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360 DEGREE SUSTAINABILITY IN COSMETICS

Shrutika Burde [1], Nibha Bajpai [2]

[1] Student [2] Assistant Professor

Post Graduate Department of Cosmetic Technology, LAD and Smt. RP College for Women, Seminary Hills, Nagpur, 440006, Maharashtra, India

Abstract: The cosmetics and personal care industry, due to its inherent characteristics, has been a contributor to global environmental problems such as climate change, waste generation, water scarcity, habitat destruction, as well as water and air pollution. Consequently, it has become more imperative than ever for companies in this industry to take responsibility and proactively address these environmental issues. The focus on sustainability in the cosmetics sector has recently been on packaging materials, but there are other ways to address the world's environmental issues. Sustainability should begin with the ingredients used and continue through the product's entire decomposition into the environment. It should also consider the product's social influence on the user. The aim of this article is to outline a comprehensive approach for the cosmetics and personal care industry to address environmental challenges and promote sustainability. This approach encompasses various aspects including ingredient sourcing, product formulation, production processes, packaging solutions, social responsibility, consumer education, collaboration, and transparency. By considering these factors, the industry should minimize its environmental impact, and contribute to a more sustainable future.

Introduction

Human demands on the planet's ecosystems have beyond Earth's biological capacity, according to a Worldwide Fund for Nature (WWF) assessment released in late 1980s. To put it simply, the rate at which people waste natural resources exceeds the rate at which nature can replenish itself. "We are living further than our possibilities, and the choices we make today will define the chances of our next generation," (1) By living beyond our means, we are depleting essential resources such as fresh water, forests, and fertile land. This over utilization leads to various environmental problems including deforestation, water scarcity, soil degradation, loss of biodiversity, and climate change. These issues not only threaten the stability of ecosystems but also have profound impacts on human societies, including food and water security, health risks, and social instability. Thus establishing a sustainable future is essential so we can ensure sufficient resources for the survival of coming generations.

The personal care and cosmetics industries has contributed to environmental problems around the world, including waste, water scarcity, habitat destruction, climate change, and air and water pollution. As a result, it is more crucial than ever for the manufacturers of personal care and cosmetics to handle environmental challenges in a responsible and proactive manner.(2)The word “sustainability” originates from the Latin world “sustainer” meaning “to bear “. In 1987 the “brundland commission” set up by the United Nations (UN) published their report as “our common future” and defined “sustainable development” for the first time as

"development that meets the need of the present without compromising the ability of the future generation to meet their needs" Sustainability can be translated simple as long term compatibility.(3)

Sustainability should be viewed holistically rather than only referring to environmentally friendly chemicals or sustainable product packaging, therefore a "360-degree" approach should involves considering sustainability at every stage of the its life cycle, from initial purchase to eventual disposal. To reduce waste and harm, we should all think about ways to consume less, reuse, recycle, and refurbish equipment.(4)

Three Pillars of Sustainability-

360-degree sustainability involves practices and strategies that maintain environmental balance, promote economic prosperity, and enhance the quality of social life for everyone, aligning with the three pillars of sustainability. The three-pillar conception of (social, economic and environmental) sustainability, commonly represented by three intersecting circles with overall sustainability at the centre, has become universal. Three pillars of sustainability representation highlights the interconnections of environmental, economic, and social factors and emphasizes the need for integrated approaches to sustainability.(Figure -1) Achieving 360-degree sustainability requires balancing and optimizing actions across all three dimensions to ensure that environmental, economic, and social goals are pursued in harmony. Organizations, communities, and societies may bring about a future that is more resilient, equitable, and wealthy for everybody by embracing holistic and integrated approaches to sustainability.(5)

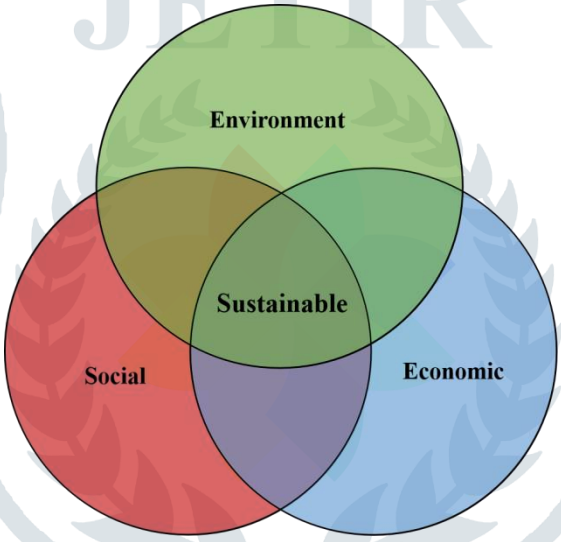

Figure 1 - Three Pillars of Sustainability

Achieving 360-degree sustainability in the cosmetics and personal care industry requires a comprehensive and integrated approach that addresses environmental, economic, and social dimensions which are discuss below

Environment-

Everything revolves around the environment, thus when sustainability is considered, the environment rightly takes center stage due to its critical importance. Almost every aspect of our daily existence, including our diets, the quality of the air we breathe, the water we drink, and the environments we live in, is significantly influenced by environmental factors. As such, the health and well-being of the environment directly impact human health, economic prosperity, social stability, and overall quality of life. This pillar focuses on preserving and protecting natural resources, ecosystems, and biodiversity. Practices and strategies within environmental sustainability include reducing greenhouse gas emissions, conserving water and energy, promoting renewable energy sources, minimizing pollution and waste generation, preserving habitats and biodiversity, and mitigating the impacts of climate change. Environmental sustainability ensures that human activities do not exceed the Earth's carrying capacity and that ecosystems can regenerate and thrive over time. Additionally, environmental sustainability encompasses efforts to minimize the cosmetic impact of human activities on the environment, ensuring that our actions maintain the aesthetic integrity of natural landscapes and minimize visual pollution.(6)

Economic -

Economic sustainability involves ensuring long term prosperity and stability by managing resources efficiently, fostering economic growth, and promoting equitable distribution of wealth and opportunities. This pillar emphasizes the importance of balancing economic development with environmental protection and social equity. Economic pillar highlights the delicate balance that industry and corporations must strike between pursuing economic growth and ensuring sustainability. While the profit-driven mindset is often inherent in industrial operations, it is essential for companies to recognize that their success relies on the resources provided by the environment and society, both natural and human. Industry depend on natural resources such as water, energy, raw materials, and ecosystems services to produce goods and services. Similarly, they rely on human resources, including employees, customers, communities, and stakeholders, to operate effectively and generate revenue. Without these resources, industry would not be able to function or thrive.
In acknowledgment of this interdependence, it becomes imperative for enterprise to embrace economic sustainability as a guiding principle. (7)

Social-

Social sustainability is indeed a crucial pillar of overall sustainability, yet it may not always receive as much attention as environmental and economic sustainability. However, its importance cannot be overstated, as it directly impacts the well-being and quality of life of individuals, communities, and society as a whole. Social sustainability focuses on promoting equity, justice, and well-being within communities and societies. It encompasses factors such as human rights, social cohesion, health and safety, education, access to basic services, cultural diversity, and social inclusion. Socially sustainable practices and strategies aim to address issues such as poverty, inequality, discrimination, and social exclusion while promoting human dignity, empowerment, and participation. Social sustainability is about creating a society where everyone can live with dignity, equality, and opportunity, while also fostering resilience, cohesion, and well-being.(8)
The three pillars of sustainability are crucial in shaping the future of the cosmetic industry. By integrating these pillars, the industry can enhance its reputation and consumer trust while contributing to a more sustainable and equitable world.

Sustainability in Cosmetic Manufacturing

Cosmetics are products applied to the body for the purpose of beautifying, cleansing or improving appearance and enhancing attractive features. (9)
The manufacturing of cosmetics involves a variety of components and processes. Achieving 360-degree sustainability in the manufacturing of cosmetic products involves considering sustainability across all steps of the production process. Cosmetics production involves three main steps which are discuss below.

A. Ingredient Sourcing and Selection
B. Manufacturing of Cosmetic product
C. Packaging

Ingredient Sourcing and Selection

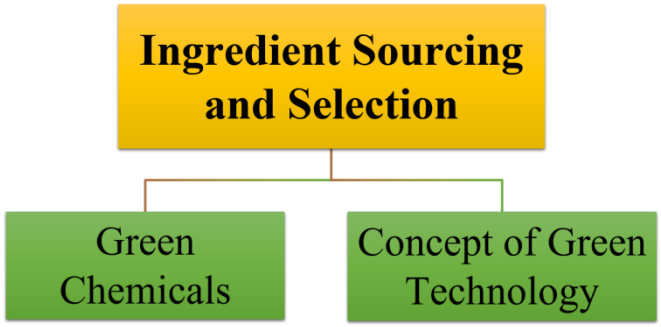

Figure 2 - Ingredient Sourcing and Selection

Green Chemicals

The formulation of cosmetics and personal care products uses a variety of chemicals as raw materials. These substances might come from synthetic, natural, or organic sources. While they might be safe for human skin and hair, they are not always good for the environment. Thus, the term "green chemicals" became popular. Nowadays, the term "green" is frequently used interchangeably with "organic" or "healthy" in marketing. In the context of the cosmetics industry, natural components derived from renewable raw materials are used to create "green" and "sustainable" cosmetic products.(10) In the cosmetics industry, the concept of "green chemicals" or "green ingredients" refers to substances that are derived from renewable raw materials and are produced using environmentally friendly processes. These green chemicals are often preferred over traditional synthetic chemicals due to their reduced environmental impact and potential health benefits.(11)

Concept of Green Technology

Green technology, also known as Clean technology or Eco-technology, refers to the development and application of innovative solutions that minimize environmental impact, conserve natural resources, and promote sustainability across various industries, including manufacturing, energy, transportation, and construction.(12) The product with the "green" feature may be viewed as being different from the others. The phrase "eco-friendly" denotes consideration for the life cycle, the production process, and additional elements such as the application of clean technology, the wise use of natural resources, product certifications, and biodegradable packaging.(13) The concept of green technology encompasses not only the products themselves but also the processes and systems used to create, distribute, and dispose of them in an environmentally responsible manner.

Green products are those that meet consumer expectations and can be improved or developed in accordance with environmental standards (Figure - 3) offering a number of benefits like:

- Reducing the use of raw material and packaging
- Developing multiple utility products,using recycled materials
- Reducing the use of natural resources
- Making products safer for health and non toxic for the environment
- Increasing the lifetime of the products
- Developing reusable products or packaging,
- Obtaining products for re-manufacture, recycling as well as recovering products for recycling. Designing products that can be buried or incinerated
- Designing products that can be converted into fertilizers [14]

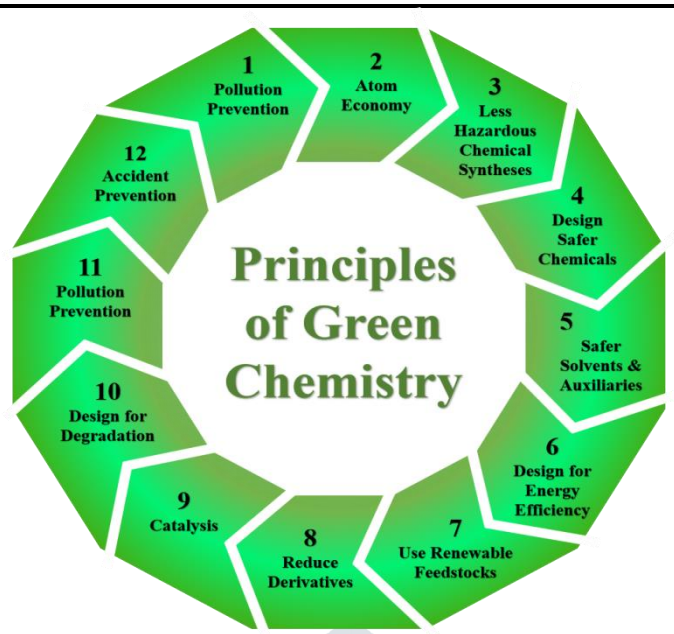

Figure 3 - Principles of Green Chemistry

Manufacturing of Cosmetic Product

The formulation of cosmetic products necessitates the use of various chemicals, including active agents and base materials, to achieve desired effects. Throughout the manufacturing process, significant quantities of water and energy are consumed. Water serves as a solvent, carrier, and component in various stages of production, while energy powers machinery and facilitates heating and mixing processes. However, this large-scale manufacturing inevitably generates waste, contributing to environmental concerns. All these points should be considered to achieve 360 degree sustainability that are explained in (Figure- 4)

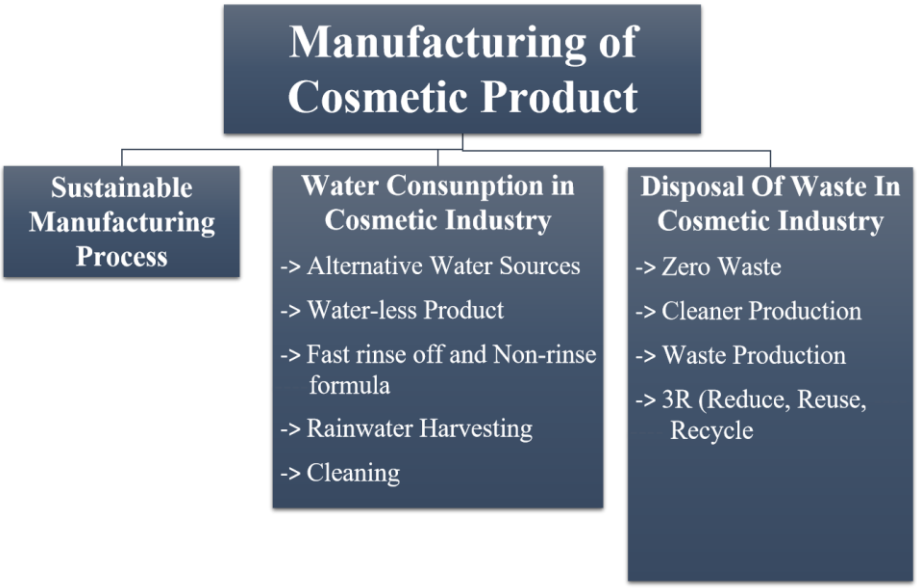

Figure 4 - Manufacturing of Cosmetic Product

Sustainable Manufacturing Processes

Environmental pollution is the result of human activity that adversely alters natural elemental qualities and significantly affects living conditions. The primary process of environmental pollution starts from the emission of polluting agents, Immission is the term describing the value of pollution at a point. It can refer to the concentration of a pollutant in the air caused by the aggregate effect of the emission of all sources modified by the transmission.(15) The cosmetics industry heavily depends on chemical energy sources and components, leading to the production of carbon emissions throughout every stage of the process, including raw material supply, manufacturing, transportation, and disposal. These emissions are consistently increasing over time.

Example, when Shea butter is sourced conventionally and used as a finished cosmetic product, it releases 10.374 kg CO2 equivalent per kg in the preceding stage.(16)

The packaging materials used in cosmetics, particularly plastics, also entail substantial energy consumption during both production and disposal phases. These steps collectively contribute to the energy demands of production. The primary sources of energy for these processes are fossil fuels like coal and oil, which emit carbon dioxide and other greenhouse gases when burned, contributing to climate change.(17) Thus, industries are increasingly pursuing the development and use of innovative technologies that reduce the environmental as well as carbon footprints which are know as Green Manufacturing.

A manufacturing technique known as "green manufacturing"of cosmetic products aims at minimizing the effects of environmental crises. It seeks to modernize outdated production methods by embracing sustainable solutions that minimize waste generation, thus reducing the likelihood and impact of environmental disasters. Green manufacturing is the process of transforming industrial processes and establishing environmentally sustainable enterprises. (Figure- 5) Green Manufacturing basically means less use of natural resources, produce less waste and pollution, recycle and reuse materials, and reduce emissions in their operations. Green manufacturers are also exploring new technologies and methods to lessen their environmental impact, aiming to reduce emissions and make their operations more sustainable overall. Examples of Green Manufacturing process are as follows :

- Decrease of temperature during manufacturing by decreasing energy consumption and CO_2 emissions.
- Using renewable energy sources like wind, solar, and geothermal to power industrial processes.
- The insulation of buildings aims to decrease the energy used for climate control purposes.
- Use of more energy-efficient modern equipment. (18)

Figure 5 - Green Manufacturing Cycle

Water Consumption in Cosmetic Industry

The cosmetics and personal care industries consume substantial amounts of water. In the process of manufacturing cosmetic products, an enormous amount of water can be utilized either directly or indirectly.(19) The majority of cosmetic products use water as their primary ingredient, which is typically designated on the product label as "Aqua" under the International Nomenclature of Cosmetic Ingredients (INCI)(20).Water typically constitutes over two-thirds of a formula's volume, exceeding the quantity of other ingredients. As an illustration, a typical cream has between 60 and 80% water, a lotion has up to 90% water, and a shower gel or shampoo has up to 95% water. Growing and processing raw materials such as palm oil or algae requires a lot of water, which can lead to water shortages in areas with limited water resources.Water serves various purposes in cosmetic production, such as, mixing, cooling, as a solvent or carrier to extract or dissolve active

ingredients from natural sources. In manufacturing, water is essential for blending ingredients, adjusting product consistency, and cleaning equipment.(21)

Over the next 12 to 15 years, India's water consumption will rise by more than 50%, but the supply will only rise by 5% to 10%. The majority of people would suffer most from this water shortage crisis, especially those who are underprivileged and dependent on agriculture.(22) Thus, the key actions listed below should be taken to recycle and preserve water.

Water Management

- **Alternative water sources-** Waterless products should be formulated with alternative water sources such as glacier waters, floral water, birch tree water, rice water, fruit and vegetable waters.

- **Water- less product** - Waterless products utilize cold emulsification technology, which eliminates the need of water for cooling and heating processes, simplifying production. This technology enables precise control over the emulsion structure, reducing production time, boosting productivity, and conserving both water and energy resources.

- **Fast rinse-off and non-rinse formulas** - The cosmetics company can also prevent water waste by creating compositions that rinse quickly or don't require rinsing. Companies can adjust their product's ingredients to use less water when it comes to skin or hair cleaning and conditioning treatments that must be rinsed after use.

- **Rainwater harvesting** - Rainwater harvesting has the potential to save 30% on main water consumption and up to 75% on potable water expenses. Rainwater harvesting systems collect rainwater from the building's roof, filter it, store it in storage tanks, and recirculate it for various purposes, including powering cooling systems, flushing toilets, and irrigating land. (Figure- 6)

- **Cleaning** - In cosmetics industry most water is used in cleaning production equipment, materials and packaging lines, and for maintaining strict hygiene standards. Companies need to find ways to use less washing water such as line production of products, high-pressure water jets from nozzles to clean out tanks, which are more efficient and require less water than traditional procedures. Continuous manufacturing (CM) plants need less floor space since multi-step equipment and quality control are combined in a single unit housed in one room with one air/water system and one common access port (23).

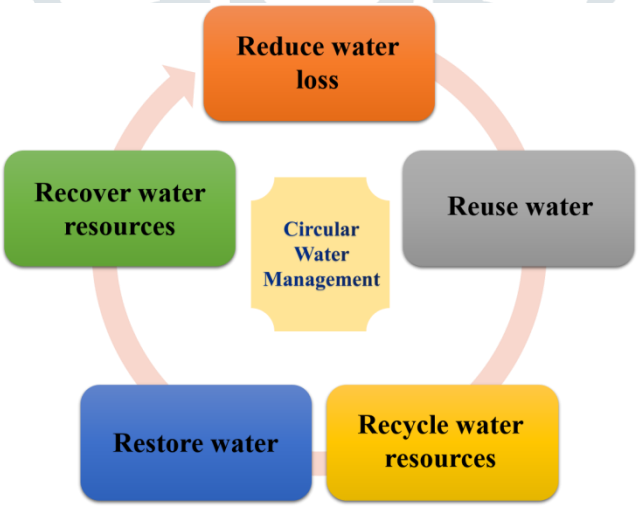

Figure 6 - Circular Water Management

Disposal of Waste in Cosmetic Industry

An increase in industrialization without enough planning or regulation results in improper disposal of industrial waste into the environment. Toxic metals and synthetic chemical pollutants are two of the main causes of

seepage resulting from improper application and disposal of heavy metals. A portion of them typically make their way into the food chain, where they disturb or deteriorate the biotic cycle and endanger the existence of entire populations of species. (24).

It has been discovered that a number of chemicals present in makeup and personal care products, including pigments, perfumes, surfactants, preservatives, and sunscreens, are hazardous. These chemicals enter rivers, lakes, and seas through sewers after being flushed out of the human body by water. As it is on a cotton pad, it is also discarded into the wild. The aquatic ecosystems' equilibrium is negatively impacted by certain chemical components.(25) Residues from personal care products, such as organic UV filters, scrubs, exfoliants, toothpaste, hand sanitizers, shampoos, and soaps, contain microplastics are found in aquatic ecosystems, including drinking water, groundwater, and surface water.(26) Many cosmetics and personal care products, including microplastics smaller than 5 mm, travel through rivers, lakes, and oceans after passing through filtration systems, spreading from one ocean to another. When aquatic animals like fish and shellfish consume them, it poses a risk to human health.(27)

Waste Management Approaches -

- **Zero waste** - The Zero waste approach considers waste as a useful resource rather than as an issue for industries, with a focus on waste reduction, minimization, and reuse. It aims to make the best use of the concept material and incorporates all material inputs into the finished product or converts them into different inputs for various procedures.

- **Cleaner production** - In adopting a waste management approach, cleaner production aims for increased productivity and environmental sustainability while minimizing negative environmental impacts. It emphasizes efficient use of raw materials, reduced energy and water consumption, lower emissions, and cost-effective product design, also known as Eco-design, to minimize waste generation and enhance resource efficiency.

- **Waste prevention** - The goal of waste prevention is to reduce waste both quantitatively and qualitatively that is, to reduce quantities and toxicity of materials and products before they are turned into waste. The top three steps of the hierarchy that is prevention, reduction, and reuse are interconnected and contribute significantly to achieving sustainable waste management practices.(28)

- **3R (Reduce, Reuse, Recycle)**- Every effort should be made to avoid creating excessive waste and to use it for other purposes, such as using the unnecessary products. Reduction, often known as waste prevention, refers to cutting back on consumption and waste. Industry should be the first to reduce waste by using less material and creating less trash during the manufacturing processes. Reusing a substance simply means putting it to use in its original or modified form again. The act of gathering and sorting items from waste and then processing them to make products that can be sold is known as recycling

Packaging of Cosmetic Products-

Cosmetic products need to packed suitably to maintained it efficacy, for protecting product from environmental hazard, transportation and storage. The U.S. Environmental Protection Agency reports that the beauty business generates 120 billion packaging units of beauty products every year, which makes up one-third of landfill garbage (29). Plastic is primarily used in packaging, accounting for nearly half of all plastic waste produced. Of that amount, only 2% is recycled into new packaging materials worldwide; the remainder is either burned or ends up in landfills, waterways, and the environment (30).

Paper products are extensively utilized in global packaging production, serving purposes such as wrappings, labels, unit packaging, and especially transport packaging. Their appeal lies mainly in their biodegradability. However, during this decomposition process, methane, a greenhouse gas, is emitted. Glass serves as another key material in packaging production. These packages are primarily prized for their aesthetic appeal and chemical inertness. Nonetheless, their manufacturing process is energy-intensive, incurring costs and contributing to greenhouse gas emissions. Additionally, glass is non-biodegradable.(31) Consequently, there is

a rise in demand for green packaging, Green packaging alternatively termed as 'Eco-green packaging,' 'eco-friendly packaging,' 'sustainable packaging,' or 'recyclable packaging,' employs environmentally friendly materials for packaging, prioritizing the effectiveness and safety of products for both human health and the environment.(32) Some example of Green packaging materials are as follows (figure- 7)

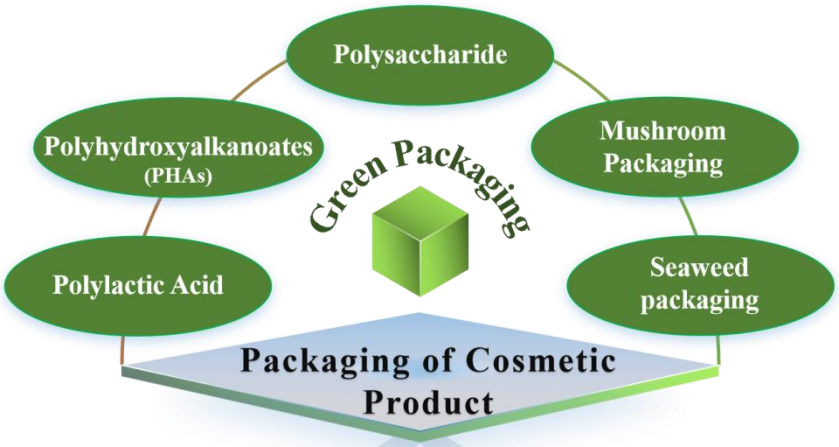

Figure 7- Green Packaging Materials

Green packaging materials

- **Poly-lactic acid (PLA)-** PLA is a chemical synthesizing of bio-based monomers which is mainly composed of lactic acid (2-hydroxy propionic acid) as they have good process ability and bio-compatibility

Figure 8 - Polylactic acid Bottles

- **Polyhydroxyalkanoates (PHAs) -** PHAs polymers are naturally produced by bacteria in general cultivated biomass. Biodegradable polymers are gaining attention for their promising properties, including high biodegradability in various environments beyond just composting plants, and their versatility. PHAs can be formulated and processed for use in many applications, including packaging, molded goods, paper coatings, non woven fabrics and adhesives.

Figure 9- Polyhydroxyalkanoates Bottles

- **Polysaccharides-** They directly extracted from bio-polymer such as cellulose, starch, galactomannans. Cellulose is the most abundantly occurring natural polymer on earth thus are the most utilized polysaccharides for packaging production, and more recently even chitosan and chitin have been proposed in particular for the production of active packaging due to their anti-microbial activity. (33,34)

Figure 10 - Poylsaccharides Bottles

- **Mushroom packaging** - It is indeed crafted from actual mushrooms. This innovative process involves blending pre-cleaned agricultural waste with mushroom roots. The resulting material is molded into the desired shape, dried, and utilized as packaging. Since agricultural waste isn't suitable for consumption, mushroom packaging circumvents the ethical concerns associated with corn starch packaging. Moreover, it naturally decomposes at a rapid pace. However, its practicality is currently limited to smaller items despite its potential as a sustainable packaging solution.

Figure 11 - Mushroom Packaging

- **Seaweed Packaging -** Seaweed serves as a sustainable packaging alternative derived from agar, a gel-like substance abundant in various seaweeds and algae. Through extraction and dehydration processes, agar is transformed into a packaging material suitable for various applications. With its origin in a plentiful and renewable resource, seaweed packaging has the potential to emerge as a prominent trend in eco-friendly packaging solutions. (35)

Figure 12 - Seaweed Packaging

Conclusions

The integration of the three pillars of sustainability environmental, economic, and social into the cosmetics industry is essential for creating a more sustainable and responsible sector. By adopting a 360-degree approach to sustainability, the cosmetics industry can significantly reduce its environmental footprint, foster economic stability, and enhance social well-being.

- **Environmental Sustainability:** The cosmetics industry heavily impacts the environment through resource extraction, manufacturing processes, and waste generation. Embracing green chemicals and technologies, optimizing manufacturing processes, and implementing effective water and waste management strategies are crucial steps. Utilizing renewable energy, reducing water consumption, and adopting green manufacturing techniques can substantially lower the industry's environmental impact. Furthermore, promoting eco-friendly packaging materials, such as bioplastics, polysaccharides, mushroom, and seaweed packaging, can reduce reliance on traditional plastics and decrease pollution.
- **Economic Sustainability:** Economic sustainability in the cosmetics industry involves balancing profit-making with responsible resource management and equitable wealth distribution. Companies need to recognize their dependence on natural and human resources and strive to operate efficiently while minimizing environmental degradation. Sustainable business practices, such as investing in green technologies and fostering innovation, can lead to long-term economic benefits. By adopting sustainable

practices, companies not only enhance their reputation and consumer trust but also ensure the longevity of their operations in a resource-constrained world.

- **Social Sustainability:** Social sustainability focuses on improving the quality of life for individuals and communities. The cosmetics industry can contribute by ensuring fair labor practices, promoting diversity and inclusion, and supporting community development initiatives. Additionally, educating consumers about sustainable products and practices can empower them to make environmentally conscious choices. Addressing social issues such as poverty, inequality, and health and safety within the industry and its supply chains can foster social cohesion and resilience.

In conclusion, the cosmetics industry has a significant role to play in advancing global sustainability goals. By integrating environmental, economic, and social sustainability into every aspect of their operations from ingredient sourcing and product formulation to packaging and waste management companies can lead the way towards a more sustainable future. This holistic approach not only benefits the planet and society but also enhances the industry's resilience and long-term profitability. Through collective efforts and innovative solutions, the cosmetics industry can contribute to a more sustainable, equitable, and prosperous world.

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