Universidade de Lisboa

Faculdade de Farmácia

The Paradigm of Sustainability in the Cosmetics Industry

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Abstract

In recent years, sustainability became an important topic in people's daily lives, and it has significantly impacted all industries, including cosmetics industry. Nowadays, customers are more informed, looking for more sustainable and environmentally friendly alternatives and are actively searching for a healthier lifestyle. In the cosmetics industry, sustainability issues exist in all phases of a product's life cycle, and companies have deployed and implemented several strategies that contribute to improve the sector's sustainability. However, a special emphasis must be devoted to the phase of sourcing/origin: the selection of ingredients.

Understanding the role of each ingredient and taking in account sustainable ingredients (mainly natural/organic) to substitute unsustainable ones is a priority for some cosmetics brands, but firstly, it's important to clarify the difference between these concepts so that industries can communicate efficiently, truthfully and transparently, according to the cosmetics regulations.

On the other hand, EU has set goals around sustainability, being the development of a European Green Deal one of its priorities, striving to be the first climate-neutral continent by 2050. This Action Plan includes boosting the efficient use of resources by moving to a clean, circular economy, restoring biodiversity and cutting pollution, with initiatives mainly related to plastics, chemical substances, packaging and waste.

Alongside with this development, market trends such as clean beauty emerges encompassing the consumer's perception. However, it's of paramount importance not to overlook the need for science-based safety, effectiveness but also transparency always complying with regulation, in order to ensure human well-being, although the lack of certification and the scarcity of accurate communication are still a limitation.

This review aims at exploring, in the first part, the initiatives that have already been implemented throughout product's life cycle, aligned with EU goals, and Green formulations with special focus on possible new ingredients and existing certifications. In a second part, four cosmetics brands representative of the Pharmacy market are analyzed as well as four examples of products which claim to be committed to sustainability. Conclusions and recommendations are issued, in order to understand which topics still deserve our greatest attention, and prospective views are provided.

Keywords: Cosmetic product; Sustainability; Ingredients; Circular economy.

Resumo

Nos últimos anos, a sustentabilidade tornou-se um tópico de extrema importância no quotidiano da população, e tem impactado significativamente todas as indústrias, incluindo a indústria cosmética. Hoje em dia os consumidores são pessoas mais informadas que procuram diariamente alterativas mais amigas do ambiente de forma a alcançar um estilo de vida cada vez mais saudável. Na indústria cosmética, a questão da sustentabilidade pode ser aplicada em qualquer fase do ciclo de vida de um produto e as empresas têm vindo a implementar diversas estratégias que contribuam para a sustentabilidade do setor. Contudo, a fase da seleção dos ingredientes merece um ênfase especial e é também das áreas que carece de maior investigação.

Perceber a função de cada ingrediente na formulação e procurar alternativas mais sustentáveis, maioritariamente naturais/orgânicas para ingredientes não sustentáveis tem sido uma prioridade para muitas empresas. No entanto, primeiramente é necessário clarificar os conceitos associados – natural, orgânico e sustentável – de forma que a comunicação dos mesmos possa ser feita de uma forma eficaz, segura e transparente, de acordo com a regulamentação dos produtos cosméticos em vigor.

Paralelamente, a União Europeia estabeleceu metas de sustentabilidade, sendo uma das suas prioridades o desenvolvimento de um Pacto Ecológico Europeu, ambicionando transformar a Europa no primeiro continente com impacto neutro no clima até 2050. Este Pacto prevê um Plano de Ação para impulsionar a utilização eficiente dos recursos através da transição para uma economia limpa e circular, restaurando a biodiversidade e reduzindo a poluição, com iniciativas mais concretas ao nível dos plásticos e embalagens, substâncias químicas potencialmente nocivas para a saúde humana e/ou para o planeta e gestão e redução de resíduos.

Conjuntamente a estes esforços e ao desenvolvimento que tem surgido, algumas tendências do mercado, tais como a *clean beauty* (beleza limpa), adicionam a esta equação a perceção e as expectativas do consumidor. Contudo, é importante nunca dissociar a segurança baseada na evidência científica, a eficácia, mas também a transparência, de forma a garantir o bem-estar da população e preservar a saúde humana, embora a falta de certificações e a falta de comunicação correta continuem a ser fatores limitantes neste tópico.

Esta monografia visa explorar, numa primeira parte, as iniciativas, alinhadas com as metas da UE, que têm vindo a ser implementadas ao longo do ciclo de vida do produto

cosmético e as formulações verdes, com especial destaque para os ingredientes e as certificações/regulamentações existentes. Numa segunda parte, são analisadas quatro marcas de produtos cosméticos representativas no mercado de Farmácia Comunitária em Portugal - Klorane, A-Derma, Caudalie e Apivita – bem como um produto exemplificativo de cada uma e que tenha sido desenvolvido segundo estas novas tendências tanto a nível de compromisso social e corporativo da marca, como a nível de ingredientes, embalagem e até ao nível da comunicação utilizada. Numa parte final, são fornecidas algumas recomendações e visões prospetivas, concluindo quais as áreas que merecem maior investigação bem como as que ainda carecem de alguma regulamentação, na premissa de que as características-chave de um produto de forma a garantir a sua segurança e eficácia devem assentar na a) Redução ao máximo das substâncias nocivas para o ser humano e para o planeta; b) Minimização do impacto ambiental; c) Harmonização dos critérios de sustentabilidade ao longo de todo seu ciclo de vida; d) Transparência ao longo do ciclo de vida do produto de forma a garantir a confiança do consumir.

Palavras-chave: Produto cosmético; Sustentabilidade; Ingredientes; Economia circular.

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Abbreviations

EEC – European Economic Community

CP – Cosmetic Product

SDG – Sustainable Development Goal

EU – European Union

PCR – Post-consumer Regrind

PET - Polyethylene Terephthalate

SPICE – The Sustainable Packaging Initiative for Cosmetics

SUE – Serious Undesirable Effects

GHG – Greenhouse Gas

ISO – International Organization for Standardization

PIR – Post-industrial Recycled Material

LCA – Life Cycle Assessment

SCCS – Scientific Committee on Consumer Safety´s

PE – Polyethylene

PLA – Polyactic acid

SLS - Sodium Lauryl Sulfate

SLES – Sodium Laureth Sulfate

IFRA – International Fragrance Association Regulations

BHT – Butylated Hydroxytoluene

BHA – Butylated Hydroxyanisole

Summary

Table and Figure summary

1 Introduction

The legislation on cosmetic products began in Europe in 1976, with Directive 76/768/EEC, with the objective of improving the harmonization of the different laws of the (then) European Economic Community (EEC) closer together, making consumer safety and protection ever greater and leading to uniform legislation at a European level (1). Portugal joined the European Community later and in 1986, Decree-Law 128/86 was approved which brough Directive 76/768/EEC into national law, contributing to a harmonization between the Portuguese legislation and the European directive (2).

Over the years a lot of changes have been made but in 2009, the Regulation (EC) No 1223/2009 of the European Parliament was adopted and then implemented, leading to the harmonization of all regulation related to the production, commercialization and distribution of cosmetic products (CP) (3). This Regulation is currently in force. Later in 2013, animal testing on cosmetics has been definitively banned. For the purposes of this European Regulation, a "**cosmetic product**" is defined as "*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 odours*" (3) and this definition plays nowadays an important role in people´s daily lives.

Unlike medicines, cosmetic products do not require authorization prior to placing on the market, but in order to ensure safety, all products must comply with the same legal requirements. For each product, there is a responsible person that must comply with Regulation (3), ensuring that the cosmetic has undergone a safety assessment, taking into account the toxicological profile of the ingredients and the final product. The labeling information must be complete and understandable in order to allow consumers to make conscious choices. For that, communication made through product claims must meet the 6 common criteria described in detail in Regulation (EC) No 655/2013, namely: legal compliance; truthfulness; evidential support; honesty; fairness and informed decision-making (4). After commercialization, and in order to guarantee their safety and efficacy, in Portugal products are controlled by the competent national

authority, INFARMED, I.P., responsible for the cosmetovigilance system, in charge of collecting and monitoring undesirable effects related to CP.

Globally, Europe is the largest cosmetics market with a value in 2019 of 79.8bn euro, followed by the USA and China, with 73.7bn euro and 54.9bn euro, respectively (5). The following product categories hold the largest share of the worldwide market: skin care (27.1%), toiletries (24.8%), hair-care products (18.7%), fragrances/perfumes (15.4%), and decorative cosmetics (14%) (5). Although this sector was growing before 2019, the Covid-19 pandemic has led to a decline of certain categories as consumers altered some ordinary habits. Nevertheless, dermocosmetics' market was the only that recorded growth in 2020, with a growth of 2% compared with the global market, which registered a decline of 8% (6). The impact of COVID-19 has not been even across the sector, mostly due to shifting consumption patterns. Over the 2019-2023 period, skin care and toiletries, two of the largest categories are expected to report a positive value annual growth rate. Last year also led to a digitalisation of beauty market, representing a 22% proportion of e-commerce compared with 14% in 2019, emphasizing the growing importance of the digital channel.

As the COVID-19 pandemic continues impacting people's lives all over the globe, there's an increasing concern around wellness - consumers are worried about what goes in and on their bodies (7). Over the last year, sustainability concerns also became of paramount importance for consumers, leading the cosmetic industry to keep up with these expectations. Companies are also trying to transform the linear economy into a circular economy, bearing in mind the EU sustainable goals. Some of the specific consumer's sustainability concerns are related to Oceans and Plastics, Global Warming, Animal Testing, Chemicals, Recycling and Fair Trade (8) and consumers request brands to talk about them honestly and transparently.

The definition commonly used for sustainability raised from the concept of sustainable development defined in a report entitled "Our Common Future" from 1987, as the "*development that is able to meet the current needs of the population without compromising future generations to meet their own needs, including two key concepts: the concept of "**needs**" and the idea of "**limitations***" (9). Although, this concept is not static and can have different interpretations, including all the three dimensions of sustainability proposed in the 2030 Agenda for Sustainable Development, adopted in

2015, namely: economic, social and environmental, in a balanced and integrated manner (10). This Agenda contains 17 Sustainable Development Goals (SDGs) and those that connect the most with the cosmetics industry are (10):

- *3) good health and well-being*
- *8) decent work and economic growth*
- *9) industry, innovation and infrastructure*
- *12) responsible consumption and production.*

Each phase of a cosmetic product´s life cycle will impact its sustainability. In this process, one of the main issues to be addressed relates to the sustainability aspects of the ingredients used to formulate such product and its security for the consumers health. Other concerns are related to the packaging materials and the consumer's use. Also, large amounts of waste and by-products of nearly zero recovery, containing bioactive compounds produced by the basic agri-food industries and strategies for their recovery and valorization in the cosmetics industry. Understanding the implications for the supply chain and how these products can be brought to market is therefore essential in order to develop the right business strategy and companies are redesigning their processes and products.

2 Materials and methods

Bibliographic Research

The elaboration of this bibliographic research work was based on the analysis and interpretation of several original or revised scientific articles, as well as some books and several pages on the internet, mainly PubMed platform (available at: https://www.ncbi.nlm.nih.gov/pubmed/), Scholar Google platform (available at: https://scholar.google.com), Infarmed I.P (available at: https://www.infarmed.pt), European Commission (available at: https://ec.europa.eu/info/index_en), Cosmetics Europe (available at: https://cosmeticseurope.eu), Cosmetic&Toiletries (available at: https://www.cosmeticsandtoiletries.com), among others brand's websites. Given the topicality of this topic, the bibliography used is mostly since the year of 2015 until now. However, some articles, as general ideas of some themes, predates this date. For this research the following keywords were used: cosmetic products; sustainability, product life cycle, ingredient; pharmacy.

Assessment of Case Studies

In order to understand how new global market trends have impacted brands, four representative brands in the pharmacy market were analyzed – Klorane, A-Derma, Caudalie and Apivita. For this analysis, information was collected from the different brands' websites and four products of the respective brands were analyzed from the existing products at the Pharmacy. The chosen products were: Klorane - Fleur d' Hibiscus Nourishing Body Lotion with Organic Capuaçu butter from Pierre Fabre company; A-Derma - Hydrating Universal Cream from Pierre Fabre company; Nourishing Body Lotion by Caudalie and Tonic Mountain Tea Moisturizing Body Milk by APIVITA. These products fall into the body hydration category, one of the three best-selling categories in the Pharmacy segment and are a sought-after type of product to help solve a variety of health and skin problems.

This analysis allowed us to verify how the formulations are adapted to new sustainable brand's commitments, mainly from analysis of Cosmetic Ingredient Review's reports (available at: https://www.cir-safety.org), and how product claims comply with regulations and guidelines developed by regulatory. The presentation of the results was carried out in a descriptive way.

3 Sustainable goals and circular economy

The reality of environmental limits was first discussed in 1987 in the World Commission on Environment and Development, where guiding principles for sustainable development were developed and reunited in a report entitled "Our common Future" (9), also where the first concept of sustainability arose. In 2012, the Sustainable Development Goals (SDGs) were born at the United Nations Conference on Sustainable Development in Rio de Janeiro and adopted by the Member States in 2015 (11). A set of goals that meet the environmental, social and economic challenges that the world is facing were announced. For many, they are considered the blueprint to achieve a better future but for others the drawbacks of ever-increasing economic growth as well as the goals prioritization have not been clearly defined on this new sustainable development agenda (12).

As proof of the EU's commitment, Sustainable Development is included in the EU Treaty as one of the 'overarching' principles of all EU policies and a major guiding principle of the published Europe 2020 strategy (13). The need to move towards more sustainable patterns of consumption and production is more important than ever. For companies, contributing to sustainable development means being responsible and committed members of society, harmonizing economic, ecological and social goals. This includes doing business in an ethical and legal manner and is inseparably linked with respect for human rights, traditions and the social values of countries in which they operate. Cosmetics industry and its customers also have their role in developing and implementing the overall sustainability agenda (14). Companies are increasingly expanding their voluntary efforts from individual environmental aspects to a complete sustainability approach, including the entire product life cycle. This means that their focus has shifted to the implementation of sustainable concepts throughout their organization and their sphere of influence (14), involving all stakeholders.

The cosmetics industry's responsibility is not only to improve its own sustainability, but also communicate correctly the sustainable use of cosmetic products. This includes a relation between "acting" and "communicating" as well as at corporate level (14). In Cosmetics Europe's view (14), sustainability-related information about products, must be:

- based on risk and by sound science.
- based in the LCT (Life Cycle Thinking).
- simple, easy to understand and credible.
- meaningful and helpful in achieving the targeted goals.
- truthful (not misleading).
- respect competition law.

As proof of the EU's commitment, one of the six European Commission's priorities for 2019-2024 is to build a *European Green Deal*, alongside with a *Europe fit for the digital age* and to build *an economy that works for people,* among others (15). Europe aims to be the first climate-neutral continent by boosting the efficient use of resources and restoring biodiversity and cut pollution (16). Achieving the EU's climate and environmental goals requires moving to a clean, circular economy policy, and this concept has gained a lot of prominence throughout the times. The EU circular economy action plan implemented in 2020 includes 35 actions and follows on efforts from the EC's fist circular economy plan from 2015 (17). A fully circular economy is essential in order to achieve climate-neutrality by 2050, to preserve natural environment, and to strengthen economic competitiveness. Measures within the Circular Economy Action Plan aimed to (18):

- make sustainable products the norm in the EU
- empower consumers and public buyers
- focus on the sectors that use most resources and where the potential is high
- include packaging, plastics, water and nutrients
- ensure less waste
- make circularity work for people, regions and cities
- lead global efforts on circular economy.

Some specific measures are around Plastics - single-use products will be phased out wherever possible and replaced by durable products for multiple use; Microplastics - restricting intentionally added microplastics, increasing the capture of microplastics at all relevant stages of the product lifecycle and Waste prevention and reduction - increasing recycled content, minimizing waste exports outside EU (19). Reusing, repairing, remanufacturing and recycling are proven to be key elements to the movement of circular economy, which ultimately aims to reduce new resources used

and reduce their impact on environment (20). Numerous brands, manufacturers and suppliers are now focused on circularity as an step forward in developing more sustainable products, playing an important role in the balance between economic issues and planet's limited resources (17).

In order to promote the circular economy, the EU Ecolabel, recognized across Europe and worldwide, was established in 1992, as a voluntary label of environmental excellence that is awarded to products and services meeting high environmental standards throughout their lifecycle (21). It encourages producers to generate less waste and CO_2 during the manufacturing process and to developed durable and recycle products. To qualify for this label, it is necessary to comply with a set of criteria throughout the whole product life cycle, in accordance with Regulation (EC) No 66/2010 (22). Related to cosmetics industry, Commission Decision 2014/893/EU establishes the ecological criteria for the award of the EU Ecolabel for rinse-off cosmetic products, which is based on the following (23):

- Toxicity to aquatic organisms
- Biodegradability
- Excluded or limited substances and mixtures
- Packaging
- Sustainable sourcing of palm oil, palm kernel oil and their derivatives
- Fitness for use
- Information appearing on the EU Ecolabel.

Also related to the *European Green Deal*, in 2020 the Chemicals Strategy was announced towards a toxic-free environment (24). People, nowadays, are concerned about the impact of chemicals present in everyday products on their health and about the impact of chemicals on the environment. With this new strategy, the EU and its member states want to (25):

- Support innovation to design safer products
- Ban toxic chemicals unless they are essential
- Limit exposure to chemicals that harm hormonal systems and to toxic combination effects of chemicals
- Improve laws and simplify procedures to assess the risk of chemicals

- Set the example for a toxic free planet.

On the other hand, the pandemic crisis due to Covid-19 has reemphasized the importance of sustainability in business (26). Consumer's concerns have also changed and awareness of the importance of health and sustainability on the planet also contributes to this movement. All this transitions means redesigning supply chains and establishing clearer metrics (27). Thus, sustainability is no longer optional and is increasingly becoming part of the business bottom line. Learning how to create a successful sustainability strategy, aligned to the SDG's, is a long-term key (28). It is important to analyze all product's life cycle and understand how we can move from linear systems to circular models, some examples focus on circular design, circular source, circular systems, suppliers, sustainable design, price or even improving the footprint of existing products, bringing disruptive innovation that could change real behaviors.

4 Cosmetic Product Life Cycle

The sustainability of a cosmetic product can involve all phases of the product´s life cycle, and the proportion of the environmental impact of each phase depends on the specificity of the product being considered. To help us understand the life cycle of a product, it´s important to talk about the Environmental Life Cycle Assessment (LCA), which is a methodology created and adopted internationally for quantifying the environmental impact associated with a commercial product, process or service (29). In the cosmetics industry, strategies like this and others are used to measure environmental impacts and help companies to prioritize adaptations to their products and processes to reach final cosmetic products with optimized environmental impact.

Companies in the cosmetics industry have implemented a range of strategies that contribute to improving the sector's sustainability, that are summarized in Figure 1 the following figure, adapted from reference (30):

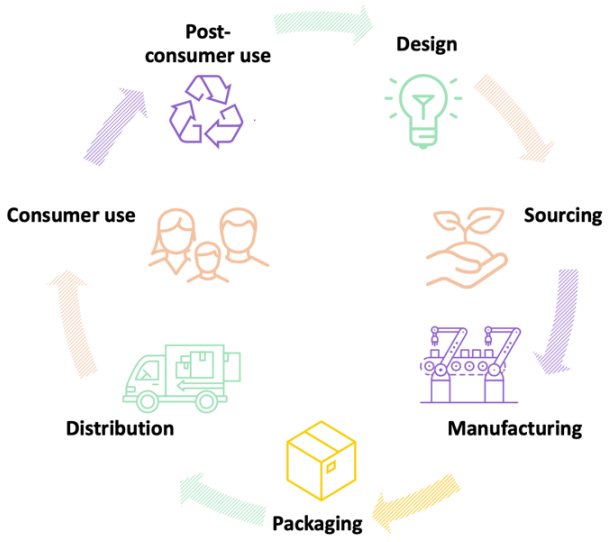

Figure 1 - Cosmetic Product Life Cycle, Adapted from Environmental Sustainability Report (5)

4.1 Design

As brands expand into global markets, it is important that cosmetic manufacturers listen to consumer perceptions and ensure that products take all steps to comply with legal requirements. This phase plays an important role in the assessment of the environmental impact of a product, combining innovation with marketing and regulatory & development, idea sharing and prioritizing according to resource allocation, material

availability and regulatory threshold. The selection of raw materials, packaging material, purpose and mode of use of the product are some steps that must be outlined and compared to existing products.

4.2 Sourcing

About the sourcing, it´s known that the cosmetics industry needs to adopt alternative feedstock for ingredients, not only because of people searching for more sustainable ingredients but also because of the declining supply of petrochemical feedstock, at the origin of some common ingredients. When it comes to choosing sustainable ingredients, it's important to consider two factors: their origin and their environmental fate (31), and all environmental, social and economic criteria should be considered to classify an ingredient as sustainable. It´s possible that the same ingredient has different origins (synthetic, vegetable or animal), and it's important to select the origin that shows less impact on sustainability. Being natural it's not enough for an ingredient to be considered sustainable (31), both vegetable and animal origins can also impact the environment negatively, such as deforestation or habitat destruction. Only if a natural ingredient has been properly cultivated, harvested and processed can be designated as sustainable. In the same way a synthetic ingredient can be sustainable if it was produced by green chemistry.

To sum up, new cosmetic ingredients are emerging specially from agricultural-based raw materials and green chemistry, and some other strategies as the valorization of by-products and crops from the food industries such as spent coffee grounds (32) or olive oil by products (33) , which also contributes to circularity. Recently, a platform named EcoVadis was created to help companies better manage and communicate their company's sustainability performance in a clear and actionable way and to choose certified suppliers that fulfil strict sustainability criteria (34).

4.3 Manufacturing

According to the Regulation (EC) No 1223/2009, means "*any natural or legal person who manufactures a cosmetic product or has such a product designed or manufactured*" (3). In the context of sustainability, the manufacturing process lies down on three principal topics: energy consumption and reducing emissions, water usage and manufacturing waste.

In recent years, many cosmetics manufacturers have increased the proportion of energy consumption from renewable sources. Cosmetics companies are investing in solar photovoltaic power, wind power, geothermic power, biomethanisation and hydropower. To reduce their carbon footprint, manufacturers have implemented environmental management systems, made processes more efficient, and made adaptations to facilities. Regarding water usage, companies need to prioritize actions to reduce their water use. Some are trying to treat the wastewater generated during manufacturing to reuse it or even rainwater collection. The base principles of waterless trend, which we'll talk about further on, are also in favor of this aspect. To prevent waste being sent to land, cosmetic manufacturers are recycling, biotreating or incinerating waste and some have implemented manufacturing processes that are designed to keep product losses around zero (30). Some industries have implemented technology to monitor waste generation in production line, while other examples consist of exploring the recovery of properly treated and processed agri-food by-products for use in other industries new products.

4.4 Packaging

Packaging is intended to protect the product inside and ensure a correct application of the product but can have a big adverse effect on the environment and contribute to land and marine pollution. The main concerns regarding the cosmetic packaging are the excessive layers and the materials used. So far, plastics were the number one choice of packaging material due to their high flexibility, low weight and reduced cost. However, they are not biodegradable and create environmental pollution. The 3R's paradigm - reduce, reuse and recycle together with biodegradability are the top strategies to get around this problematic. The importance of recycling plastics has grown recently and a number of cosmetic companies are now using Post-Consumer Regrind (PCR) plastics (35) and recycled PET. Besides that, new materials like biopolymers or plant-based plastics and other raw materials such as bamboo are also being used (31).

A recent example of this was L'Oréal that made a partnership with LanzaTech and Total to produce the first cosmetic plastic bottle made from captured and recycled carbon emissions (36). This initiative became a technological and industrial success demonstrating the commitment of the three partners to the development of a sustainable

circular economy for plastics, ambitioning to use this in L´Oréal bottles of shampoo and conditioner by 2024 (36).

4.5 Distribution

According to Regulation, distributor means "*any natural or legal person in the supply chain, other than the manufacturer or the importer, who makes a cosmetic product available on the Community market*" (3). Some strategies being adopted include route planning or using big warehouses, using larger container trucks, introducing new format products and looking for more ecological fuel alternatives (like biofuels, green gas, hydrogen, among others) and vehicles.

4.6 Consumer use

The end user means "*either a consumer or professional using the cosmetic product*" (3); It's well known that that a large proportion of the environmental footprint of rinse-off products occurs during 'use' phase, and, very important, the waste produced can cause aquatic contamination of habitats. For a leave-on product the aim should be to provide the consumer with information with the amount per use and use frequency. The labeling information plays an important role here, since it must contain the "mode of use" for consumers. Social media also gives brand the opportunity to communicate directly with their customers and to educate them in how to use a specific product in a more sustainable way. Some other the strategies consist in the formulation of "2 in 1" products or trying to improve the formulas themselves (30).

4.7 Post-consumer phase

The use of biodegradable, recyclable and reusable packaging continues to increase, and packaging is designed based on a life cycle reasoning (30). Amongst the waste management techniques are reutilization, recycling, incinerating with energy recovery or composting. Other kind of strategies may include educating the consumers, alerting to changes in daily habits both in advertising and in the packaging itself, informing consumers of what can be done to packaging, while others may rely on refilling products or even extending the product´s life. Besides that, a lot of initiatives are taking place, such as The Sustainable Packaging Initiative for CosmEtics (SPICE) which goal is to collectively shape the future of sustainable packaging by developing business-

oriented methodologies and data to support resilient decision making to improve the environmental performance of the entire packaging value chain (8).

5 Cosmetic Claims Orientations

Over the years the consumer had to adapt to what the market offered, starting to have more attention to information that previously didn't have, as the one that appears on the label.

According to Kotler and Keller's *Marketing Management* book, consumer behavior is strongly influenced by cultural, social, personal and psychological factors. There are several characteristics that influence consumer's choice, such as need, age, life-stage and lifestyle, with marketing, by itself, playing a fundamental role (37). Until there is a decision on which product to buy, the consumer goes through several stages, from determining the need to evaluating different alternatives in the market. In order to help and make this decision easier, claims arise, which, when done correctly and with the right intention, direct the consumer until the decision of buying a product, formulating, therefore, an opinion.

It is essential that consumers make informed choices, but for this to occur the manufacturer must be honest and aware of the marketing strategies used, without ever misleading the consumer. Therefore, claims of cosmetic products serve to inform end users about the characteristics of a product and are used to differentiate products.

In order to guarantee its correct use, cosmetic claims should comply with Article 20 of the Cosmetics Regulation which states: "*In the labeling, making available on the market and advertising of cosmetic products, text, names, trademarks, pictures and figurative or other signs shall not be used to imply that these products have characteristics or functions which they do not have"* (3), fulfilling the following basic topics (8):

A) **Specific** - claims should be specific, complete and accurate.
B) **Measurable** - claims should be measurable and verified. Third-party reviews are mandatory when making comparisons.
C) **Relevant** - relate important benefits in areas aligned with brand purpose.
D) **Understandable** – the information claimed should be understandable, strong and technical language should be avoided.
E) **Accessible** – it´s important to guarantee that all information and sources are available.

In order to comply with these requirements, the Regulation (EC) No 655/2013 on the common criteria for the justification of claims was created, which clarifies - Legal compliance, Truthfulness, Evidential Support, Honesty, Fairness and Informed decision-making (4) – to ensure a high level of protection for end users, in particular from misleading claims:

1. **Legal compliance:** "Claims which convey the idea that a product has a specific benefit when this benefit is mere compliance with minimum legal requirements or that it was approved or authorized by a competent authority within the Union shall not be allowed" (4).
2. **Truthfulness:** "If it is claimed (…) that it contains a specific ingredient, it shall be deliberately present. (…) claims referring to the properties of a specific ingredient shall not imply that the finished product has the same properties when it does not. Marketing communications shall not imply that expressions of opinions are verified claims unless the opinion reflects verifiable evidence" (4).
3. **Evidential support: "**Claims shall be supported by adequate and verifiable evidence regardless of the types of evidential support used to substantiate them. Studies used as evidence, shall be relevant to the product and to the benefit claimed, shall follow well-designed, well-conducted methodologies (valid, reliable and reproducible) and shall respect ethical considerations." (4)
4. **Honesty: "**Claims shall not attribute to the product concerned specific characteristics if similar products possess the same characteristics. Presentations of a product's performance shall not go beyond the available supporting evidence." (4)
5. **Fairness:** "Claims for cosmetic products shall be objective and shall not denigrate the competitors, nor shall they denigrate ingredients legally used." (4)
6. **Informed decision-making: "**Marketing communications shall consider the capacity of the target audience to comprehend the communication. Marketing communications shall be clear, precise, relevant and understandable allowing the average end user to make an informed choice." (4)

Later on, in 2017, the Technical Document on cosmetic claims was created (38). It's not legally-binding and does not reflect an official position of the European Commission, but it aims to provide guidance for the application of this regulation.

The European Union has also two key reporting systems that help regulate the use of cosmetics in the European Union. This reporting system, called the Cosmetics Product Notification Portal (CPNP), is a large database of all cosmetics distributed within the European Union (39). The second reporting system is the reporting of Serious Undesirable Events - SUE (40). This type of reporting became mandatory under the notion that consumers in EU should have a level of transparency about the products they choose to buy and what effects those may have according to the communication previously made. These SUE reports are then shared with governments in order to keep everyone involved informed.

5.1 The concept of "Greenwashing"

Regarding the topic of sustainability, industries corporations want to attend consumer desires and, in doing so, are not necessarily representing the true health information about their products (41). In some cases, brands are misleading consumers to think that their products are truly healthy or environmentally friendly. This method of misleading consumers and inaccurately claiming "green", "natural", "organic", or "well-being" attributes has been named *greenwashing*. In recent years the amount of "green" claims which refer to alleged organic or sustainable properties of products increased in all areas (42).

A study by TerraChoice, an environmental marketing group, found that 99% of products reviewed (in the US market) were found to be guilty of committing one of the six sins of greenwashing (43):

- The sin of hidden trade-off - products considered "green" based on a single environmental attribute without attention to other environmental issues.
- The sin of no proof - any environmental claim that cannot be substantiated by accessible supporting information, or by a reliable third-party certification.
- The sin of vagueness - every claim that is so poorly defined that it´s real meaning is likely to be misunderstood by the intended consumer.
- The sin of irrelevance - making an environmental claim that may be truthful but is unimportant for consumers seeking environmentally preferable products.
- The sin of lesser of two evils - "green" claims that may be true but distract the consumer from the environmental impacts of the category.
- The sin of fibbing - environmental claims that are simply false.

This study reinforced the need to build a more honest and effective dialogue on the environmental impacts of products. When these challenges are overcome, it's expected that consumers will gain greater confidence in green claims, and products that are truly sustainably preferred will also gain a foothold in the market. This will be good for both the consumer, the business, and the planet.

Alongside with this and considering the growth of green cosmetics worldwide, there is a need-to-know what consumers understand of green cosmetics, the real definitions, and the labels which certify this green origin. There are some buzzwords like synthetic, natural, natural derived, nature identical, organic and green usually associated. Some of these definitions are provided below (44):

- **Synthetic –** A substance or material produced by chemical processes and not occurring naturally.
- **Natural -** Any material that has been harvested, mined or collected, and which subsequently may have been processed, without chemical reaction (although physical processes such as washing, decolourising, distilling, grinding/milling, separation and/or concentration of the material are pallowed), to yield a chemical or chemicals that are identifiable in the original source material.
- **Natural derived -** An ingredient where a natural raw material is used as the starting point of a chemical process to produce a new chemical that may not be available in nature or in the starting material.
- **Nature identical -** A substance that has been produced synthetically, not usually from a natural starting material, in order to produce a material that is identical to that occurring in nature.
- **Organic -** Natural ingredients that result from organic agricultural methods (which avoids the use of synthetic fertilizers, pesticides, plant growth regulators and livestock feed additives). Organic farmers should practice crop rotation, integrated pest management, crop residues, animal manures and mechanical cultivation to maintain soil productivity. Farms need to have certification to be used as 'certified organic' cosmetic ingredients.

To help clarify and harmonize the concepts of natural and organic cosmetics, ISO 16128 was created and published in 2016 (45,46). It provides guidelines on definitions for

natural and organic cosmetic ingredients among other ingredient categories and has two parts:

- The first one published in 2016 (45) – provides guidelines on technical definitions for "natural" and "organic" cosmetic ingredients and products, harmonizing criteria and clarifying the market.
- The second published in 2017 – used as characterization and calculation tool related to the different categories of ingredients (47).

However, ISO 16128 does not address product communication (e.g. claims and labelling), human safety, environmental safety and socio-economic considerations (e.g. fair trade), and the characteristics of packaging materials or regulatory requirements applicable for cosmetics (46), which means that this guidance accomplishes the regulation (EU) no 655/2013.

5.2 Certifications

There are also certifying organizations, which are independent entities that establish standards that must be complied throughout the product's life cycle. The existence of certification symbols on cosmetic products packaging not only allows a better differentiation between sustainable and non-sustainable products, but also offers added value to the product, ensuring transparency and reliability within consumers (48). There is a wide range of certification agencies with standards for natural and organic cosmetics, adopted mainly at a national level, such as: **BDIH** (Germany, 1951) (49); **Natrue** (Belgium, 2008) (50), **Ecocert** (France, 1991) (51), **Cosmebio** (France, 2002) (52), **ICEA** (Italy, 2000) (53) and **Soil Association** (UK, 1946) (54).

In recent years, the attempts to create a harmonized standard in the EU lead to the development of COSMOS-standard, founded by BDIH, Cosmebio, Ecocert and Soil Association and is now an internationally accepted standard for organic and natural cosmetics. However, as it is usually associated together with more certifications, it can still be confusing for consumers as the criteria evaluated aren't common at European level. EU should continue to make efforts in order to develop only one reliable and sustainable label, recognized by all consumers at the time of purchase.

While it is not possible to officially label a cosmetic product as "sustainable" there are also fair-trade labels, eco-labels and sustainability and corporate social responsibility (CSR) indexes that in this context tend to draw nearer to the classification of what a sustainable cosmetic is. Other sustainability symbols that address more generic

concepts, which can be bound on product's labelling are described in Table 1. Symbols or indications on the packaging or in any other cosmetic document which claim efficacy tests have not been carried out on animal are not allowed since, according to Regulation No 655/2013 it goes against criteria of Legal Compliance (4), representing a case of greenwashing.

Table 1 - Other symbols found on cosmetic products packaging

Symbols	Description	Reference
	FSC (Forest Stewardship Council) International: confirms that the forest preserves biological diversity and benefits the lives of local people and workers, while ensuring it sustains economic viability	(55)
	1% for the planet: 1% of its sales to help fund environmental non-profit organizations.	(56)
	Ecocert 26000: based on principles of ISO 26000 to assess the level of social and environmental responsibility.	(51)
	Certified B Corporation: measures a company's entire social and environmental performance.	(57)

5.3 Clarifying other concepts used in claims

Some other initiatives have been undertaken in order to harmonize the communication through strong recommendations or even guidelines (8). Recently, L´Oréal and Quantis published a claim guideline (8) addressed primarily to companies' internal teams, including marketing and brand communications, sales, corporate communications, R&D, packaging, legal, and regulatory departments:

- **Environmental footprint** refers to the impact a company, product, package, or activity has on the environment. Impact indicators include: the greenhouse gas (GHG) emissions, land use, water usage, lack of resource, ecotoxicity, among others. When doing a LCA, several indicators must be performed, according to Product Environmental Footprint recommendations (58).
- **Resource optimization** means a reduction in the number of materials, energy or water used to produce a product, its packaging or other component. Resource optimization aims at reducing adverse environmental impacts while maintaining the same performance and efficiency.(8)

- **Renewable materials** are materials composed of biomass from living sources that can be continually renewed, such as trees and plants. Examples of renewable materials are paper and bio-based plastics (8).
- **Recycled content** refers to materials that were previously used (59).
    - Pre-consumer material: "*material diverted from the waste stream during the manufacturing process*" (post-industrial recycled material – PIR)
    - Post-consumer material: "*material generated by households or by commercial, industrial facilities that can no longer be used for its intended purpose*." (post-consumer recycled material – PCR).
- **Biodegradable materials** refers to a natural process where materials decomposes by the actions of microorganisms into simple, non-toxic components (60), in a short period of time.
- **Compostable** means that a product is capable of decomposing into natural elements in a compost environment leaving no toxicity. Typically, this must occur 90% in about 12 weeks. The key characteristics are biodegradability, disintegrability, chemical composition and quality of the final compost.
- **Reusable** is "*a characteristic of a product or packaging that has been conceived and designed to accomplish within its life cycle a certain number of trips, rotations or uses for the same purpose for which it was conceived*" (59). Packaging can also be considered **rechargeable** if it has been designed to receive a new component.
- **"Absent of" claim** aims to tell consumers that the substance that may be harmful to their health is absent and so, guarantee that the product is safe. Although, they shouldn't be the main selling point of a product. If cosmetics regulation bans an ingredient, this claim cannot be made, according to Regulation (EC) 655/2013, once it goes against Legal Compliance. If other substance or category has not been formally characterized as one likely to be harmful, it's not legal either.

6 Green formulations

Pressure from consumers, activists and governmental goals led formulators to remove several significant conventional ingredients used in natural cosmetic formulations and there is an explanation for their lack of acceptability. The main concerns are related to their potential health issues or petrochemical origin. With the increase in knowledge and transparency in the cosmetic industry, the use of some ingredients previously said to be "conventional" began to be accurately evaluated and regulated. These conventional ingredients include among other preservatives, such as parabens, and formaldehyde, emollients and surfactants, including even UV filters. It is common to see products packaging communicating the brand's green credentials and better safety profile by virtue of the absence of synthetics that have created controversial opinions in terms of their safety and effectiveness. Associated with this, some years ago, cosmetics companies started using claims like "absent of" as explained above, once people involved in the practice believed consumers were looking for this information. However, it is always important to ensure that this communication follows the criteria in the cosmetics claims regulation (4).

It's important to understand that neither all-natural ingredients (vegetable/animal origin) are good, nor all synthetic ingredients are harmful. A synthetic ingredient can be considered more sustainable than its replacement if processed according to green chemistry principles. *Green chemistry* can be defined as the "design of chemical products and processes to reduce or eliminate the use and generation of hazardous substances" (61). Furthermore, the same ingredient can come from different origins, (animal, vegetable or synthetic origin) and as current EU legislation does not require the origin of ingredients to be specified in the label it's hard to the consumer to understand the real ingredient origin.

For that it´s important to understand the impact of existing replacements and added difficulty in formulating with different ingredients, guaranteeing the same efficacy and quality of the product. Understanding the different categories of cosmetics and classes of ingredients is one of the first steps we're going to explore.

6.1 Cosmetic products categories

Cosmetics products can be divided into seven principal categories – oral care (e.g., mouthwashes, toothpastes), skin care (e.g., moisturizers, serums, exfoliators, cleansing

lotions), sun care (e.g., lotions, oils, gels, sprays), hair care (e.g., shampoos; conditioners, mousses), decorative cosmetics (e.g., foundations, powders, eye shadows, lip & eyeliners), body care (e.g., soaps, antiperspirants, body washes, shower gels) and perfumes (e.g., perfumes, after shave, among others) (62).

Inside each category cosmetic products can have different formulas depending on the final purpose of a product, including:

Solutions

These are the simplest type of cosmetic formulas and consist in a homogeneous mixture of soluble ingredients. Mainly are used in shampoos, body wash, hand cleansers, colognes, among others. (63)

Emulsions: Creams and Lotions

Emulsions are heterogeneous systems composed of immiscible liquids and include in the formula an oil phase, aqueous phase, and an emulsifier. It can be O/W (external phase: water) or W/O (external phase: oil) (64). They are used for products like hand moisturizers, make-up, hair conditioners, sunscreens (63).

Sometimes creams can be too heavy or greasy, so the lotion form is used. Lotions are emulsions with low viscosity, so the way of formulation is similar to creams (64). They are used for facial moisturizers and cleansers, leave-in hair conditioners (63).

Ointments/Pastes

These are very thick products, usually anhydrous, sticky and greasy. Typically used for hair styling, in oral care and for most facial masks (63).

Suspensions

Suspensions are heterogeneous systems in which the dispersed (solid) phase, is distributed, in small units, in the dispersing (liquid) phase. Represent normally clear products with visible particles, like gelatin beads or inorganic minerals suspended in the formula and includes the use of a polymer or clay. (63). They are used in exfoliator scrubs, facial masks, sunscreens, hand washes or shampoos.

Foundations consist in a mixture of a suspension and an emulsion either o/w or w/o (sometimes named *suspoemulsion*) and the continuous phase generally contains the pigment particles that interact with emulsifiers, making the formula more complicated than standard emulsions (65).

Powders

Powders are used for color cosmetics to make eye shadows, blushes, pressed and loose powders and as baby powders and foot powders (64). They are mixtures of solid raw

materials blended into a fine powder. Typical ingredients include talc, silicates, starch and titanium dioxide (63).

Gels

Gels typically are clear, thicker than a liquid with limited flow properties, being from transparent to opaque (64). Their formation includes the use of gums or thickening agents as appropriate and can be water based becoming more fluid or oil based. Gels are used for hair products, body washes, serums, shaving products and also in toothpaste. (64).

Sticks

Sticks are solid forms that deliver active ingredients through a rubbing action (63). The ingredients are melted, mixed and poured into a mold, becoming solid at room temperature (63). This form is used mainly for lipstick, antiperspirants and soap bars. The development of "bar" products is also associated with the waterless and water reduction trend that is continuously growing. Bar products can be moistened at the time of use to become the products (66), for example, shampoo/conditioner bars that can be wet in the shower and foam up just like a regular product.

Aerosols

An aerosol is a heterogeneous system consisting of a solid/liquid phase distributed in a gaseous phase. Any cosmetic delivered from a pressurized can, filled by a formula with a concentrate and an appropriate propellant (63). The used of aerosols have been reduced due to volatile organic compound regulations (67) and environmental issues, but are still used in hairsprays, shaving creams, deodorants, sunscreens and also in perfumes.

The different types of ingredients play a fundamental role in the formula in order to fulfill all the requirements, such as physical stability, chemical inertness, safety and efficacy profile, while maintaining the sensory attributes (31).

So, next will be described almost all the categories of ingredients from emollients, exfoliators, polymers and solvents, to colorants, fragrances and UV filters, ending with ingredients for stabilizing such as surfactants, preservatives and antioxidants, including the sustainable replacements for conventional ingredients that are being made by companies. As said before, one of the main challenges of this replacement is to guarantee the same effectiveness, quality and sensorial attributes with sustainable

ingredients as usual with conventional ingredients, because of their different physicochemical properties.

6.2 Sustainable replacements of conventional ingredients

6.2.1 Emollients

Emollients can be described exactly as emollients as well as occlusive and humectants. They are a large class of mostly oily, that smoothen and soften the skin, also known as a moisturizer ingredient, and are related to the sensory properties of cosmetics. Based on their chemical structures, emollients can be categorized as hydrocarbons, fatty alcohols when in quantities inferior to 5%, esters, silicone derivatives (31), among others. Replacement of synthetic derived emollients by natural oils, butters, fats or naturally derived esters can be made by a wide range of highly effective emollient oils and butters. However, the skin feel, spreading, absorption characteristics and stability of the product can be affected (44). The skill of the formulation chemist is related to her/his ability to select the right natural emollients, emulsify them adequately, if appropriate, and keep them stable which may need the addition of natural antioxidants (44).

6.2.2 Exfoliators

There are physical and chemical exfoliators, both designed to remove dead skin cells and at the same time prepare the skin for absorbing correctly the moisturizer. The mechanism of action in physical exfoliators involves abrasion and physical action, whereas the chemical exfoliators are designed to be absorbed by the skin to increase cell turnover.

Physical exfoliators normally used to contain small spherical particles made from synthetic plastic polymers, known as plastic microbeads. The most used synthetic plastic polymers include polyethylene, polylactic acid, polypropylene and polystyrene (31). Besides being insoluble in water, these microbeads have the capacity to absorb chemical pollutants and are often mistaken as food by marine life animals and consequently cause cellular necrosis and inflammation of tissues. Having this in mind in 2015 the United States banned its use in cosmetics products such as cleansers, toothpaste and shampoo (68) and this topic started to gain impact worldwide. More recently in 2020, The European Chemicals Agency's (ECHA's) Committee has adopted a proposal that aims to ban products from the European market that intentionally contain added microplastics if they proof to be harmful to the environment (69).

To solve this problem, biodegradable (e.g., from cellulose), natural (from fruits e.g. peach seeds), organic (e.g. sugar) and mineral microbeads can be a substitute to reformulate mixtures with alternative materials. Chemical exfoliators include fruit enzymes and “gentle” acids but because of their acidic characteristics, they can have a harmful impact for the aquatic environment (31).

6.2.3 Surfactants

Surfactants at different concentrations have different functions, acting as emulsifiers, wetting and foaming agents and dispersants. A general classification of surfactants is based on the charge of their hydrophilic part and can be divided as anionic, cationic and amphoteric. Some of the common synthetic surfactant are quaternary ammonium compounds, sodium lauryl sulfate (SLS) and sodium laureth sulfate (SLES) (31). Alternatives to the conventional SLES used in foaming products include natural materials with surfactant properties, including plants saponins. However, they are often highly colored and difficult to formulate into an acceptable foaming product, and expensive. Coco, lauryl and decyl glucosides belong to a class of mild, biodegradable surfactants called alkyl polyglucosides (APGs) and are produced from fatty alcohols and glucose, considered to be the most natural of the chemically produced surfactants (44).

6.2.4 Polymers

Polymers are widely used in cosmetics, particularly in skin emulsions, as thickeners and rheology modifiers, but also as emulsion stabilizers and emulsifiers. A broad spectrum of polymers includes natural (e.g. xanthan gum), semi-synthetic (e.g. cellulose derivatives) and synthetic (e.g. carbomers, silicones, poloxamers, polyacrylamide, polyethylene and its co-polymers) polymers (31). Because of their advantages, as high viscosity at low concentration and excellent organoleptic characteristics, carbomer polymers have a wide applicability, but there are issues around their petrochemical origin and impurities. Several natural polymers that can be used as replacements, although they may not be able to fulfil all the functions of synthetic polymers. The major disadvantage of many of these materials is the sensation of sticky skin feel or stringy appearance to the product (44).

6.2.5 Solvents

Solvents are substances used for extractions, separations, formulations and synthesis processes and their replacement needs to be deeply analyzed.

Water is the most common and considered natural solvent. However, the types of water defined according to ISO 16128 may be treated differently (45):

- Constitutive water is the liquid (juice) content of fresh plants.
- Reconstitution water is equivalent to the water found in the original material and is used to restore the dry material to its original content.
- Extraction water is the water used to physically extract ingredients from a material mixture.

Organic solvents are the most common alternative, but are recognized to have a big environmental impact on i) pollution, because most of them come from the petrochemical industry; ii) energy usage, iii) contributions to air quality, since most solvents are volatile organic compounds (67) and iv) climate change. Besides that, such solvents can be harmful to human health, causing skin irritation and sensitization, and, possibly, penetrating the skin and weakening cellular structures.

Redesigning processes to use less solvent or allow solvent re-use are some of the solutions but also the selection of a green solvent. As more sustainable option for the petroleum-based solvents, there are biofermentation-derived glycols with lower GHG emissions (31).

6.2.6 Colorants

Colorants can be divided into pigments and dyes and are used to increase products appearance and acceptance and cannot be excluded from formulations. They can be subdivided in organic/inorganic pigments and organic dyes (31). The difference between them is that pigments are organic or inorganic opaque solids insoluble in the vehicle and are dispersed as particles, while dyes are organic molecules soluble in the application medium.

Natural colorants are the most accepted in sustainable cosmetics, as synthetic colorants raise health and environmental concerns. In summary, there are a lot of natural colorants that can be used to achieve more sustainable cosmetics. However, they still play only a minor role. Annex IV of the cosmetics Regulation (3) includes a list of colorants allowed in cosmetic products, their color and in which type of products they should be used.

6.2.7 Fragrances

Fragrances consists in organic compounds with a characteristic smell, used in in a low quantity. They aim at increasing product's acceptance. Regardless of its source, can be

associated with skin irritation and allergic reactions, and environmental concerns also exist, as they are volatile compounds (67), and have low biodegradability (31). The Cosmetics Regulation (3) includes a list of substances which are forbidden in cosmetic products, including allergen fragrances such as atranol and chloroatranol, being considered banned ingredients – Annex II – and a list of substances, including other allergen fragrances, such as geraniol, eugenol, linalool, among others which are allowed, but subject to restrictions – Annex III. Some of the substances in Annexes II and III are associated with contact allergy and are known as fragrance allergens. In this list were identified 26 fragrance allergens (70) that should be subject to the obligation of individual labelling on the package of a cosmetic product, in addition to the words 'parfum' or 'aroma', when its concentration exceeds 0,001% in leave-on products and 0,01% in rinse-off products (3).

Natural fragrances can be complex compositions of essential oils, isolates, exsudates, concentrates and other natural aromatic compounds. (31). They should comply to IFRA (71) and are described in better detail in ISO 9235:2013 (72). As stated, amendments to the Cosmetics Regulation are dynamic and the SCCS is currently considering several other issues that concern the fragrance industry.

6.2.8 UV filters

UV filters means *"substances which are exclusively or mainly intended to protect the skin against certain UV radiation by absorbing, reflecting or scattering UV radiation"* (3), and can be classified as physical or chemical filters. Physical filters, also known as mineral sunscreens, consist mainly of inorganic micropigments that reflect the UV radiation. Chemical or organic filters penetrate the skin absorbing the UV radiation that is then converted into heat energy. It is known that chemical and physical filters have a negative impact in the environment, once they reach coastal waters, cause bioaccumulation and affect marine life. Another concern is the health safety of the chemical filters, because ingredients are suspicious of causing endocrine disruption.

The Annex VI of the Cosmetics Regulation (3) lists the UV filters allowed in cosmetic products in the EU. Besides the identification of the ingredient, this list also contains the maximum concentration of use in ready for use preparation and the conditions of use for each of the UV filters allowed. For example, the annex VI of this regulation was amended in 2016 by SCCS considering that zinc oxide in non-nano and nano form should be authorized for use as a UV filter, both forms at a maximum concentration of

25%, except in applications that may lead to exposure of the end-user's lungs by inhalation (73).

Companies can make use of plant extracts, such as black tea, green coffee, shea butter, cacao extract and other plant extracts rich in UV absorbing phyto-chemicals (31). There is a lack of evidence about natural plant derived sunscreen agent's action. Consequently, no approved natural sun-filters are allowed by EU regulations. Although, these can boost SPF efficacy, but they cannot be used as the only sunscreen ingredient. The ideal UV filter in terms of sustainability should be from renewable raw materials, biodegradable, feature low toxicity to aquatic organisms, and should not be endocrine active (31).

6.2.9 Preservatives

Preservatives are used mainly to inhibit the development of microorganisms in a cosmetic product and help to maintain it in good conditions for a long period after opening. The list of preservatives allowed in cosmetics products is described in Annex V of the regulation (3).

Parabens are amongst the most used preservatives, and some examples are methylparaben, propylparaben and methylparaben. Parabens have a high efficacy at a low percentage and have non-irritating and non-sensitizing properties in most people, but studies on their potential harmful effect in human health, makes them an ingredient with controversial acceptance (31).

The controversy associated with the acceptance of certain substances like parabens (but also UV filters and antioxidants) arise from several studies that have demonstrated the harmful effect of some substances (synthetic and natural) as endocrine disruptors (74). Starting in 2018, the Commission committed to create a priority list of potential endocrine disruptors that weren't covered by the regulation bans yet, that culminated in the creation of a list of 28 substances (74). From 16th May to 15th October of 2019, 14 substances have been identified as high priority for assessment by SCCS, such as propylparaben (preservative), triclosan (preservative), Benzophenone-3 (UV filter), kojic acid (bleaching), 4-methylbenzylidene camphor (UV filter), among others (74). Then, the Commission should, as soon as possible, take steps to ban or restrict the use of these substances in cosmetics, if necessary.

Formaldehyde releasers are the next most common preservatives, usually used in "*paraben-free cosmetics"* (75). These substances dissociate into formaldehyde, a

substance that can also have toxic effects in humans. Some of the most used are imidazolidinyl urea, diazolidinyl urea, sodium hydroxymethyl glycinate and benzylhemiformal (3,31).

According to the regulation (3), all finished products containing formaldehyde or substances in Annex V and which release formaldehyde must be labelled with the warning *"contains formaldehyde"*. Recently, the SCCS adopted a Scientific Advice on the threshold for the warning reducing the present threshold by a factor of 50, that is, to 0.001%, applying to total free formaldehyde irrespective of whether a product contains one or more formaldehyde releaser(s).

Phenoxyethanol is other preservative authorized in cosmetic formulations, limited at a maximum concentration of 1.0%. In 2016 due to some possible skin irritations, mainly in children under 2 years-old, described by some safety agencies, SCCS formulated an opinion report considering this preservative safe for use in the concentrations previously established (76).

In order to replace such preservatives, the following options are available (31), having in mind that *"the ideal preservative does not – and probably cannot – exist"* (75):

i) the utilization of synthetically produced nature identical preservatives (such as organic acids),
ii) the use of natural preservatives,
iii) self-preservation techniques using raw materials that avoid germ growing,
iv) the use of multi-functional ingredients.

6.2.10 Antioxidants

Antioxidants are used to stabilize formulations, in particular from the rancidity of fatty substances and also perform as skin care actives, providing protection from oxidative stresses and consequently, the signs of aging (31). The most used are synthetic antioxidants like butylated hydroxytoluene (BHT) and butylated hydroxyanisole (BHA), because of their stability during processes, although allergic reactions in the skin have been reported as adverse effects in scientific literature (31). Natural antioxidants can be used, and vitamins extracted from plant sources like Vitamin E (tocopherol), A (retinyl palmitate), and C (ascorbic acid) are the most frequently used.

7 2021: Market trends

Over the years and with the emergence of all these concerns around sustainability, the cosmetic industry has evolved, and some trends have emerged and stand out in this area in which we would like to highlight *clean beauty* and *waterless products*.

Consumers are increasingly aware and more conscious of their health and safety, much due to COVID-19 and clean is now top of mind (7). People want to make sure whatever comes into their homes and bodies is not going to adversely impact their health and transparency is a priority. It's important to understand the market trends, in order to understand what consumers are looking for and how brands position themselves in face of these trends.

7.1 Clean beauty

Clean beauty is a cosmetic trend that is characterized by products that are created and manufactured without any proven or suspected toxic ingredients (77) and should list all of the ingredients in a transparent label. The clean concept is often associated to natural ingredients yet can also include synthetics considered safe and that demonstrate effectiveness in formulas. In some words, natural can be clean but clean is not always natural (78). The main concerns are often related to their potential health issues or petrochemical origin. Some efforts have been made at the regulatory level in order to clarify which ones are prohibited or restricted within the different categories (3). Some of the categories that require more attention are:

- **Endocrine disruptors:** To address potential health risks, the regulation includes a system of restrictions on and bans of certain substances in cosmetics. Restrictions are based on SCCS risk assessments. It judges whether endocrine/hormonal activities are linked to critical endpoints to assess the safety of these substances for consumers.
- **Nanomaterials:** According to Regulation (3) Article 16 (10a) there is a catalogue of all nanomaterials used in cosmetic products placed on the market. Nanomaterials used as UV filters, colorants and preservatives must be specified in a different section. The catalogue should indicate the categories of cosmetic products and the foreseeable exposure conditions**.**
- **Carcinogenic, mutagenic, or toxic for reproduction (CMR substances):** Article 15 of the Cosmetics Regulations (3) contains provisions on the use of CMR in cosmetic products. As a general principle, substances classified as

CMR substances of category 1A, 1B, or 2 under Part 3 of Annex VI to Regulation (EC) No 1272/2008 are banned for use in cosmetic products. Exceptions to this rule are possible.

- **Preservatives:** The European Commission ensures an updated list of scientifically evaluated safe preservatives for their use in CP and guides national authorities to monitor products on the EU market.
- **Fragrance allergens:** According to Article 19 (g) of Cosmetics regulation (3), cosmetic products should list their ingredients on the packaging. Now, 26 fragrance allergens are subject to individual labelling (annex III of the cosmetics regulation).

Despite the efforts made in this regard, the consumer has a lot of responsibility to pay attention and it's also about making ourselves more aware about the most common toxins/suspicious ingredients and be informed about their safety regardless of their origin. Some examples of lack of transparency that doesn't meet with regulations and must be watch carefully are greenwashing which goes against Regulation (EC) No 655/2013, and also about the labeling, as including fragrance in the list of ingredients, since these contain allergens that according to the Regulation (EC) No 1223/2009 must be listed individually at certain concentrations (3).

One initiative developed by Good Face Project (79) – the Good Face Index - is a project developed around clean beauty, in which each cosmetic ingredient is analyzed, and safety ratings are given based on scientific studies and research papers on cosmetic ingredients in order to help consumers.

7.2 Waterless products

Related to the rise of clean beauty and sustainable concerns, people are looking for healthier and more sustainable alternatives. As consumers are increasingly aware of how precious water is and since it's one of the most common ingredients found in cosmetic products, normally as a solvent, waterless products are considered the future for many (80). The concept of w*aterless beauty* originally started in South Korea and started to gain more interest later in Europe. Waterless means a reduced use of water during the different phases of production, whether it be with raw materials, finished products or within manufacturing operations (81).

W*aterless beauty* is about more than efficacy: it can represent a desire for clean, and non-toxic formulas along with growing sustainability concerns (80).

Using water in formulations may also have some disadvantages, especially the need for preservatives and emulsifiers. It is also worth noting that when used in excess, it can dry out the skin and break its natural barrier (82). In addition, when using water in a formulation, the overall effectiveness of the product is reduced. One factor of skincare effectiveness is molecule size. Water molecules are big, meaning less of the formula penetrates the skin and greater the need for consumption. The more you consume, the more packaging you need, which can create some environmental issues (82). Waterless skincare may have the advantage of making the formulation able to travel deeper into skin, demonstrating greater power.

Although waterless products look promising, there are some issues that should be addressed: waterless products are usually formulated with other liquids as a base, such as hydrating botanical oils, aloe vera juice, plant extracts or other active ingredients (83) and we may inadvertently cause other environmental issues, depending on sourcing and processing of alternatives ingredients. As we have already seen, a product should not be evaluated for its environmental impact by only one factor (water) but for all life cycle, which must keep up with these changes in order to become preferential. Furthermore, they often come as powder or solid forms and require water to consumer-use (83). On one hand, some of these products formulated without water, such as solid shampoos, need water for its usage, so it is necessary to evaluate this water consumption, as it may not be an advantage over traditional product. On the other hand, products like dry shampoo, in addition to not having water in their composition, don´t need water in use and allow spacing of hair washing, which has a positive environmental impact on water consumption, proving to be promising products in this trend.

8 Assessment of Case Studies

In April 2021, the "consumer health market" had grown around 21% in value, compared to the homologous period, representing 26% of the total turnover of the pharmacy market. Consumer health market includes OTC (over the counter), PEC (personal care), PAC (patient care) and NTR (Nutrition), representing 54.9%, 23.1%, 19.3% and 2.9%, respectively (84). The segment of personal care products includes cosmetic products, such as skin care, hair care, personal hygiene, oral hygiene, deodorants, fragrances, shower and bath, and make-up. Data from July 2019 show that "the beauty products market" totalized more than 103 million € in sales in the Pharmacy channel, showing a growth of 4.3% in comparison with the previous year, showing the big impact that this segment plays in the channel (85).

In this topic, four cosmetic brands – Klorane, A-Derma, Caudalie and Apivita – representative of the cosmetics market in the Portuguese pharmacy channel and which have been trying to align themselves with these new trends will be analyzed. As well, one product from each will also be studied, as well as their commitments, product claims, packaging labelling and certifications, if any.

The body moisturizers/ emollients are of one of the best-selling categories in the pharmacy, after anti-aging/anti-wrinkles for woman and general use beauty products, excluding sunscreen products (85), and that's the main reason for the chosen products to belong to this category. These products are used by consumers daily, sometimes more than once a day, and can be intended for normal, dry or sensitive skin, or even for some specific skin problems that require specialized dermatological treatment. The information below was taken from the respective websites of the brands in Portugal and Europe as well as from the existing products and packaging in pharmacy.

8.1 Klorane – a Pierre Fabre cosmetic brand

Klorane is a Pierre Fabre cosmetic brand with more than 50 years, that inspired by botany manufactures hair, body, face and sun care products for all ages. Over these years, it has been working on its products in order to classify itself as:

a) **"A natural and controlled dermo cosmetic"** – from identification of active ingredients to collection, the control of plant's lifecycle and the respect of their surrounding eco-systems is a priority (86). It's supported by

Botanical Expertise Pierre Fabre's 4 pillars: innovation; protecting biodiversity; guaranteeing quality, safety, and efficacy; and respecting partners (87).

b) **"An eco-responsible brand"** – other main goal is to provide 100% eco-conceived products (86). Committed to reduce the consumption of resources and energy, reduce waste and CO_2 emissions and retain product performance. Certified with the ECOCERT 26000 label (88).

c) **"A supportive botany"** – committed to the Klorane Botanical Foundation, to plant heritage protection and valorization around the world (86).

In the category of body products, one of the main active ingredients used by Klorane is Capuaçu Butter of natural origin. The product selected for review, available for sale at the pharmacy channel, is **Fleur d 'Hibiscus Nourishing Body Lotion with Organic Capuaçu butter** (89). According to the website, the following information can be read:

- Active Ingredient: Cupuaçu has its origin in Amazon and respects the rules of organic farming according to the principles of sustainable management, being considered organic. The Capuaçu butter is made from the seeds, rich in fatty acids (omega-6, omega-9), which help to retain water within the epidermis.
- Eco responsibility: Formula 96% of natural origin and bottle 25% recycled PET. No ingredients from animal origin.. Produced in certified manufacturing facilities. Free from parabens, phenoxyethanol, MIT, volatile alcohols, BHT, EDTA.
- Product claims: The product present three claims of effectiveness *"hydration 24h"*, *"reduces skin dryness with long-lasting effect"* and *"soft skin"* and it's intended for all types of skin.

Evaluating in greater detail this product, it has principal active ingredient with known origin and the main benefits of its use are explained on the website. However, and despite the mention on the % of natural ingredients and their non-animal origin, synthetic/vegetable origin it's not mentioned which doesn´t allow the consumer to answer this question by itself as we can analyze in greater detail in the listing below – Table 1. The product also mentions some categories of ingredients from the suspicious list ("Free from parabens, phenoxyethanol, MIT, volatile alcohols, BHT, EDTA") which we can confirm that are excluded from formulation, but this type of claims goes

against what's mention in Regulation No 655/2013 (4). In terms of product claims, are supported by the respective efficacy tests which comply with criteria from Regulation No. 655/2013 – Evidential support.

Furthermore, no certification or ISO compliance is displayed besides the ECOCERT 26000 which is not specific for this product. If there was any this could increase consumer's trust and would represent compliance with existing requirements.

Table 2 - Fleur d 'Hibiscus Nourishing Body Lotion Formula

Fleur d 'Hibiscus Nourishing Body Lotion Formula			
INCI/ Substance Name	**Function** (90–92)	**Origin**	**Reference**
Water	Solvent	Natural	(45)
Glycerin	Humectant/ Solvent/ Skin Conditioning	Natural/ Synthetic	(93)
Caprylic/ Capric Triglyceride	Skin Conditioning, Perfuming	Natural / Synthetic	(94)
Carthamus Tintocrius Seed Oil	Skin Conditioning/ Perfuming	Natural (vegetable)	(95)
Isopropyl palmitate	Binding/ Emollient	Natural / Synthetic	(96)
C14-22 Alcohols	Emulsion Stabilizing	Synthetic	*
Dimethicone	Skin Conditioning – Emollient/ Antifoaming	Synthetic (silicone-based)	(97)
Benzoic Acid	pH adjusters/ Preservative / Fragrance	Natural (vegetable)/ Synthetic	(98,99)
Blue 1 (CI 42090)	Colorant	Synthetic	(92)
C12-20 Alkyl Glucoside	Surfactant - Emulsifying agent	Natural (vegetable)	(100)
C20-22 Alcohols	Binding/ Emulsion Stabilizing / Viscosity Controlling	Natural/ Synthetic	*
C20-22 Alkyl Phosphate	Surfactant - Emulsifying agent	Synthetic	(101)
Caprylyl Glycol	Skin Conditioning - Emollient	Natural derivate/Synthetic	(102,103)
Fragrance (Parfum)	Fragrance	Natural/ Synthetic	*
Helianthus Annuus Seed Oil (Sunflower)	Skin Conditioning - Emollient, Fragrance	Natural (vegetable)	(95)
Hydroxyethyl Acrylate/Sodium Acryloydimethyl Taurate Copolymer	Emulsion Stabilizing/ Viscosity Controlling	Synthetic	(104)
Polysorbate 60	Surfactant - emulsifying agent	Synthetic	(105)
Red 33 (CI 17200)	Colorant	Synthetic	(92)
Sodium Hydroxide	Buffering/ Denaturant	Synthetic	(106)
Sorbitan Isostearate	Surfactant - emulsifying	Natural-derivate/ Synthetic	(92,107)
Squalene	Skin Conditioning - Emollient	Natural-derivate / Synthetic	(108)
Theobroma Grandiflorum Seed Butter	Skin Conditioning	Natural (vegetable)	(95)
Tocopherol	Antioxidant	Natural (vegetable)	(109)
Xanthan Gum	Binding/ Emulsion stabilizing, Skin-conditioning/ Surfactant – emulsifying/ Viscosity controlling	Natural	(110)
Yellow 6 (CI 15985)	Colorant	Synthetic	(92)

* – Supportive scientific bibliography not found

8.2 A-DERMA – a Pierre Fabre dermo-cosmétique brand

A-Derma is also a Pierre Fabre brand with more than 30 years, known for the dermatological properties of a unique plant-based active, Aveia Rhealba®, that soothes and repairs fragile skins, with a special care for atopic skin (111). It known mostly for skin care products for use since birth, but the commitment goes beyond it as A-DERMA tries to meet both ecological and social commitment:

a) Values the production made 100% in France (112);
b) Supports local farmers and co-workers (112),
c) Protects the environment - Rhealba® Oat is cultivated according to organic farming standards with sustainable development in mind; it consumes little water; and everything is produced locally to limit the carbon footprint (112);

This brand is sought after in the pharmacy market because it offers products for different health issues, such as atopy-prone, acne-prone, irritated/reactive or scarred skin. It also offers a range of products named "The Essentials" in which **Hydrating Universal Cream** (the product we will analyze next) is included, for the daily protection of fragile skin (113):

- Active Ingredients: Rhealba® Oat extract - known for its soothing, anti-irritant properties; Hyaluronic acid - hydrates, repairs; Shea butter - Nourishing; Plant-based glycerin - moisturizes and protects.
- Eco responsibility: Formula 98% of natural origin.
- Product claims: This product has four claims of effectiveness: *"moisturizes"*, *"nourishes"*, *"soothes"* and *"helps repair"* fragile skin. It can be used by infants (from 28 days), children, adults, seniors and it's intended to be applied in face, body, hands, eye contour and after shaving.

In this case, it is indicated the origin of the four main active ingredients, but the remaining formulation despite mentioning being 98% of natural origin, doesn't inform the consumer about ingredients origin. In this formulation the use of polyacrylate-13, polyisobutene and polysorbate 20 mimics silicone like texture without using silicone, although the EU also sets limits for the amount of residual acrylamide allowed in products containing polyacrylamide (90). Despite being mentioned hyaluronic acid the

formulation is composed by sodium hyaluronate, a salt form of ingredient hyaluronic acid considered more effective for skin due to its greater compatibility (91). This products declares to be fragrance-free, silicone-free and alcohol-free , but with the analysis of the ingredients found below – Table 2 (113), it's possible to find two alcohols on formulation - cetearyl alcohol and batyl alcohol, which can demonstrate some lack of coherence. No science-based tests are available for consumer used to support claims which doesn´t comply with cosmetics regulation. Once again, no certification or ISO compliance is displayed.

Table 3 - Hydrating Universal Cream

Hydrating Universal Cream			
INCI/ Substance Name	**Function** (90–92)	**Origin**	**Reference**
Water	Solvent	Natural	(45)
Caprylic/ Capric Triglyceride	Skin Conditioning/ Perfuming	Natural / Synthetic	(94)
Glycerin	Humectant/ Solvent/ Skin Conditioning	Natural (Vegetable)	(93)
Butyrospermum Parkii (Shea) Butter	Skin Conditioning/ Viscosity Controlling	Natural (Vegetable)	(95,114)
Cetearyl Alcohol	Surfactant – Emulsifying/ Emulsion stabilizing/ Emollient	Natural-derived/ Synthetic	(115–117)
Glyceryl Stearate	Emollient/ Surfactant – Emulsifying	Natural-derivate/ Synthetic	(118,119)
Palmitic Acid	Emollient/ Surfactant – Emulsifying	Natural	(120)
Stearic Acid	Emulsion stabilizing/ Refatting/ Surfactant – Emulsifying	Natural	(120)
Alanyl Glutamine	Humectant/ Skin Conditioning	Natural/Synthetic	(121)/?
Avena Sativa (Oat) Leaf/Stem Extract	Skin Conditioning	Natural (Vegetal)	(122)
Batyl Alcohol	Skin Conditioning / Emulsion stabilizing/ Emollient	Natural-derivate/ Synthetic	(123)
Benzoic Acid	pH adjusters/ Preservative/ Fragrance	Natural/ Synthetic	(98)
Caprylyl Glycol	Skin Conditioning - Emollient	Natural/ Synthetic	(102)
Cetearyl Glucoside	Surfactant - Emulsifying	Natural (Vegetable)	(100)
Polyacrylate-13 (III/66)	Film forming	Synthetic	(124)/ *
Polyisobutene	Binding/ Film Forming	Synthetic	(125)
Polysorbate 20	Surfactant - Emulsifying	Natural-derivate/Synthetic	(105)
Sodium Hyaluronate	Humectant/ Skin Conditioning	Natural	(126)
Sodium Hydroxide	Buffering/ Denaturant	Synthetic	(106)
Sorbitan Isostearate	Surfactant - Emulsifying	Natural-derivate/Synthetic	(107)
Tocopheryl acetate	Antioxidant	Natural	(109)
Xanthan Gum	Binding/ Emulsion stabilizing, Skin-conditioning/ Surfactant – emulsifying/ Viscosity controlling	Natural	(110)

* – Supportive scientific bibliography not found

8.3 CAUDALIE – Caudalie Paris

Caudalie is a skincare brand born in 1995 in Bordeaux, which uses active ingredients obtained from the grapevine and grape. Caudalie tries to combine a balance of effectiveness, naturalness and sensoriality in their products, avoiding the use of suspicious ingredients, aligned with ecological commitment, being the largest *1% for the planet* contributor of the global cosmetic industry, giving 1% of its turnover to environmental associations for reforestation (127). Their commitments focus on:

a) **Selecting effective ingredients of natural origin** (128) – natural active ingredients that respect the environment and skin;
b) **Never use suspicious or undesirable ingredients** (128) – avoids use of suspicious endocrine disrupting preservatives; ingredients of animal origin, mineral oils (petrochemical derivatives) and irritating or pollutions agents.
c) **Complete transparency** (128) – tries to get as close as possible to 100% natural, but allows the use of synthetic ingredients if needed to guarantee the effectiveness and sensorially of products.

Caudalie offers fragrances, face, body and sun care products. In the body care category, one of the best sellers is **Nourishing Body Lotion** (129), also on sale at the pharmacy market, in which we can find:

- Active Ingredients: Hyaluronic acid (moisturizer and anti-aging action), organic shea butter (acting as softener and moisturizer) and antioxidant polyphenols (prebiotic and soothing).
- Eco responsibility: Formula 98% of ingredients of natural origin. Bottle in plant-based plastic.
- Product claims: Claims *"skin moisturized throughout the day*" with the following benefits: *"skin soft, supple, glowing…"*. In terms of security, it also claims, *"dermatologically tested"* and *"light fragrance"*.

This product mentions it was tested dermatologically presenting the test results on the website, representing its effectiveness and supporting claims. It also mentions the formula has "no parabens, phenoxyethanol, phthalates, mineral oils or ingredients of animal origin", as we can in the ingredient list – Table 3, although this once again goes against Regulation No 655/2013. Sodium benzoate has been evolved in some

controversy because of its potential to interact with ascorbic acid (a derivative of vitamin C) and produce benzene, potentially carcinogenic, although science proof its safe used in cosmetics as a preservative (130). Although it says *"ligh fragrance"* we can find some perfuming agents in formulation, and some of the mentioned ones are considered possible allergens at certain concentrations which, despite complying with the regulation, can be controversial when we look at it from the point of view of human health. Once again, it's impossible for consumer to understand the origin of ingredients, excluding animal origin.

Table 4 - Nourishing Body Lotion

Nourishing Body Lotion			
INCI/ Substance Name	**Function** (90–92)	**Origin**	**Reference**
Water	Solvent	Natural	(45)
Coco-Caprylate/Caprate	Skin Conditioning/ Emollient	Natural (Vegetable)	(96)
Glycerin	Humectant/ Solvent/ Skin Conditioning	Natural/ Synthetic	(93)
Vitis Vinifera (Grape) Fruit Water	Skin Conditioning	Natural (Vegetable)	(95,131)
Butyrospermum Parkii (Shea) Butter Extract	Skin Conditioning	Natural (Vegetable)	(95,114)
Vitis Vinifera (Grape) Juice	Antioxidant/ Skin Conditioning	Natural (Vegetable)	(131)
Palmitoyl Grape Seed Extract	Skin Conditioning	Natural (Vegetable)	(91)/*
Sodium Hyaluronate	Humectant/ Skin Conditioning	Natural	(126)
Candelilla/Jojoba/ Rice Bran Polyglyceryl-3 Esters	Emulsion Stabilising/ Surfactant - Emulsifying	Natural-derivate	(132)
Glyceryl Stearate	Emollient/ Surfactant – Emulsifying	Natural-derivate/ Synthetic	(118,119)
Saccharide Isomerate	Humectant	Natural/Synthetic	(133)
Cetearyl Alcohol	Surfactant – Emulsifying/ Emulsion Stabilising/ Emollient	Natural-derived/ Synthetic	(115–117)
Sodium Stearoyl Lactylate	Surfactant - Emulsifying	Natural-derived/ Synthetic	(134,135)
Parfum (Fragrance)	Fragrance	Natural/Synthetic	*
Acrylates/ C10-C30 Alkyl Acrylate Crosspolymer	Emulsion Stabilising/ Film forming/ Viscosity controlling	Synthetic	(136)
Caprylyl Glycol	Skin Conditioning - Emollient	Natural	(102,103)
Xanthan Gum	Binding/ Emulsion stabilizing, Skin-conditioning/ Surfactant – emulsifying/ Viscosity controlling	Natural	(110)
Tocopherol	Antioxidant	Natural (vegetable)	(109)
Helianthus Annuus Seed Oil	Skin Conditioning - Emollient, Fragrance	Natural (Vegetable)	(95)
Sodium Phytate	Chelating	Natural-derivate/Synthetic	(137)
Citric Acid	Buffering/ Chelating	Natural	(138)
Sodium Hydroxide	Buffering/ Denaturant	Synthetic	(106)
Sodium Benzoate (V/1)	Anticorrosive/ Preservative	Synthetic	(98)
Sodium Citrate	Buffering/ Chelating/ Fragrance	Natural-derivate	(138)
Citral (III/70)	Perfuming	Natural	*
Geraniol (III/78)	Perfuming	Natural	*

Limonene (III/88)	Perfuming	Natural	*
Linalool (III/85)	Perfuming	Natural	*

* – Supportive scientific bibliography not found

8.4 APIVITA – Laboratoires Dermatologiques D' Uriage Portugal:

Since 1979, Apivita develops traceable, sustainable and clean active formulations, offering effective natural beauty products, using the properties of Greek pure bee products. In brand's formulas, it's expected to found: naturality (prioritize natural ingredients, good for the environment and skin); traceability (network of registered local farmers and beekeepers); sustainability (protecting bees, safeguarding local biodiversity and reducing impact on the environment); ethics; efficacy (formulas designed with only the effective ingredients) and safety (raw materials evaluation, finished product tests and marketed product monitoring) (139). Apivita's environmental commitment impacts two main SDG's (11 – Sustainable cities and communities and 12 – Responsible production and consumption) (140) with:

a) Eco-friendly packaging
b) Bioclimatic headquarters - energy, water and waste management
c) Responsible partners - prioritize relation with regional producers and beekeepers.

Also certified as B-Corporation, which measures a company's entire social and environmental performance from supply chain and input materials to charitable giving and employee benefits (141), and also *1% for the planet* contributor of sun care and e-shop sales. The brand has a variety of products, from face and body care to sun and hair care products. The "Tonic Mountain Tea" is a common ingredient used in body care products, as shower gel and body milk, but also in APIVITA's face water. The product we're going to explore is **Tonic Mountain Tea Moisturizing Body Milk** (142), highlighting:

- Active Ingredients: The infusion of a combination of 3 organic *Sideritis* species from organic cultivations (replaces water, contributing as antioxidant and moisturizing); organic Malotira (antioxidant); organic bio-active aloe, panthenol, arginin, bisabolol and allantoin (moisturize and soft); organic olive

oil, the organic shea butter and almond oil (intensive nourishment and skin protection)

- Eco responsibility: Formula 96% of ingredients of natural origin. Bottle - 50% post-consumer recycled PET, 100% recyclable and pump currently non-recyclable. Label - PP, 100% recyclable.
- Product claims: Three claims of effectiveness *"moisturizes and softens the skin"*, *"provides natural antioxidant protection"* and *"revitalizes"* and one claim of security *"dermatologically tested"*. It is intended to apply after shower, for both, man and woman.

This last product has a lot of active ingredients with their origin described on the website as well as them contribute to the final formulation. It claims "dermatologically tested" although the results are not shown. In addition to the similarities with the previous product regarding allergens, this product has another particularity due to the extensive list of ingredients, which can lead us to question the contribution of all in the final formulation. Analyzing in better details – Table 4, formula contains PEG's (PEG-100 stearate and PEG-20 stearate), a class of ingredients that despite those ones being proof to be safe, have been involved in controversy, in part because of possible toxicity due to the presence of impurities during the manufacturing process. As well, bergamot oil contains furanocoumarins that have some documented phototoxic effects (143). Furocoumarins use is restricted in Annex II of Regulation (EC) No 1223/2009, except for normal content in natural essences used. Like the other products, this example also doesn´t show any certification.

Table 5 - Tonic Mountain Tea Moisturizing Body Milk

Tonic Mountain Tea Moisturizing Body Milk			
INCI/ Substance Name	**Function** (90–92)	**Origin**	**Reference**
Water	Solvent	Natural	(45)
Coco-Caprylate	Skin Conditioning/ Emollient	Natural (Vegetable)	(96)
Glycerin	Humectant/ Solvent/ Skin Conditioning	Natural/ Synthetic	(93)
Caprylic/Capric Triglyceride	Skin Conditioning, Perfuming	Natural / Synthetic	(94)
Glyceryl Stearate	Emollient/ Surfactant – Emulsifying	Natural-derivate/ synthetic	(118,119)
Cetearyl Alcohol	Surfactant – Emulsifying/ Emulsion stabilizing/ Emollient	Natural-derived/ Synthetic	(115,117)
Sorbitol	Humectant/ Skin Conditioning	Natural/Synthetic	(144)
PEG-100 Stearate	Surfactant - Cleansing	Natural-derivate/Synthetic	(145,146)
Parfum	Fragrance	Natural	*

Olea Europaea Fruit Oil	Fragrance/ Skin Conditioning	Natural (Vegetable)	(147)
Prunus Amygdalus Dulcis Oil	Skin Conditioning	Natural (Vegetable)	(95,148)
Butyrospermum Parkii (Shea) Butter	Skin Conditioning	Natural (Vegetable)	(95,114)
Polysorbate 20	Surfactant - Emulsifying	Natural-derivate/Synthetic	(105)
Water	Solvent	Natural	(45)
Honey	Humectant/ Skin Conditioning	Natural	(149)
Sideritis Perfoliata Flower/Leaf/Stem Extract	Antioxidant	Natural (Vegetable)	*
Sideritis Scardica Flower/Leaf/Stem Extract	Antioxidant/ Skin Conditioning	Natural (Vegetable)	*
Sideritis Raeseri Flower/Leaf/Stem Extract	Antioxidant	Natural (Vegetable)	*
Lavandula Angustifolia (Lavender) Flower Extract	Fragrance/ Refreshing	Natural (Vegetable)	*
Sideritis Syriaca Extract	Antioxidant/ Skin Conditioning	Natural (Vegetable)	*
Aloe Barbadensis Leaf Juice Powder	Skin Conditioning	Natural (Vegetable)	(150)
Eucalyptus Globulus Leaf Oil	Perfuming/Skin Conditioning	Natural (Vegetable)	(151)
Citrus Aurantium Bergamia (Bergamot) Peel Oil*	Perfuming	Natural (Vegetable)	(152)
Helianthus Annuus (Sunflower) Seed Oil	Skin Conditioning - Emollient, Fragrance	Natural (Vegetable)	(95)
Panthenol	Antistatic/ Skin Conditioning	Natural (Vegetable)/ Synthetic	(153)
Sodium Hyaluronate	Humectant/ Skin Conditioning	Natural	(126)
Arginine	Antistatic/ Skin Conditioning	Natural/ Natural-derivate	(121)
Bisabolol	Skin Conditioning/ Soothing	Natural	(154)
Allantoin	Skin Conditioning/ Soothing	Natural	(92,155)
Tocopherol	Antioxidant	Natural (vegetable)	(109)
Tocopheryl Acetate	Antioxidant/ Skin Conditioning	Natural (vegetable)	(109)
Phospholipids	Skin Conditioning	Natural	(156)
Capryloyl Glycerin/Sebacic Acid Copolymer	Film forming, Skin Conditioning/ Skin Protection	Natural-derivate/ synthetic	(91)
Ethylhexylglycerin	Skin conditioning	Synthetic	(123)
Sodium Acrylates Copolymer	Binding/ Film Forming	Synthetic	(91,136)
Xanthan Gum	Binding/ Emulsion stabilizing, Skin-conditioning/ Surfactant – emulsifying/ Viscosity controlling	Natural	(110)
Dehydroacetic Acid (V/13)	Preservative	Synthetic	(157)
Diheptyl Succinate	Skin conditioning - Emollient	Natural-derivate	(158)
PEG-20 Stearate	Humectant, Surfactant – emulsifying	Natural-derivate/Synthetic	(92)
Tetrasodium Glutamate Diacetate	Chelating	Natural-derivate/Synthetic	(159)
Polyglyceryl-10 Stearate	Skin conditioning	Natural derivate/Synthetic	(91,132)
Hydrogenated Polydecene	Fragrance, Skin conditioning - Emollient	Synthetic	(91,125)
Benzyl Alcohol (III/45)	Perfuming	Natural/Synthetic	(98,99)
Limonene (III/88)	Perfuming	Natural	*
Linalool (III/85)	Perfuming	Natural	*
Alpha-Isomethyl Ionone (III/90)	Perfuming	Natural	*
Coumarin (III/77)	Perfuming	Natural	*

Citral (III/70)	Perfuming	Natural	*
Geraniol (III/78)	Perfuming	Natural	*

9 Discussion

Over time, the way sustainability is impacting the cosmetic industry is undeniable. Several practices have been adopted around the product's life cycle in order to follow this change, and some strategies have been addressed throughout this work. However, it is also clear that there is still a long way to go, and further investigation to be made, namely about ingredients.

9.1 Product's Life Cycle

One of the main strategies in product's development is the replacement of unsustainable ingredients for sustainable alternatives, whether they are sustainable synthetic ingredients, or natural/organic sustainable ingredients, and this is an important message to keep: there are no perfect ingredients. Instead, it's necessary to assess the sustainable impact - ideally at an environmental, social and economic level – of an ingredient in comparison to its alternative. Furthermore, because many ingredients can be of animal, vegetable or synthetic origin, consumers cannot be certain of the ingredients source since the present EU legislation does not require the origin of ingredients to be explicit in labeling. This would be a great step forward for consumers to understand the true origin of the ingredients and make more informed decisions.

Related to this topic, another subject that deserves attention is the absence of a single certification for natural and organic products. It's important to emphasize that all existing certifications are private and national entities which have different criteria. Despite the efforts of EU, the lack of harmonization adds to the consumer confusion on this subject, and it's also necessary to guarantee that economic issues are not involved and that ethical issues overlap. Most existing certifications refer to the origin of ingredients (natural/ organic), although in the examples studied any of them mentions ISO 16128 which is the one who clarifies these concepts, and do not globally evaluate the sustainability of a product, since it is difficult to summarize it in just one accurate certification. In all analyzed products, despite the mention of the percentage of natural ingredients, none was associated with any certification of a third-party entity. If these certifications existed, this could lead to an increase in trust by consumers. Other symbols and certifications are used but doesn't necessarily mean that the finished cosmetic product is sustainable that is, there are symbols that have no relation to the

composition of the product, but are related to other brand's commitments, like *1% for the planet* certification.

In addition to the concerning environmental impacts of certain ingredients, there was also a great deal of controversy and doubt regarding the impact of some classes of ingredients on the human's health. Combining consumer's lack of knowledge with brands' willingness to follow trends led many brands to resort to greenwashing (43), misleading the consumer while making their products stand out. Several efforts have been made to overcome this issue, but many brands continue stating on websites that some ingredients recognized as harmful or controversial for health or the environment are excluded from formulations, such as parabens, silicones, formaldehyde and formaldehyde donors, phthalates, mineral oils, SLS, among others.

In recent years, the EU has been trying to regulate cosmetic products in a more controlled and rigorous way, and there are annexes in the regulation that ban or restrict the use of certain ingredients that have effectively demonstrated some potential or actual health risk (3), based on the principle of toxicology – *dose makes the effect*. This risk-based approach, coupled with solid regulations across the globe, is what has always allowed cosmetic brands to ensure their safety (160). Science has worked to gain the trust of consumers, investigating the effectiveness of ingredients while ensuring their safety. Furthermore, in some of the examples analyzed, efficacy tests which should support claims are not provided, which also demonstrates a still-existing lack of transparency. This demonstration of results, despite mandatory at a regulatory level (4), can also educate consumers and make them feel more secure about a product and its effectiveness.

9.2 EU Sustainable Goals

It is interesting to compare the goals established by EU until 2030 and the efforts that are being made, particularly in this industry. Brands are trying to align themselves with these goals, especially in terms of plastics, using biodegradable or recycled materials, as we can see in the examples analyzed. At the level of chemical substances despite the studies, there is still a lot of research that needs to be clarified in order to really understand which ingredients are harmful to health. However, in terms of waste, there are some efforts that are worth investigation. The choice of ingredients for the formulations already takes into account the environmental impact they can have at the end of the product's life cycle, but an approach that is still little explored by brands and

has been subject of study in FFUL and FCUL, is the reuse of natural by-products from some industries, such as coffee grounds (32), olive-oil (33) and cork by-products (161), which have demonstrated properties as active ingredients, also contributing to circular economy. In my point of view, other interesting challenge around this topic is, without a doubt, the balance between the economic growth that countries want to achieve and the circular economy, since it seems kind of incompatible to promote an ever-growing economy with the circular economy, which promotes the use of less materials and the continuous reuse of waste. As one of the EU's six priorities is to create *an economy that works for people*, with a more attractive investment environment and growth that creates quality jobs, especially for young people and small businesses (15), it is necessary to ensure sustainable economic growth that does not compromise the population's lifestyle.

9.3 Final considerations

Achieving a global world in which all aspects are regulated turns out to be very difficult, which is why, around sustainability the strategy must involve educating brands and consumers. In other words, it's important that we continue to question the ways in which the cosmetic industry communicates with us, making our choices, as consumers and pharmacists, based on evidence, always striving for transparency. It must be a civic duty to ensure the well-being of the population and the planet, with the help of the tools and guidance that have been built over the years. And it's in this process that pharmacists play a very important role. Starting with the pharmacist who may be involved in the production process, who investigates the ingredients in order to guarantee a better relationship between effectiveness and security. As well, the pharmacist working for a brand, who defines several other processes in the product life cycle, responsible for transparent, safe and scientific communication. And even more importantly, the community pharmacist who is the direct bridge between the consumer and the product and who can educate the consumer and advise them on the best product that meets their needs and promotes their well-being. Although the sale of cosmetic products has gained increasing importance in the digital channel, also due to the Covid-19 pandemic, in my opinion a mixed system will prevail for these products. Despite all the tools that have emerged, the pharmacy channel will always be a specialized channel, which, due to the pharmaceutical knowledge about products and brands, will always be

a place of trust sought by consumers for counseling, mainly to help solve different cosmetic problems.

All these interactions have room for improvement from the beginning of the cycle to the end of it and it's expected that once the limitations are overcome, the established goals will be met in order to achieve a sustainable development, both for the sake of human and planet health.

10 Conclusions

Sustainability is a word in the cosmetics agenda, both for brands and for consumers. The cosmetic industry has been trying to embrace it by adopting several practices in their processes through all the product's life cycle. Although there are still improvements and further investigation to be made.

Since a while ago, people and companies are searching for more sustainable products. One of the main steps is the search for "green" ingredients in alternative to the regular ones. In one hand, understanding the information in the marketplace is essential - not all synthetics are bad, nor all nature-base are good, or equivalent and the lack of uniformization of a single certification for natural and organic products adds confusion on this topic. Due to the lack of specific regulation for these products, in Portugal and in Europe, and the existence of a growing number of companies responsible for marketing cosmetics a lot of initiatives and associations have been working in cooperation with the aim of harmonizing the product communication by brands and consumer's perception.

In the other hand, companies are looking to make the transition to a circular economy, due to the goals established by the EU and the efforts that have been made at a global level, which also has a big impact on the product lifecycle, with an impact on the global waste crisis we are experiencing. Covid-19 pandemic came to force sustainable brands to evolve. At first, people searched for protection and focused on health, looking specially for home care. Then, in a medium-term people started looking for safe beauty preferences. In a long term, clean beauty is expected to be the standard, as well as sustainability, biotechnology and green techs.

In the future, the aim will be to ensure that a product is safe and effective, it's sustainable and conscious, and it's also clean and transparent. One of the biggest challenges is having a product with a high level of natural and non-controversial ingredients and maintaining its effectiveness, stability and being transparent in the product communication. In summary, this is a developing area of research requiring interdisciplinary investigation in order to meet consumer's and planet's needs, striving for a sustainable development.

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