted in a decline in some species and extinction in others, with a general decrease in biodiversity in high-use areas [113–115]. Some plant traders do not harvest sustainably; therefore, they need to be educated on responsible harvesting techniques, as heavy harvesting leads to the scarcity of popular medicinal plant species like *Helinus integrifolius* [113].

The preservation of *Helinus integrifolius*, a species of considerable conservation concern, is influenced by various ecological factors. Grazing intensity has been identified as a critical determinant of its conservation status, as noted by Yang et al. [111]. Research by Edelstein and Shriberg [112] underscores the importance of heavy grazing in Sweden for enhancing germination rates and seedling survival of this species. However, habitat fragmentation and the reduction in natural disturbances like wildfires pose significant threats to its habitat, as highlighted by Olaokun and Ntini [75]. Chauhan and Mahajan's [113] findings emphasize the vulnerability of *Helinus integrifolius* to mortality during the growing season, particularly under drought conditions, necessitating tailored management practices. Conservation agriculture (CA), as advocated by Widén [114], offers a holistic approach to sustainable productivity enhancement and natural resource preservation. Kassam [115] further argues for the integration of such conservation strategies to support biodiversity and ecosystem health. Despite its endangered status, *Helinus integrifolius* has been assigned an automated status of Least Concern due to a limited detailed assessment and exclusion from screening processes, as noted by Foden and Potter [29].

For the large-scale conservation and propagation of medicinally significant and endangered plants, in vitro culture techniques provide incredibly effective instruments [116]. A study conducted by Ndawonde et al. [116] identified unthreatened and threatened plant species sold by plant traders in Zululand to select species for propagation in communal gardens. In this way, plants like *H. integrifolius* can be sustained. Most of the harvesting is carried out by the community; therefore, their knowledge and perception regarding plant availability are important because they would contribute to a better understanding of plant conservation at the local level [117]. Conservation used to be carried out using law enforcement, but it became futile; therefore, propagation has become necessary [109,118].

It is recommended that future research on *Helinus integrifolius* concentrates on standardizing extraction techniques, comprehending its biological mechanisms, and carrying out long-term safety and efficacy trials. Comprehensive clinical trials, ingredient interactions, bioavailability optimization, and the promotion of sustainable practices should all be the focus of future research. Through these initiatives, its use in sustainable, safe, and effective supplements and cosmetics will be improved. Closely addressing these gaps will improve its application in creative, potent, and environmentally friendly cosmetics.

9. Conclusions

In conclusion, the exploration of *Helinus integrifolius* as a botanical resource for the cosmetics industry reveals promising avenues for sustainable and effective formulations. By conducting a thorough analysis of its pharmacological, botanical, and cosmetic characteristics, this manuscript highlights the capacity of *Helinus integrifolius* to address the rising need for natural and environmentally friendly cosmetic remedies. The discussion around safety, compatibility in formulation, and adherence to regulations in this critique promotes the inclusion of *Helinus integrifolius* in cosmetic merchandise. The emphasis on its adaptability and versatility in this article draws attention to the unexplored possibilities of *Helinus integrifolius* in reshaping the cosmetics industry. As consumer preferences increasingly prioritize sustainability and natural ingredients, the utilization of *Helinus integrifolius* represents a significant step towards meeting these demands. Ultimately, this review seeks to inspire further research and development efforts aimed at unlocking the full cosmetic capabilities of *Helinus integrifolius*, thereby propelling innovation in natural cosmetics and contributing to a more sustainable future.

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