

## Review

# Innovation and Sustainability in the Cosmetics Industry: A Global Perspective with Local Insights

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## Abstract

The shift toward sustainable cosmetic systems has become a strategic priority in response to rising environmental pressures, biodiversity loss, and regulatory demands for traceability and responsible sourcing. This review critically examines the Brazilian sustainability model in the cosmetics industry, focusing on three key pillars: (i) traceability and certification of origin aligned with international standards; (ii) community partnerships and equitable value sharing; and (iii) technological innovation tailored to local biodiversity contexts. It synthesizes scientific articles, regulatory documents, and industry reports published mainly between 2005 and 2025, including international certification schemes (COSMOS, ECOCERT, NATRUE, IBD) and Brazilian biodiversity laws. Quantitative export data show that Brazil's cosmetic industry surpassed US\$ 300 million in exports to major markets, emphasizing the global importance of sustainability-driven competitiveness. This study presents a conceptual framework combining biodiversity-based innovation, socio-environmental governance, and certification systems as a unique sustainability pathway distinct from traditional green cosmetic strategies. The review highlights technical challenges such as supply chain traceability, harmonization of international standards, regulatory asymmetries, and the scalability of community-based value chains. The findings indicate that Brazil's model offers a hybrid sustainability architecture that combines biotechnological innovation, fair-benefit sharing mechanisms, and compliance with international standards. Future research should focus on quantitative impact assessment metrics, life-cycle evaluations of biodiversity-derived ingredients, and mechanisms for regulatory convergence to improve industrial scalability and global market integration.

**Keywords:** Brazilian biodiversity; market trends; sustainable development; technological innovation

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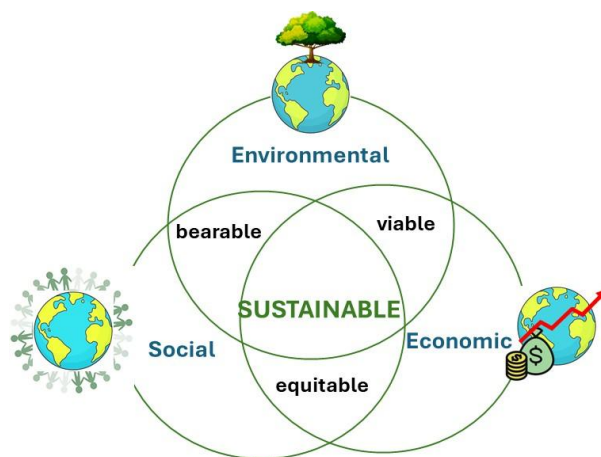
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## 1. Introduction

The concept of sustainable development was introduced globally through the Brundtland Report, released at the United Nations Conference on the Human Environment in Stockholm in 1987. This concept advocates a growth model that meets the needs of the present generation without compromising future generations' ability to meet their own needs. It has been widely adopted across various sectors of society and industry, addressing environmental, economic, social, and technological dimensions [1,2]. Given the rising environmental concerns, it is increasingly crucial to implement manufacturing practices that prioritize sustainability. This approach encompasses not only environmental factors but also social and economic elements throughout the entire production process, striving to minimize negative impacts and, whenever possible, transform them into benefits [3,4].

The three dimensions of sustainability are outlined as follows (Figure 1): (i) environmental, which involves preserving natural capital and ensuring the environment's source and sink functions stay intact; (ii) social, which focuses on maintaining social cohesion and the ability to work toward common goals; and (iii) economic, which aims to ensure financial viability and promote development aligned with social and environmental sustainability [5].



**Figure 1.** Three key dimensions of sustainability [3,6].

The document “Agenda 21,” a comprehensive action plan adopted at the United Nations Earth Summit in Rio de Janeiro, Brazil, in 1992, marked a significant shift by identifying production and consumption patterns as the main causes of environmental degradation. To tackle this issue, it advocated implementing a new development model that would replace traditional production and consumption practices with sustainable alternatives [7].

Growing awareness around sustainability has transformed market dynamics, with consumers becoming increasingly attentive to the origin and safety of the products they use. Concerns about the environmental impacts and health risks associated with traditional ingredients underscore the need for more responsible options. In the cosmetics sector, sustainability extends beyond selecting natural raw materials; it encompasses the full production cycle, from extraction to disposal [8]. A truly sustainable cosmetic must reflect this commitment at every stage, from development to post-consumption [9–12].

Sustainable cosmetics stand out in this scenario. Such products are made with natural ingredients, such as plant extracts, microbial derivatives, and organic raw materials free of pesticides and synthetic additives. They avoid potentially harmful substances and comply with strict sustainability standards that govern every stage, from ingredient selection to final delivery [13].

The debate around climate change, deforestation, and biodiversity loss has been a key driver of the sustainable cosmetics sector. This segment offers more responsible options for individuals seeking personal and beauty care products while upholding environmental commitment [14]. These formulations eliminate components such as parabens, phthalates, silicones, artificial preservatives, sulfates, and petrochemical derivatives, thereby reducing the generation of toxic waste and pollution. Thus, sustainable cosmetics constitute a more conscious choice for both human health and environmental preservation [5,6].

Within green formulations, waterless or low-water cosmetics have gained increasing popularity in Brazil and worldwide [15]. The average annual growth of the global waterless cosmetics market between 2021 and 2027 is expected to be 10.5% [16,17]. Solid shampoos and powder formulas are examples of this movement, combining innovation, sustainability, practicality, and high performance, with a lower environmental impact. In addition to dispensing with plastic packaging, the composition is water-free, significantly reducing the need for preservatives and inhibiting microbial growth. In addition to shampoos, other solid cosmetics, such as conditioners, facial soaps, deodorants, and skincare products, are available in bars or powders, reducing water use in manufacturing and minimizing waste, with greater durability and ease of storage for consumers [18,19].

Unlike soaps, solid shampoos are not made through saponification with caustic soda, which would alter their acidic pH, which is compatible with hair. Furthermore, as such products do not contain water, they have a higher concentration of active ingredients, a lower risk of microbial contamination, and a lower need for chemical preservatives [20–22]. According to Euromonitor International, the main benefits of solid shampoos include (a) economic, due to the greater concentration of active ingredients and prolonged shelf life; (b) practicality, due to the ease of transportation and storage; (c) hair care with fewer chemical additives; and (d) sustainability, with less water consumption and the use of biodegradable packaging [23].

This adoption reflects the industry's growing focus on innovative, environmentally conscious solutions for personal care. Although still underexplored and lacking national regulation, sustainable cosmetics represent a promising opportunity for Brazil, especially given their strong appeal in international markets. The development of sustainable products enables the creation of a future consumer market for Brazilian natural cosmetics [9].

In fact, apart from Italy, Spain, the United States, France, South Korea, and the United Kingdom, the number of studies conducted in developed countries is minimal. Developed countries with access to resources need to invest more in research and development to improve the sustainability of the cosmetic industry [24,25].

This study examined trends and innovations in the Brazilian cosmetic market, emphasizing the potential of green formulations as sustainable, high-performance alternatives. While most review articles cover the circular economy, explore the role of upcycling and other sustainable practices in transforming the cosmetics industry from product design to post-consumer use in a global context, or showcase applications of sustainable ingredients from various sources, our goal was to gather information on the rapidly expanding Brazilian market, highlighting its challenges and opportunities amid global advancements. We compiled data aligned with recent trends and consumer needs and structured this review based on company websites and reports, as there is limited information on the Brazilian industry in traditional literature. The search strategy to select scientific publications and market reports used multiple databases, which included PubMed, Scopus, Web of Science, and Google Scholar search engines, with the use of 'sustainability', 'cosmetics', 'circular economy', 'green chemistry', 'biodiversity', and 'technological innovation' as keywords in a combined manner. The publication time interval spanned 2005 (the year that marked the subject's relevance) to 2025.

## 2. From the Evolution of Cosmetics to Natural, Organic, and Vegan Innovations: Advancing Market Sustainability

Cosmetics have been an essential part of human life for thousands of years, evolving from ancient traditions to vital elements of modern daily routines. These products, from basic hygiene items like toothpaste and soap to makeup for esthetic enhancement, are key components of the large cosmetics industry [5,6,26].

Cosmetics are formulations developed from natural or synthetic compounds intended for external application on different parts of the body. The primary purpose is to clean, perfume, protect, modify appearance, neutralize odors, and promote skin health. Such products play an essential role in the personal care routine, contributing to consumers' well-being, self-esteem, and quality of life [9,27].

According to Regulation (EC) No. 1223/2009 of the European Commission, a cosmetic product is "any substance or mixture intended to be placed in contact with the external parts of the human body (epidermis, hair system, nails, lips and external genital organs) or with the teeth and the mucous membranes of the oral cavity with a view exclusively or mainly to cleaning them, perfuming them, changing their appearance, protecting them, keeping them in good condition or correcting body odors" [28].

The history of cosmetics reflects humanity's cultural and scientific development, with uses that go far beyond beauty [29]. In ancient civilizations, cosmetics served spiritual, religious, and social purposes, helping shape identity and keep traditions alive [30]. The earliest records date back about 5000 years to Ancient Egypt, where products such as creams, oils, malachite-based eye makeup, and henna (*Lawsonia inermis* L.) were common. In Greece (around 400 BC) and later in the Roman Empire (around 180 AD), hygiene and beauty routines became more advanced, with figures like Claudius Galenus creating formulations such as the "cold cream". During the Middle Ages, cosmetic use declined in Europe due to religious influences, but practices gradually returned after the Crusades and gained popularity again during the Renaissance, especially in perfumery. In the 17th and 18th centuries, cosmetics symbolized status among European elites, establishing France as a leader in the industry, although resistance continued in places like England. The 19th-century Industrial Revolution and women's emancipation eventually turned cosmetics into a formal industry, increasing production and diversifying products for both women and men. The 20th century saw major changes in the cosmetics industry, driven by scientific and technological advances, mass production, and media influence, establishing it as a significant global economic sector [30].

However, traditional approaches in the modern cosmetic industry failed because they prioritized short-term results, cost savings, and quick market turnover over long-term environmental and social impacts. These models typically relied on petrochemical ingredients, linear production methods ("take-make-dispose"), excessive packaging, and limited transparency in supply chains [31–33]. As consumer awareness grew and regulations became stricter, these approaches struggled to address sustainability, ingredient safety, ethical sourcing, and lifecycle impacts. Consequently, they proved inadequate for meeting current demands for circularity, clean formulations, responsible innovation, and alignment with global sustainability goals. Ongoing innovation has led to technologies such as microemulsions, liposomes, nanotechnology, biotechnology, and sustainable processes, with increased focus on quality control, safety, efficacy, and product stability [32,34].

The environmental impact of cosmetics, bioaccumulation in the body, and the biodegradability of packaging have pushed companies to invest in more sustainable practices [26,35]. This trend has opened space for green, or sustainable, and plant-based cosmetics, which now represent a significant portion of the global market, aligning innovation with

environmental responsibility, and responding to consumer demand for safer, more ethical products [36,37]. The preference for using products with all ingredients derived from natural sources—biocosmetics—has emerged with great force, generating new labels to better meet consumer expectations regarding cosmetics in terms of sustainable practices [21,38] (Figure 2).



**Figure 2.** Sustainable strategies and trends in cosmetics (created with assistance from ChatGPT—OpenAI, GPT-5).

Globally, the sustainable beauty and skincare industry is rapidly growing and is expected to reach over US\$326 billion by 2031 [39], indicating a shift in consumer values. Recent studies show this change: 68% of consumers view sustainability as a key factor in their purchasing choices, while 66% are willing to pay more for products with positive environmental and social impacts [40]. In this context, companies' interest in natural or organic cosmetic products is increasing. However, one of the main issues is that natural ingredients may not perform as well as conventional ones [41]; additionally, new ingredients must ensure human safety in accordance with the annexes of the EU cosmetics legislation [28].

In Brazil, as in many other countries, there is no specific legislation regulating cosmetics labeled natural, organic, or vegan. This is a relatively recent topic that generates significant debate, mainly because of the difficulty of precisely defining what constitutes a “natural cosmetic”. Simultaneously, green chemistry has gained prominence by promoting a preventive approach that reduces pollution and protects the environment, spanning from the molecular scale to the full product lifecycle [15,42]. This approach is intrinsically linked to the pillars of sustainability—environmental, economic, and social. In parallel, increasingly environmentally conscious consumers have been pressuring industry to develop more sustainable solutions, aligned with responsible practices [8,43–45].

Some argue that for a cosmetic to be genuinely considered natural, it must be composed exclusively of natural-origin ingredients, with very rare exceptions. It is not only the origin of the inputs that matters, but also the processes used to obtain them, as chemical or physical practices that are not environmentally sustainable should be avoided [46,47]. However, not all brands adhere to this standard. Some use the term “natural” merely as a marketing strategy, even when the formula contains only minimal quantities

of such ingredients, often less than 1%. In these cases, the ecological appeal does not reflect the product's actual nature [43,47].

In response to this gap, national and international certification bodies have emerged, establishing specific, detailed criteria for awarding seals of conformity, as detailed below. These standards consider not only the origin of ingredients, but also aspects such as toxicity, biodegradability, and production processes. Although certification bodies share common principles, such as excluding certain preservatives and petrochemical derivatives, each sets its own requirements that brands must follow strictly to obtain certification [44,45].

Natural cosmetics can be understood along a spectrum. At one end are products that use green marketing esthetics without meeting rigorous standards, while at the other are certified products that comply with strict requirements to ensure high levels of natural content. In between are formulations that prioritize natural ingredients, but still incorporate synthetic substances when no viable natural alternatives exist [48].

To be classified as natural, a cosmetic must consist predominantly of ingredients such as water, minerals, and plant- or animal-derived extracts, with no synthetic additives. If the formula includes both permitted and prohibited elements, it cannot be fully classified as "natural" and is instead labeled as "made with natural raw materials" [49–51].

As occurs with natural and organic products, there are no official regulations for vegan cosmetics. However, the concept of a vegan product has a more homogeneous definition: it must not contain components of animal origin, nor be tested on animals, either directly or indirectly [4,52,53].

Organic products, in turn, are subdivided into two main categories: 100% organic, which require at least 95% of raw materials certified as such, and those "made with organic ingredients", whose composition must include 70% to 95% of these inputs [48].

In summary, while all organic cosmetics are necessarily natural, the reverse is not always true. To be genuinely recognized as natural, a cosmetic must be composed mainly of natural ingredients, not merely contain them. Organic cosmetics are distinguished by a higher proportion of certified raw materials than products that include only a small percentage of natural ingredients [48].

According to a Grand View Research survey, the global organic cosmetics market reached approximately US\$25.11 billion in 2025. The survey also reveals that 84% of consumers choose these products for health reasons, whereas environmental concerns rank only sixth among Brazilians. This consumer profile places high value on transparency and demands products with authentic formulations and a high concentration of natural and organic ingredients [8,17].

To be considered suitable for use in a certified natural cosmetic, an ingredient must be listed on the raw material lists approved by the certification boards. During the certification process, boards require the presentation of ingredient commercial names, since the analysis is not limited to composition but also covers origin, production process, and the entire supply chain [14,54]. Today, suppliers offer a broad range of certified natural raw materials, providing greater flexibility in developing formulations. These ingredients include emollients, emulsifiers, thickeners, surfactants, conditioning agents, and proteins [55].

Emollients are vital for cosmetic development, providing hydration and softness while improving the spreadability of products on skin and hair [56,57]. Natural cosmetic-approved emollients include olus oil, *Passiflora incarnata* seed oil, caprylic/capric triglyceride, octyldodecanol, dicaprylyl carbonate, undecane, and tridecane. *Passiflora incarnata* seed oil is rich in essential fatty acids and bioactive compounds, making it especially effective for skin barrier repair, deep hydration, and anti-aging products. Its lipid profile features a high level of unsaturated fats, especially linoleic acid (Omega-6), which

supports skin barrier restoration and reduces flaking. Along with fatty acids, the plant contains active compounds with antioxidant and soothing effects, such as flavonoids, ascorbic acid (vitamin C), vitamin A, and pectin, which contribute to texture and hydration [58].

Surfactants also have a wide application in natural cosmetics. Some approved types include sodium lauryl sulfate, coco-betaine, cocamidopropyl betaine, coco-glucoside, decyl glucoside, and lauryl glucoside [43,44,59]. The combination of these surfactants is essential for developing products that provide effective cleaning and adequate foaming while remaining gentle on the skin, thus meeting the expectations of the national market [48,52]. In emulsions, approved natural emulsifiers include both oil-in-water types, such as lauryl glucoside, polyglyceryl-2 dipolyhydroxystearate, and glycerin, and sucrose polystearate and cetyl palmitate, as well as water-in-oil types, such as polyglyceryl-2 dipolyhydroxystearate [44].

Regarding viscosity, various approved thickeners are essential for ensuring formulation stability and texture. Examples include glyceryl stearate, cetearyl alcohol, cetyl palmitate, and cocoglyceride. Although the variety of inputs is significant, the limited availability of these ingredients in the Brazilian market continues to affect local production of natural cosmetics [44,57].

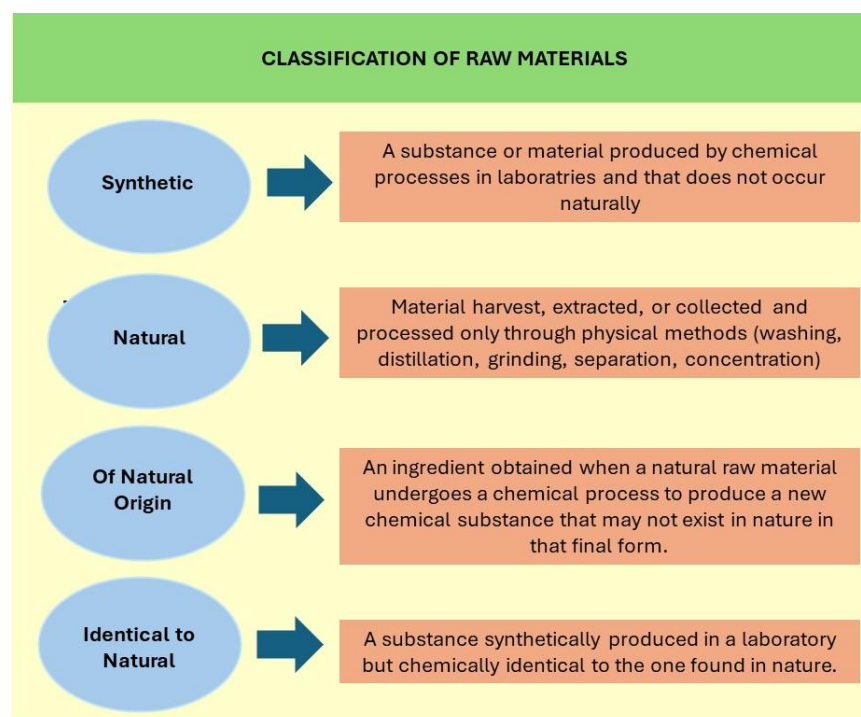
Vegan cosmetics rely on a wide range of raw materials, provided such ingredients are of plant or mineral origin and do not involve any form of animal exploitation or testing. Thus, it is possible to develop high-quality vegan products that are cost-competitive with conventional products [44].

Developing genuinely natural cosmetics presents significant challenges, mainly due to restrictions on certain ingredients. Substances such as synthetic dyes and fragrances, polyethylene glycols, quaternary ammoniums, silicones, artificial preservatives, diethanolamides, and petroleum derivatives are strictly prohibited by major certification bodies. These limitations complicate development, particularly in terms of formulation stability and performance [46,60].

Traditional preservatives such as phenoxyethanol, DMDM (dimethyl-dimethyl) hydantoin, methylchloroisothiazolinone, and methylisothiazolinone, which are commonly used in conventional cosmetics, are not allowed in natural formulations. Therefore, alternatives like benzoic acid, dehydroacetic acid, benzyl alcohol, potassium benzoate, sodium benzoate, potassium sorbate, and sorbic acid are used. Their effectiveness depends on various factors, especially the formulation's pH, which should typically range from 5.0 to 5.5. The effectiveness of these alternatives can be improved by combining them with other preservatives or coadjuvants, such as aromatic alcohols and multifunctional glycols, and by adding chelating agents to boost antimicrobial activity. The success of sustainable preservative systems also relies on strict control of the initial microbiological load, ingredient compatibility, adherence to good manufacturing practices, and the use of suitable packaging solutions. Therefore, maintaining strict water quality control, following good manufacturing practices, and using packaging that minimizes exposure to external contaminants are crucial for reducing microbial contamination risks [43].

To meet the expectations of a more demanding public, the cosmetics industry must adopt tools that guarantee both product quality and consumer acceptance. In this context, sensory analysis is indispensable, as it enables the evaluation of attributes such as appearance, texture, fragrance, and performance through consumer perception. These assessments involve sensory, emotional, and cultural dimensions and play a key role in the development and success of new products [41,61].

Figure 3 describes the definition of raw materials for cosmetics production.



**Figure 3.** Definition of raw materials for the production of cosmetics [41].

### 3. Brazilian Cosmetics Market

The global cosmetics market accounts for a significant part of the industrial sector. The cosmetics industry is a crucial economic sector in Europe, valued at €104 billion in 2024, and ranks second worldwide, behind the United States. Germany leads the European market, followed by France, Italy, the United Kingdom, Spain, and Poland. This industry includes thousands of companies, led by the French firm L'Oréal and the German company Nivea (Beiersdorf AG), and provides more than 3.5 million jobs, showing its extensive social and economic influence [62].

The Brazilian Personal Hygiene, Perfumery, and Cosmetics (PHPC) market is expanding rapidly and already accounts for 5% of the global market. According to the Brazilian Association of the Personal Hygiene, Perfumery, and Cosmetics Industry (ABI-HPEC), there are 3483 companies active in the PHPC sector in Brazil. Despite this high number, the majority of revenue is concentrated in just 20 large corporations, which account for 73% of the net revenue, excluding taxes. These companies are classified as large-scale, with annual revenues exceeding R\$100 million. Geographically, there is a notable concentration in the Southeast region, which hosts 2053 of these businesses. Of these, 1414 are located in São Paulo, representing 40.59% of all PHPC companies nationwide [22].

The cosmetics and personal care market in Brazil is estimated at approximately USD 39.6 billion in 2026 and projected to reach USD 56.1 billion by 2031, with a compound annual growth rate (CAGR) of approximately 7.2% per year, reflecting a diverse demand for beauty and wellness products. Personal care products hold the predominant share, accounting for approximately 90.9% of total revenue in 2025, driven by segments such as haircare, skincare, and daily hygiene, with specific consumption impulses linked to Brazilian climatic and cultural demands. Within this context, although the hair care segment represents a smaller share in terms of units produced, it stands out for its strategic relevance and strong growth rates in products such as shampoos and specialized treatments, in addition to accounting for a large portion of retail and professional sales. In parallel, there is an accelerated adoption of trends such as clean beauty, whose revenue in Brazil reached approximately USD 264.4 million in 2023 with projected growth at a CAGR of

15.4% until 2030, while the organic cosmetics segment, although still representing a smaller share of the total market, is growing more robustly than the average of conventional products due to greater consumer awareness of natural ingredients and sustainability [63–67].

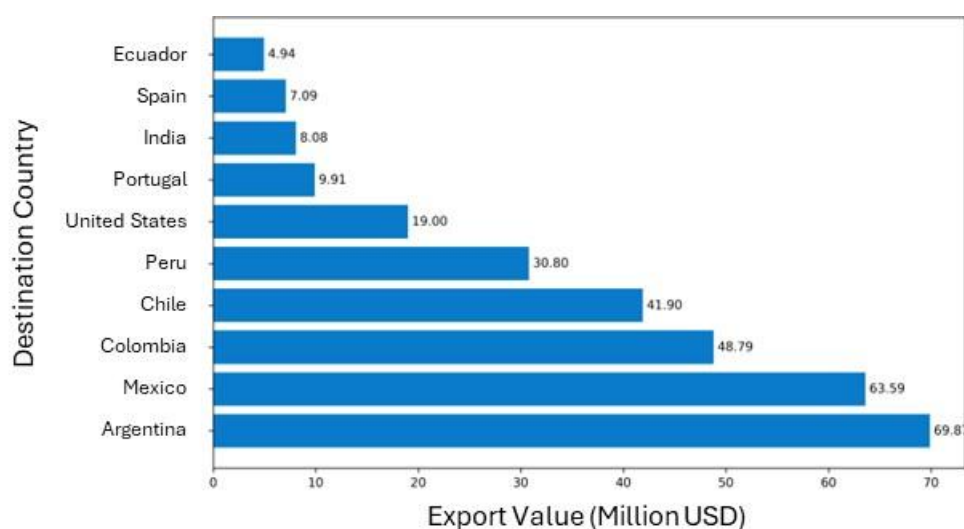
Within this scenario, prominent segments include fragrances, men's products, deodorants, hair care, sunscreens, children's items, makeup, bath and skin care, and hair removal products [65,66].

A significant contributor to Brazil's prominent position in the global cosmetics market is its predominantly hot, humid climate, which encourages frequent hygiene habits, including multiple daily baths and regular hair washing. This routine explains the high demand for hair, bath, deodorant, and fragrance products, which are among the most significant segments of the national sector [66].

According to MINTEL (Market Intelligence and Research Global Agency), a company specializing in market and behavioral analysis, the Brazilian cosmetics consumer profile is diverse and reflects specific trends. For instance, men aged 25 to 34 have shown increasing interest in scientifically supported products and are willing to pay up to 29% more for formulations that guarantee efficacy and innovation [68].

Overall, Brazilian consumers seek cosmetics that combine quality, innovation, and sustainability. Natural products with ethical appeal, aligned with the clean beauty movement, have gained traction, particularly among young women influenced by digital platforms and social media. Women over 40, on the other hand, tend to favor products focused on anti-aging and well-being [68–71].

The year 2025 marked a major milestone for companies supported by Beautycare Brazil, an export initiative launched by ABIHPEC in partnership with ApexBrasil (Brazilian Trade and Investment Promotion Agency). The 162 supported companies reached US\$363.4 million in exports, selling 126 product types to 130 international markets. Latin America emerged as the main destination for supported exports, with Argentina, Mexico, Colombia, Chile, and Peru as key markets. Other important markets included the United States, Portugal, India, Spain, and Ecuador, indicating ongoing growth in Brazilian exports across both established and emerging regions (Figure 4). Finished products accounted for 84% of exports, underscoring the global recognition of Brazilian products in the sector. Ingredients and packaging accounted for 10.7%, while related products comprised 5.3%, showcasing the diversity of the national offering [22,72].



**Figure 4.** Main export destinations of the Brazilian cosmetic industry [72].

#### 4. Global Certifiers of Organic and Natural Cosmetics

On the international level, the International Nomenclature of Cosmetic Ingredients establishes a standard nomenclature for cosmetic ingredients, adopted globally. This nomenclature is regulated by an international committee comprising representatives from the US FDA (Food and Drug Administration), the European Commission, and the health ministries of Canada and Japan, ensuring uniformity and transparency in ingredient identification [73–76].

The global certification for organic and natural cosmetics sets strict standards to verify ingredient origin, processing, and labeling. It aligns with ISO (International Organization for Standardization) 16128-1 [77] and ISO 16128-2 [78], which define principles and methods for calculating the naturalness and organicity indexes of raw materials and cosmetic formulas. While these standards provide the technical foundation for classifying and measuring natural ingredients and derivatives, ISO 14040 [79] and ISO 14044 [80] support this framework by establishing principles for Life Cycle Assessment (LCA), allowing the evaluation of environmental impacts from raw material extraction to product disposal (Figure 5). This combination of global certifications and ISO standards enhances the sector's credibility, encourages transparency and traceability, promotes environmental responsibility, and fosters honest communication with consumers [81].



**Figure 5.** Life cycle of cosmetic products [3,5,6] (created with assistance from ChatGPT—OpenAI, GPT-5).

Cosmetics in Brazil are regulated by health standards that encompass manufacturing, packaging, marketing, imports, and exports, as established by Law No. 6360 of 23 September 1976. The inspection and authorization of these activities fall under the responsibility of the National Health Surveillance Agency (ANVISA), created by Law No. 9782 of 26 January 1999. ANVISA, linked to the Ministry of Health and integrated into Brazil's universal healthcare system, coordinates the National Health Surveillance System and oversees the licensing of cosmetic products in the country [29,74].

The official definition of cosmetics in Brazil is provided in Collegiate Board Resolution (CBR) No. 07 of 10 February 2015. It defines personal hygiene products, cosmetics, and perfumes as preparations composed of natural or synthetic substances, intended for external use on body parts such as skin, hair, nails, lips, external genitals, teeth, and the oral mucosa. Their purpose includes cleaning, perfuming, altering appearance, modifying odors, and protecting or preserving these regions. Thus, any product that meets this description is legally classified as a cosmetic, regardless of whether its ingredients are

natural or synthetic. Cosmetics are divided into two risk categories: Grade 1, considered low risk, and Grade 2, which presents a greater risk due to its formulation or intended use. Samples of finished products must be stored in their original packaging or in equivalent containers and maintained under specific conditions to enable at least two complete analyses. These samples must include labels with essential information, including identification, batch number, and expiration date [74].

Brazil does not yet have specific official regulations for certified organic and natural cosmetics, as described above. Such products comply with the standards of independent certification boards, which ensure that manufacturers meet national requirements for cosmetics and personal hygiene, and that they demonstrate ANVISA registration and authorization for production and marketing [74–76].

Organic and natural cosmetics are recognized primarily as cosmetic products and must comply with current regulations on manufacturing, quality control, registration, and marketing, as well as the specific requirements of the contracted certification boards. CBR No. 07/2015 remains the primary reference for these products in Brazil [74,82,83].

To be classified as organic or natural, a cosmetic must meet strict certification criteria. These include the use of ingredients from organic farming, which exclude pesticides, aim to preserve natural resources, ensure proper working conditions, and protect producers, consumers, and the environment from contamination [84].

Certification is widely accepted in organic agriculture and serves as a guarantee of product origin and quality, verified through audits conducted by certification bodies. These entities oversee the entire product lifecycle—from raw materials and cultivation areas to the finished product—ensuring strict compliance. The producer bears certification costs [85,86].

Due to the lack of specific official regulations, certification boards' standards are continually reviewed and adapted to reflect market demands and diverse contexts, while maintaining transparency and accessibility [76]. Among the leading global certifiers of organic and natural cosmetics, the following stand out:

(a) COSMOS (Cosmetic Organic Standard) is a private European standard developed by five organizations: BDIH (German Federation of Industries and Trade Enterprises for Pharmaceuticals, Health Products, Food Supplements and Personal), Cosmebio (French association for organic and natural cosmetics) and Ecocert Greenlife (France), ICEA (Italian Institute for Ethical and Environmental Certification, and Soil Association (United Kingdom), aiming to standardize minimum certification requirements at the international level [47]. To comply with the COSMOS standard, it is necessary to follow detailed rules on the origin of inputs, production processes, and the sustainability of the production chain. Although not yet widespread in Brazil, COSMOS certification has gained traction, particularly among companies focused on the European export market. In Brazil, COSMOS is represented by Ecocert, and the number of products certified under this standard continues to grow annually [75].

(b) ECOCERT (Ecocert Organic Certificate): The French certification body Ecocert® developed its own standard to support cosmetics manufacturers that prioritize environmental friendliness and the quality of natural ingredients. This initiative was developed in response to the lack of official regulations for natural and organic cosmetics and to address the confusion caused by the proliferation of private European standards, which often hinder consumers' clear product identification [75,87]. ECOCERT requires that a natural cosmetic contain at least 50% organic plant ingredients, based on the total plant content, and a minimum of 5% certified organic ingredients in relation to the total product weight. An organic cosmetic must have at least 95% of plant ingredients from organic farming and 10% of certified organic ingredients in the total formulation, respecting the lists of authorized and prohibited ingredients defined in the certifier's reference. Products

that meet these criteria may bear the mandatory indications “ecological cosmetic” or “ecological and organic cosmetic” in accordance with specific ECOCERT rules [75].

(c) NATRUE (International Natural and Organic Cosmetics Association): Founded in Europe in 2007, NATRUE is an international non-profit organization that aims to standardize and promote natural and organic cosmetics worldwide [61,88]. Like COSMOS, it establishes strict criteria from the selection of raw materials to final manufacturing. In Brazil, the NATRUE seal is mainly found on imported or export-oriented products, while the Biodynamic Institute’s seal is more prevalent in the domestic market.

(d) IBD (Biodynamic Institute): The largest certification board in Latin America, IBD has a strong presence in the Brazilian market. Since 2014, it has followed NATRUE guidelines to certify natural and organic cosmetics. The partnership between IBD and NATRUE enables the mutual recognition of seals, thus facilitating the international marketing of certified products. In the absence of official national regulations, IBD grants certification using the labels “Natural” and “Natural Ingredients”. Regarding labeling, IBD requires that certified cosmetics comply with the standards of CBR No. 211/2005 and its subsequent updates before adding the specific “Natural” or “Organic” seals. Moreover, all labels must clearly state the total percentage of natural and organic ingredients in the product [76].

Table 1 summarizes the criteria defined by the main certification boards.

**Table 1.** Criteria defined by different certification boards [75,76,87,88].

| Certifier                | Key Principles                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|--------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| ECOCERT                  | <ul style="list-style-type: none"> <li>• Use of biodegradable, recyclable, and renewable ingredients produced through ecological processes.</li> <li>• Prohibits GMOs, parabens, nanoparticles, silicones, PEGs, synthetic fragrances/dyes, phenoxy-ethanol, and animal-derived ingredients.</li> <li>• Minimum organic content requirements:               <ul style="list-style-type: none"> <li>Natural &amp; Organic Cosmetics:                   <ul style="list-style-type: none"> <li>≥95% of plant-based ingredients are organic</li> <li>≥10% of total formula organic</li> </ul> </li> <li>Natural Cosmetics:                   <ul style="list-style-type: none"> <li>≥50% of plant-based ingredients are organic</li> <li>≥5% of total formula organic</li> </ul> </li> </ul> </li> </ul> |
| SOIL ASSOCIATION ORGANIC | <ul style="list-style-type: none"> <li>• Maximizes organic ingredients and minimizes synthetics.</li> <li>• Requires minimal processing and clear labeling.</li> <li>• No animal testing.</li> <li>• Products must not harm human health or the environment.</li> <li>• Categories:               <ul style="list-style-type: none"> <li>Made with Organic Ingredients: ≥70% organic</li> <li>Organic: ≥95% organic</li> </ul> </li> </ul>                                                                                                                                                                                                                                                                                                                                                            |
| COSMOBIO                 | <ul style="list-style-type: none"> <li>• Prohibits GMOs (genetically modified microorganisms) and restricts synthetic substances.</li> <li>• Two labels:               <ul style="list-style-type: none"> <li>BIO Label:                   <ul style="list-style-type: none"> <li>≥95% natural ingredients</li> <li>≥95% organic plant-based ingredients</li> <li>≥10% of total formula organic</li> </ul> </li> <li>Eco Label:                   <ul style="list-style-type: none"> <li>≥95% natural ingredients</li> <li>≥50% organic plant-based ingredients</li> <li>≥5% of total formula organic</li> </ul> </li> </ul> </li> </ul>                                                                                                                                                              |
| COSMOS                   | <ul style="list-style-type: none"> <li>• Prohibits nanomaterials, GMOs (genetically modified microorganisms), irradiation, and animal testing.</li> <li>• Organic cosmetics:</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |

|        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|--------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|        | <p>≥95% of physically processed agro-ingredients are organic</p> <p>≥20% of total product organic (≥10% for rinse-off/mineral products)</p> <p>Gradual increase in organic chemically processed ingredients</p> <ul style="list-style-type: none"> <li>• Requires environmental management plan (production, storage, packaging, waste).</li> <li>• No minimum organic requirement for “natural” category.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                       |
| IBD    | <ul style="list-style-type: none"> <li>• Prioritizes natural and organic ingredients.</li> <li>• Prohibits GMOs and animal testing.</li> <li>• No ingredients from vertebrate animal sacrifice.</li> <li>• Allows honey and milk from certified organic systems.</li> <li>• Requires environmental impact reduction and clear labeling.</li> <li>• For natural certification: <ul style="list-style-type: none"> <li>≥20% non-chemically modified natural substances</li> <li>≤15% natural-derived substances</li> </ul> </li> </ul>                                                                                                                                                                                                                                                        |
| NATRUE | <ul style="list-style-type: none"> <li>• Encourages non-chemically modified natural raw materials.</li> <li>• Restricts processed natural-origin substances.</li> <li>• Three categories: <ul style="list-style-type: none"> <li>Natural Cosmetics</li> <li>Partially Organic Natural Cosmetics: <ul style="list-style-type: none"> <li>≥15% non-modified natural substances</li> <li>≤15% processed natural-origin substances</li> <li>≥70% certified organic plant/animal substances</li> </ul> </li> <li>Biocosmetics: <ul style="list-style-type: none"> <li>≥20% non-modified natural substances</li> <li>≤15% processed natural-origin substances</li> <li>≥95% certified organic plant/animal substances</li> </ul> </li> </ul> </li> <li>• Recommends minimal packaging.</li> </ul> |

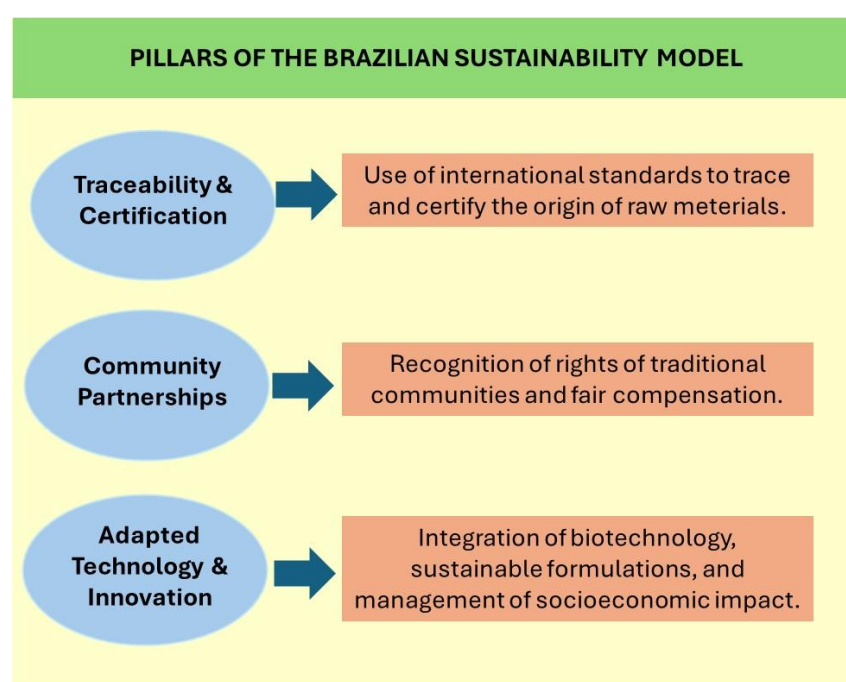
Vegan cosmetic formulas are produced without any animal-derived ingredients, such as lanolin, collagen, gelatin, honey, or beeswax [89]. Within the vegan market, many companies create their own symbols to indicate that their products are free of animal-derived ingredients and are not tested on animals. These symbols often include the letter “V”, a rabbit icon, the term “cruelty-free”, or other proprietary identifiers. In Brazil, the following certifiers stand out in the regulation and recognition of vegan products:

(a) SVB (Brazilian Vegetarian Society): Founded in 2013, the SVB certification program covers multiple sectors, including food, cosmetics, and personal hygiene products. The SVB vegan seal ensures that the product contains no animal-derived ingredients and that neither the manufacturer nor its suppliers engage in animal testing [90].

(b) PETA (People for the Ethical Treatment of Animals): Created in 1980, this international NGO (Non-Governmental Organization) is one of the best known in the defense of animal rights and has two seals applied to cosmetics—Cruelty-Free and Approved Vegan [91]. The Cruelty-Free seal guarantees that the product and its ingredients were not tested on animals. However, it is essential to note that not all products bearing this certification are vegan, as some may include animal-derived ingredients, such as honey or keratin, provided their production does not involve animal suffering. The Approved Vegan seal goes beyond, ensuring that the product does not contain any animal ingredients and was not tested on animals, thus characterizing it as vegan.

In the Brazilian cosmetics industry, Brazilian biodiversity, especially from the Amazon and other biomes such as the Caatinga, located in the Brazilian Northeast, is a unique source of natural raw materials, functional actives, and inspiration for differentiated formulations [92,93]. Currently, biodiversity suppliers account for approximately 80% of natural raw materials, which represent the core of the sustainable business model of many Brazilian companies. Brazilian companies base part of their Research & Development

strategy on bioprospecting and bioeconomy, transforming native species into high-value-added ingredients. This contributes to both product innovation and the preservation of ecosystems by linking conservation with income generation for local communities [94]. Companies that value biodiversity adopt models that integrate sustainable and certified extraction of natural resources (with traceability and responsible use agreements), partnerships with traditional communities that generate local income and environmental preservation, reverse logistics and circular economy programs (new cycles of material use), and the development of product lines with less environmental impact and greater perceived value for the conscious consumer [95,96]. The global replication of this Brazilian model is based on three important pillars: (i) traceability, (ii) community partnerships, and (iii) technological innovation (Figure 6). This model already inspires companies outside Brazil to value traditional ingredients and knowledge, integrating sustainability into their core business [97].



**Figure 6.** Pillars of the Brazilian sustainability model.

The importance of sustainable sourcing practices in the Brazilian cosmetics industry can be seen in the reduction in degradation and preservation of biomes through responsible management, which reduces damage to ecosystems, focusing on a circular economy (less use of resources, recycling and reuse of materials), decreasing greenhouse gas emissions and water and energy consumption, and in the generation of income and socioeconomic inclusion achieved through partnerships with extractivists and traditional communities, strengthening sustainable ways of life [34,98]. Finally, these practices bring many corporate benefits, as they expand access to international markets that require environmental and social certifications, improve brand reputation, and attract investments linked to Environmental, Social and Governance (ESG) criteria [99,100].

The adoption of sustainable practices by the Brazilian cosmetics industry is also shaped by consumers and social media, which play a strategic role in influencing everything from purchasing choices to how brands communicate their environmental and social initiatives. Research in Brazil shows that most consumers are more inclined to select sustainable products. About 60% of Brazilians say they make an effort to buy cosmetics with ecological raw materials, such as natural, organic, or vegan ingredients, and environmental concerns are a major motivation for this decision. Consumer trust in a brand's

commitment to the environment strongly influences conscious buying decisions regarding environmental and social issues [9,24,101].

Social media, on the other hand, enhances visibility and raises public expectations. Recent studies indicate that up to 70% of purchases can be influenced by content seen on social media, where consumers discover, compare, and comment on cosmetic products [101]. Research shows that many Brazilians actively seek information about companies' sustainable practices before making a purchase, and many consider switching brands if they perceive a lack of genuine commitment to the environment or society. Consequently, this pressure encourages the industry to communicate more transparently about inputs, processes, and certifications, to publish sustainability reports, and to integrate environmental and social initiatives into the brand strategy—not just in advertising [102].

## 5. Market Prospects of Sustainable Cosmetics

In the cosmetics sector, the adoption of sustainability principles has become increasingly prevalent in production practices, fostering the development of products classified as sustainable, natural, green, or ecological. This segment extends beyond the use of plant-based or renewable raw materials, encompassing production methods and consumption practices that reduce environmental impact across the entire product lifecycle [2,103].

In the international regulatory landscape, cosmetics are governed by specific legal frameworks that set requirements for safety, labeling, and manufacturer liability. In the European Union, the primary regulation is Regulation (EC) No 1223/2009, which outlines obligations such as safety assessment, notification on the Cosmetic Product Notification Portal (CPNP) portal, and substantiation of claims, under the oversight of the European Commission [28], as described in the early sections. In the United States, cosmetics are overseen by the Food and Drug Administration (FDA), under the Federal Food, Drug, and Cosmetic Act (FD&C Act), recently amended by the Modernization of Cosmetics Regulation Act of 2022 (MoCRA) [73], which mandates facility registration, product listing, and mandatory reporting of adverse events. These official guidelines serve as key references for regulatory compliance and the international distribution of cosmetic products.

It is important to emphasize that, in Brazil, sustainable cosmetics must comply with ANVISA standards in the PHPC category, meeting strict criteria for safety, efficacy, labeling, registration, and cosmetovigilance [74].

These products differ from conventional ones by prioritizing natural ingredients, typically extracted through clean, ethical, and sustainable processes, and by excluding harmful synthetic compounds such as parabens, sulfates, and phthalates. As discussed earlier, Eco-friendly packaging—whether recyclable, reusable, or biodegradable—is another common feature, along with the rejection of animal testing and the use of vegan formulations, which add value to cosmetic products [23,52,76].

As consumer behavior evolves globally, interest has grown in products that offer more than esthetic benefits and reflect ethical and environmental values. This has motivated the strategic repositioning of several brands, which have begun investing in innovation to develop environmentally responsible cosmetics. One example is the German brand “Stop The Water While Using Me!”, which advocates the rational use of water, the use of natural ingredients, biodegradable packaging, and opposition to animal testing [104].

Green marketing strategies and the repositioning of traditional brands play a central role in this context. Companies aim to meet the expectations of increasingly informed and demanding consumers, whose purchasing decisions are shaped by factors such as transparency, ingredient traceability, environmental certifications, and a product's social impact. Consistent, well-founded communication about sustainability strengthens corporate reputations and contributes to consumer loyalty [105].

The “Green is the New Black” survey in 2020 showed that 32% of Brazilians prioritize health and sustainability when choosing their products, with the trend more evident among young people and urban residents. This behavior drives not only the demand for sustainable cosmetics but also conscious consumption habits, such as packaging reuse, refills, and preference for companies involved in socio-environmental initiatives [89].

Thus, sustainability in the cosmetics sector transcends the production stage and encompasses reverse logistics, carbon offsetting, renewable energy use, and the inclusion of traditional communities in production chains. It is a systemic approach that assesses social and environmental impacts from conception through product disposal. Life Cycle Assessment (LCA) has become an increasingly used tool for measuring and mitigating these impacts [32,69,106].

Regarding environmental, social, and governance (ESG) principles, Brazilian cosmetics companies have been integrating them more strategically, using these practices not only to comply but also as drivers for sustainable innovation in their business models [102]. This integration happens across multiple areas—from production and product design to supplier relations, social inclusion, and management transparency—and aims to create long-term value, minimize negative impacts, and meet the expectations of consumers, investors, and civil society. Several companies have set ambitious long-term goals aligned with the UN (United Nations) Sustainable Development Goals (SDGs), fostering consistent strategic planning and measurable ESG performance indicators [107,108].

From an environmental standpoint, innovation is becoming more focused on ecological impacts, leading Brazilian companies to adopt natural, organic, and certified ingredients. They are investing in formulas with reduced environmental impact in accordance with international sustainability standards. Some top companies in the Brazilian cosmetics industry have invested in renewable energy, water management, waste management, and reverse logistics to reuse post-consumer packaging, thereby decreasing the supply chain’s environmental footprint and promoting the circular economy [99]. Sustainable products and packaging have become a significant area of investment in the cosmetics market, as they are crucial for innovation. The implementation of collection and reuse programs is increasingly common in the Brazilian market. Additionally, fair trade practices with Amazonian extractive communities are gaining importance, integrating traditional knowledge into product innovation and supporting local development [89]. Major companies in the sector have also advanced in diversity and inclusion policies, increasing representation of underrepresented groups in leadership roles, and fostering a more inclusive and innovative corporate culture. Environmental education initiatives have also been targeted, encouraging consumers to make sustainable choices and raising awareness and social responsibility related to the consumption and use of products [109]. It is worth noting that ESG-oriented governance drives investments in technologies for testing cosmetics without animals and utilizing biotechnology to develop new active ingredients [34,107,110].

Brazilian biodiversity constitutes a strategic competitive advantage for the cosmetics industry, as discussed earlier. The country holds approximately 20% of the world’s biodiversity, with more than 50,000 cataloged plant species, of which only 2% are commercially exploited [111,112]. The sustainable use of these resources can generate added value, foster sustainable production chains, and boost the bioeconomy, provided that the principles of fair access and benefit sharing are respected, as established in the Convention on Biological Diversity and the Biodiversity Law (Law No. 13,123/2015) [113].

Beyond the Biodiversity Law, scientific validation for research on Brazilian biodiversity is a rigorous process that combines advanced methodologies, long-term monitoring, and strict compliance with environmental and genetic resource access laws. The key components of validation, in terms of legal validation and access (compliance), include the

following: (i) SISGen (National System for the Management of Genetic Heritage and Associated Traditional Knowledge) [114], a vital tool as any research accessing Brazilian genetic heritage (native species, including microorganisms) must be registered in SISGen; (ii) SISBio (Authorization and Information System on Biodiversity) [115], which is managed by ICMBio, and from which it is necessary to obtain authorization to collect biological material and conduct research in conservation units; and (iii) SALVE (System for Assessing the Risk of Extinction of Biodiversity), an ICMBio tool for validating the conservation status of species.

The ABIHPEC encourages companies to invest in research and development, focusing on natural ingredients, clean technologies, and sustainable processes. In partnership with SEBRAE (Brazilian Service of Support to Micro and Small Businesses), the association announced that the natural cosmetics sector in Brazil is growing between 8% and 25% per year, confirming the consistent expansion of this segment [116].

According to a MINTEL market study, 41% of Brazilian consumers prefer PHPC products with natural ingredients. However, cost remains a significant obstacle, with 80% of respondents citing price as the main barrier to purchasing sustainable cosmetics. Other essential factors mentioned were “cruelty-free” certifications (73%), the absence of toxic substances such as bisphenol A (67%), and greater product durability (63%) [68,117]. Consumer behavior research indicates that elements like brand, fragrance, and third-party recommendations influence purchasing decisions [118]. The search for detailed information on composition and benefits is also relevant, underscoring the importance of transparent, scientific, and accessible communication, especially in ecological appeals [119].

The Brazilian active ingredients with the most significant potential for the cosmetics industry are açaí, cupuaçu, murumuru, buriti, andiroba, Brazil nut, and babassu, which are known for their emollient, antioxidant, anti-inflammatory, and moisturizing properties. Moreover, exotic raw materials, such as jackfruit, with a whitening effect, and bamboo, with exfoliating properties, have been incorporated into innovative formulations [120–123].

The main obstacles faced by the Brazilian cosmetics industry include scaling up and the costs associated with sustainable technologies like biotechnology and regenerative agriculture. These technologies, despite their potential, require financial support and proper infrastructure, such as the building of fermentation plants. Additionally, the lack of a sustainable supply chain for inputs can be a barrier, making it difficult to access certified raw materials. As discussed in this article, regulatory barriers and the complex environmental certifications for organic ingredients can also be bureaucratic challenges for small and medium-sized enterprises. On the other hand, collaboration among companies, universities, and research institutes through research and development projects accelerates the development of innovative ingredients, such as biotechnological ingredients or cosmetics free of microplastics. The increasing demand for sustainable products also serves as a driver, as consumers and global markets are placing greater value on cosmetics with lower environmental impact, fostering innovation in formulations, packaging, and processes. Lastly, initiatives that fund green startups, like sustainable innovation accelerators, lower barriers to entry and support new business models. Therefore, tax incentives in the cosmetics sector, partnerships among companies, universities, and communities, and the promotion of integrating ESG principles from design to the final product are crucial for overcoming these market barriers [124,125].

The sustainable cosmetics market is also driven by rising global income and consumer segmentation, whose specific needs and preferences stimulate the diversification of product lines, the development of new textures, fragrances, and functionalities, in addition to the creation of hypoallergenic, organic, dermatologically tested cosmetics

certified by internationally recognized seals, such as ECOCERT, NATRUE, and USDA [75,87,88,126].

Progress in the sector is supported by investments in research and development, partnerships with innovation centers, and cooperation with local communities, strengthening biotechnology and valuing traditional knowledge. The use of technologies such as artificial intelligence, nanotechnology, and bioprospecting has expanded the possibilities of creating high-performance, sustainable, personalized cosmetics [121,127,128].

The future of the sustainable cosmetics market will depend on the ability to combine technological innovation with social and environmental responsibility, use natural resources ethically, promote consumer education, and comply with regulatory requirements with transparency and effectiveness. In this way, the sector will be able to not only meet the growing demand for conscious products but also actively contribute to the Sustainable Development Goals (SDGs), especially in the fields of health, gender equality, responsible consumption, and the protection of biodiversity [106].

The future market for sustainable cosmetics is likely to evolve through an integrated life-cycle analysis that considers the stages of manufacturing, use, and end-of-life/recycling [46,129,130]. In the manufacturing stage, technologies such as green chemistry, industrial biotechnology, and low-energy consumption processes stand out, such as fermentation of natural active ingredients, extraction with green solvents, and manufacturing using renewable energy, directly contributing to the UN SDGs, especially SDG 9 (Industry, Innovation and Infrastructure) and SDG 12 (Responsible Consumption and Production). In the use stage, reformulating products for greater biodegradability, lower aquatic toxicity, and reduced water consumption—such as “waterless” or multifunctional cosmetics—strengthens alignment with SDG 6 (Clean Water and Sanitation) and SDG 3 (Good Health and Well-being). At the end of their life cycle, adopting single-material packaging, refills, compostable bioplastics, and reverse logistics systems promotes circular economy practices, aligning with SDG 12 and SDG 13 (Climate Action) [131,132]. Furthermore, innovations in materials and digital personalization broaden the connection between sustainability and market competitiveness. The use of biopolymers, regenerative raw materials, and upcycled ingredients reduces environmental impacts throughout the life cycle, while data-driven personalization technologies—such as AI (Artificial Intelligence)-powered skin diagnostics and on-demand production—reduce waste and excess inventory [5,6,46]. These strategies reinforce more resilient and circular business models, promoting resource efficiency (SDG 12), technological innovation (SDG 9), and reducing emissions associated with overproduction (SDG 13). Thus, by integrating clean manufacturing technologies, sustainable design, new materials, and data-driven market strategies, the sustainable cosmetics sector consolidates a systemic approach that connects environmental performance, economic value, and effective contribution to the UN’s global sustainable development agenda [133,134].

## 6. Conclusions

This review improves the understanding of sustainability in the cosmetics industry by defining the Brazilian model as a three-pillar framework that includes (i) traceability and certification compliance, (ii) community-based value co-creation, and (iii) locally adapted biotechnological innovation. Unlike generic green cosmetic strategies that mainly focus on natural ingredients, the Brazilian approach combines biodiversity valorization, regulatory governance, and socio-economic inclusion. Export data shows that sustainability has shifted from a reputation booster to a competitive factor. The most significant new insights from this review include the following:

- Sustainability competitiveness depends on certification, interoperability, and regulatory alignment.

- Community benefit-sharing mechanisms strengthen supply chain resilience but face challenges related to scalability and traceability.
- Biodiversity-based innovation requires the integration of biotechnology, sustainable formulation chemistry, and impact management systems.
- Regulatory asymmetries between Brazilian biodiversity laws and international certification standards continue to be a structural obstacle.

From an industry perspective, regulatory convergence and digital traceability systems will be crucial for increasing participation in global markets. Gaps in standardization among international certification bodies and differing thresholds for organic content create barriers to harmonized global commercialization. Quantitatively, the industry shows measurable growth in exports to Latin American, North American, European, and Asian markets, reinforcing the economic viability of sustainability-focused strategies. However, future progress depends on the following:

- Developing standardized socio-environmental impact metrics.
- Conducting life-cycle assessments (LCA) of biodiversity-derived raw materials.
- Implementing digital traceability technologies.
- Harmonizing international sustainability certification standards.

In conclusion, the Brazilian model constitutes a scalable, yet regulation-dependent, sustainability framework. Its success will require regulatory improvements, technological investments, and alignment with international standards to transform biodiversity-based innovation into a fully global industry strategy.

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## Abbreviations

The following abbreviations are used in this manuscript:

|         |                                                                                  |
|---------|----------------------------------------------------------------------------------|
| ABIHPEC | Brazilian Association of the Personal Hygiene, Perfumery, and Cosmetics Industry |
| AI      | Artificial Intelligence                                                          |

|          |                                                                                                                                |
|----------|--------------------------------------------------------------------------------------------------------------------------------|
| ANVISA   | Brazilian National Health Surveillance Agency                                                                                  |
| BDIH     | German Federation of Industries and Trade Enterprises for Pharmaceuticals, Health Products, Food Supplements and Personal Care |
| CAGR     | Compound Annual Growth Rate                                                                                                    |
| CBR      | Brazilian Collegiate Board Resolution                                                                                          |
| COSMOS   | Cosmetic Organic Standard                                                                                                      |
| CPNP     | Cosmetic Product Notification Portal                                                                                           |
| DMDM     | Dimethyl-Dimethyl                                                                                                              |
| ECOCERT  | Ecocert Organic Certificate                                                                                                    |
| ESG      | Environmental, Social and Governance                                                                                           |
| FDA      | USA Food and Drug Administration                                                                                               |
| FD&C Act | Federal Food, Drug, and Cosmetic Act                                                                                           |
| GMOs     | Genetically Modified Organisms                                                                                                 |
| IBD      | Biodynamic Institute                                                                                                           |
| ICEA     | Italian Institute for Ethical and Environmental Certification                                                                  |
| ISO      | International Organization for Standardization                                                                                 |
| LCA      | Life Cycle Assessment                                                                                                          |
| MINTEL   | Market Intelligence and Research Global Agency                                                                                 |
| MoCRA    | Modernization of Cosmetics Regulation Act                                                                                      |
| NATRUE   | International Natural and Organic Cosmetics Association                                                                        |
| NGO      | Non-Governmental Organization                                                                                                  |
| PEG      | Polyethylene glycol                                                                                                            |
| PETA     | People for the Ethical Treatment of Animals                                                                                    |
| PHPC     | Personal Hygiene, Perfumery and Cosmetics                                                                                      |
| SALVE    | System for Assessing the Risk of Extinction of Biodiversity                                                                    |
| SDGs     | Sustainable Development Goals                                                                                                  |
| SEBRAE   | Brazilian Service of Support to Micro and Small Businesses                                                                     |
| SISBio   | Authorization and Information System on Biodiversity                                                                           |
| SISGen   | National System for the Management of Genetic Heritage and Associated Traditional Knowledge                                    |
| SVB      | Brazilian Vegetarian Society                                                                                                   |
| UN       | United Nations                                                                                                                 |

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