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Review Article

Biotech beauty: a novel perspective in cosmetics

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ABSTRACT

The cosmetics and personal care industry has in the past responded to environmental and health concerns associated with its ingredients, evidenced by the fact that many companies have moved to eliminate dangerous solvents, volatile organic compounds, heavy metals, and other toxins from their formulations. The beauty industry is moving ever faster towards a clean and sustainable future. Modern technologies play a big role in this process. Today, biotech-derived cosmetic raw materials are gaining popularity not only because of their effectiveness and safety but also by protecting the environment. Biotech ingredients are widely used in several cosmetic product formulations. Key players in the market are using these ingredients as they are more sustainable and efficacious as compared to petroleum-based products. Besides, the use of biotechnology in developing active ingredients for use in cosmetic products is cost-effective and generates a low carbon footprint, thereby making it more favorable. This is expected to boost the growth of the active ingredients segment over the forecast period. Sustainability can be beautiful and beauty can be sustainable.

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INTRODUCTION

Biotechnology is defined as the application of knowledge in life sciences to create products or services that are beneficial to humans, being used to improve the quality and efficiency of the production of cosmetic active ingredients, drugs, and vaccines.

Biotechnology is a type of laboratory technology that is used to replicate endangered elements to better people's lives, or in the case of beauty, skin, or to help address an old problem. Biotechnology is defined as the application of knowledge in life sciences to create products or services that are beneficial to humans, being used to improve the quality and efficiency of the production of cosmetic active ingredients, drugs, and vaccines. Biotechnology has such a wide range of applications that it may now be used in practically any industry. It means that these industries will be able to develop new or improved items more quickly and efficiently. Biotechnology is used by cosmetics industries to find, develop, and create cosmetic formulation components, as well as to examine the activity of these components on the skin, particularly how they affect aging changes (Gomes et al., 2020). Biotech beauty is a concept that defines lab-made elements that either blend elements of nature with synthetic chemicals or produce synthetic alternatives to natural ingredients. It is a perfect blending of science and nature. Our planet's resources are scarce, and biotechnology allows us to replicate powerful natural ingredients without environmental pollution or harming the ecosystems (Alyssa Montemurro, 2021). It prevents resource exhaustion by reducing over consumption. This is because growing ingredients lets businesses get their raw resources without the negative consequences of fishing, farming, extraction, or other operations that often raise prices and increase carbon emissions. We will describe why biotech

beauty is crucial for the future of the beauty business, why biotech beauty products are sustainable, and how they are environmentally friendly in this review, as well as the products of firms that employ this technology (Hannah, 2022). The use of biotechnology-derived components, genetic profiling for specific skin-care or nutritional regimes, stem-cell-based products and therapies to rejuvenate aging tissues, or cell and tissue engineering for cosmetic goals are all examples of the next wave of cosmetics (Rinaldi, 2008). Biotechnology employs fermentation technology to commercially produce a variety of primary and secondary metabolites from microorganisms, plants, and animal cells. Due to their fascinating skin- and hair-care functions and potential to replace dangerous synthetic chemicals, the cosmetic industry has been employing several biotechnologically produced compounds in their cosmetic compositions (Pandey et al., 2015).

The negative aspects of the beauty industry

The beauty industry has long been chastised for its role in polluting and degrading the environment. Their product formulations contaminate soil and water packaging more than they did in 1960 as the leading user and polluter of single-use plastic, but most of the plastics also end up in a landfill. As a result, it is necessary to transition to renewable raw resources, employ "greener" components, and use sustainable packaging. This is why, to create a sustainable beauty industry, biotechnology or biotech is becoming the preferred choice among beauty fans and brands (Preeti, 2020).

The unsustainable usage of natural resources is not exclusive to the beauty business. Natural resources that aren't renewable, such as fossil fuels and metals, are also impacted. The many fossil fuel-derived components used in cosmetic products and packaging have a large carbon footprint. Carbon pollution is a major problem even when natural components are harvested and processed in non-sustainable methods. Producers have removed large tracts of natural forests to make way for plantations that supply an abundance of plant-based raw materials for the cosmetics industry. Large-scale industrial deforestation has made a considerable contribution to global warming (Okafor, 2021).

Environmental benefits of biotechnology

Aside from improved safety and efficacy, biotechnology's capacity to generate organically based products while minimizing environmental impact remains the driving force behind the movement. By lowering harmful chemical pollutants and greenhouse gas emissions, new industrial and environmental biotechnology developments are helping to make manufacturing processes cleaner and more efficient. Greenhouse gas emissions are also reduced by renewable biofuels made from algae and other cellulosic materials (Alyssa, 2021). The responsible application of biotechnology for economic, social, and environmental benefits is inherently appealing, and it has resulted in a spectacular evolution of research from traditional fermentation technologies to modern techniques (gene technology, recombinant DNA technologies) for efficient synthesis of low toxicity products, renewable bioenergy, and new environmental monitoring methods. The demand for alternative chemicals, fuel feedstocks, and a wide range of commercial products has risen dramatically in the early twenty-first century, owing to the high price of petroleum, policies to promote alternatives and reduce reliance on foreign oil, and increased efforts to reduce net carbon dioxide and other greenhouse gas emissions (Gavrilescu, 2010).

Industrial biotechnology (white biotechnology) focuses on employing biological organisms to generate or alter goods in a way that benefits the industry. It creates goods and processes that produce less waste and protects natural non-renewable resources as a consequence of cleaner manufacturing, such as manufacturing with less pollution or using fewer raw materials (Gavrilescu, 2010). Industrial biotechnology, which is based on renewable resources, may save energy in manufacturing processes and cut CO2 emissions dramatically. It boosts economic growth while also conserving water, energy, and raw resources, as well as reducing waste generation. Industrial biotechnology has the potential to eliminate the use of finite fossil fuels as starting materials, but it competes with consumable feedstocks in some cases (OECD, 2011).

Impact of biotechnology on cosmetics

A variety of chemical compounds have been widely employed in cosmetics, although they have the potential for negative side effects. Herbal cosmetics, which contain plant extracts, have gained consumer attention and have formed a niche in the cosmetics and personal care market since the early 1990s, owing to the side effects and environmental repercussions of chemical chemicals. Certain microbial-derived chemicals have demonstrated fascinating skin and hair-care qualities, making them useful active ingredients in cosmetic formulations (Pandey et al., 2015). The improved safety and performance of skin care products are one of the distinctive advantages of biotechnology. When genetically modified microorganisms generate active substances, this technique provides for greater consistency and quality control in the manufacturing process.

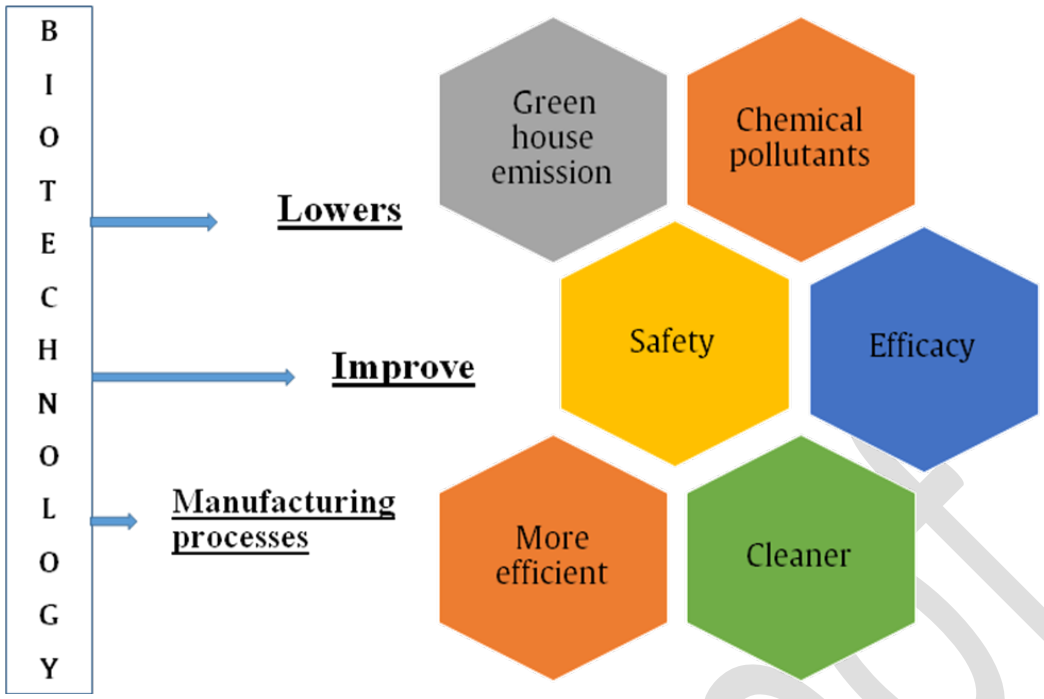

Figure 1. Benefits of biotechnology.

Formulators can better regulate the growth and development of these components since they are cultivated in a controlled environment, reducing the risk of contaminants and abnormalities (Alyssa, 2021). Biotechnology-derived ingredients, genetic profiling for specific skin-care or nutritional regimes, stem-cell-based treatments and therapies to rejuvenate aging tissues, and cell and tissue engineering for aesthetic reasons are all examples of biotechnology-derived ingredients. Cosmetics will make use of technology that enables observable outcomes to be achieved through topical application (Rinaldi, 2008). Biotechnology is used by cosmetics businesses to find, develop, and create cosmetic formulation components, as well as to analyze the activity of these components on the skin, particularly how they affect aging changes. As a result, biotechnology is a viable alternative for producing active substances that can reduce the aging process (Gomes et al., 2020).

Green beauty

Green isn't only the latest attractive color; it's also a way to protect our planet and the people who live on it. "Green technology" or "Sustainability technologies" refers to a constantly growing range of methods and materials ranging from energy generation techniques to non-toxic cleaning solutions. New raw material extraction methods from natural resources and botanicals, as well as enhanced production processes and updated emulsification techniques, are now bringing new ideas and chances to create cosmetic products more chemical-free and sustainable. It allows for more efficient resource usage and reduces environmental stress (Feng, 2016). A cosmetic can be considered "green" if it contains active ingredients derived from plants, such as minerals and plants, rather than analogous active ingredients chemically reproduced in the lab, and it is manufactured in an environmentally sustainable manner using processing methods that respect nature and plants grown according to organic crops (Dini and Laneri, 2021).

The word "eco-friendly" denotes that the manufacturing process, the life cycle, and other elements, such as the use of clean technology, the efficient use of natural resources, product certifications, and biodegradable packaging, are all taken into consideration. Green products have the same qualities and functions as regular products, but they cause less environmental harm throughout their lives, and they contain features that help to reduce their environmental effect (Poku, 2021).

The rising need for sustainability in the beauty industry has spawned a slew of green beauty micro-trends, the most recent of which is biotech beauty. With the growth of biotech beauty, more effective substances that are not only safe for humans but also for the environment are becoming available (Hannah, 2022). Clean beauty should imply items made with cutting-edge components that are healthy for people while not depleting the environment or causing excessive pollution. Basically, wherever feasible, helping the environment. In such circumstances, biotechnology is the best sector to deliver pure clean beauty (Poku, 2021).

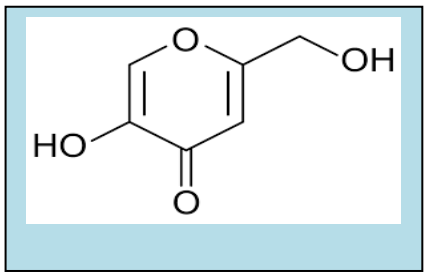

Figure 2. Kojic acid.

Kojic acid (*Aspergillus oryzae*)

The term "kojic acid" comes from the Japanese word "koji." In cosmetic formulations, kojic acid is utilized as skin whitening, skin lightening, or depigmenting ingredient. It is also made from the fermentation of various Asian foods (such as soy sauce and rice wine), and it serves as a fungus or inoculum primer. Various species of *Penicillium* and *Acetobacter*, as well as acetic acid bacilli, generate it naturally (Saeedi et al., 2019).

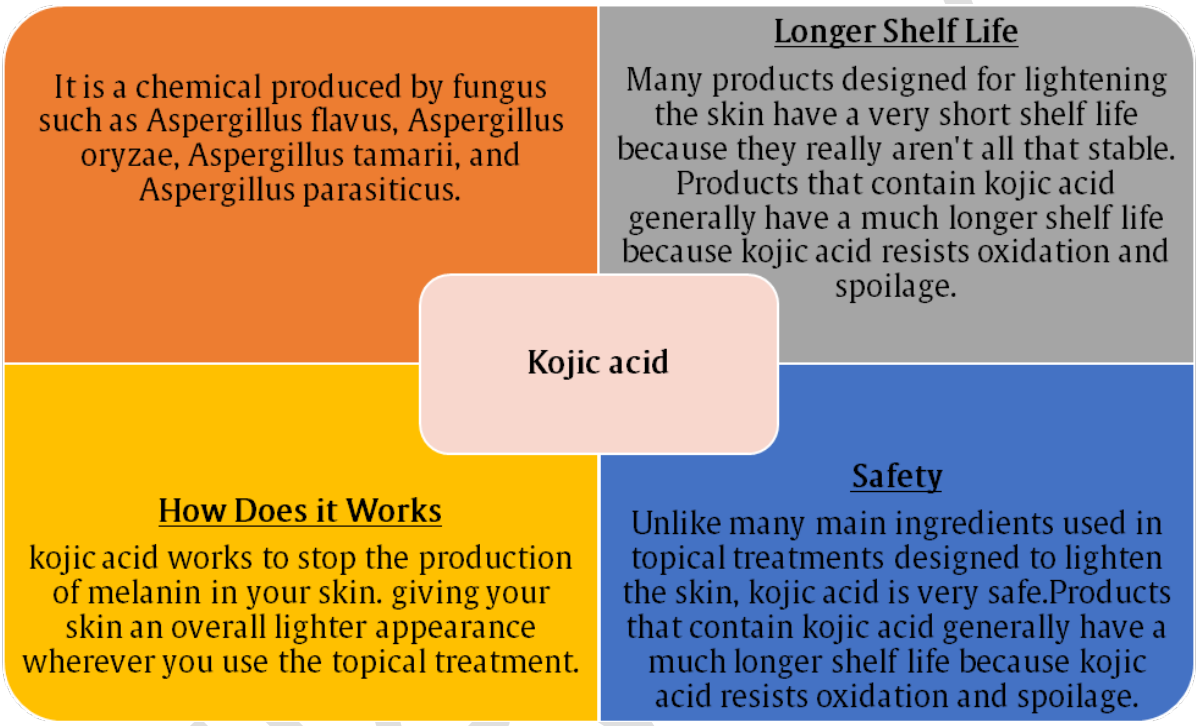

Figure 3. Kojic acid properties.

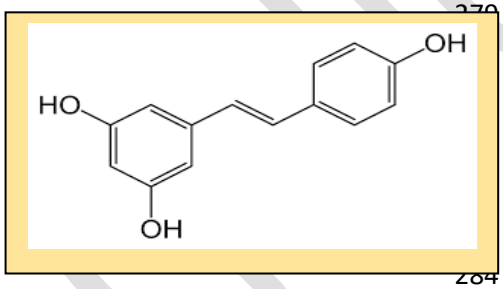

Figure 4. Resveratrol.

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Active ingredients obtained by biotechnology :

"Active ingredients" or "cosmeceuticals" are compounds utilized in cosmetic formulas to achieve demonstrated local biologic effects and are obtained using biotechnological procedures. Biotechnology has had a significant influence on the cosmetics industry. Biotechnology is used by cosmetic firms to find, develop, and create cosmetic formula components, as well as to analyze the activity of these components on the skin, particularly how they affect aging changes. Bio-sustainable ingredients are simply better for the environment, as both the industry and consumers are now aware (Zappelli, 2016). Several chemical compounds have been utilized in cosmetics, and some of them may have unfavorable consequences on their consumers. Herbal extract cosmetics have garnered customer attention and have been highly significant in the cosmetics sector since the early 1990s because of these effects and the environmental impact of chemical components. Currently, certain biotechnologically produced substances have demonstrated noteworthy skin-care effects and may be regarded as beneficial ingredients (Gomes et al., 2020).

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Resveratrol (*Saccharomyces cerevisiae, Pichia pastoris*)

Resveratrol is a polyphenol phytoalexin that plants produce in reaction to stress and fungal diseases. It was discovered in the roots of Veratrum grandiflorum for the first time (white hellebore). Resveratrol is an active component in cosmetics that has antioxidant and anti-inflammatory properties (Ratz-Łyko and Arct, 2019). Prokaryotes such as *Escherichia coli*, *Lactococcus lactis, Streptomyces venezuelae,* and *Corynebacterium glutamicum,* and *eukaryotes such as Saccharomyces cerevisiae* are often employed hosts for resveratrol synthesis (Thapa et al., 2019). Resveratrol is often synthesized chemically or biotechnologically from the yeasts Saccharomyces cerevisiae or Pichia pastoris for industrial use. A filtrate of a product obtained by the fermentation of resveratrol and plant extracts by the bacterium Lactobacillus or a product obtained by the fermentation of resveratrol and plant extracts by the microorganism Lactobacillus (Ratz-Łyko and Arct, 2019).

The antioxidant potential of a resveratrol-based cosmetic formulation was 17 times higher than that of idebenone, and topical administration resulted in photoaging prevention. Engineered microorganisms with a recombinant stilbene synthase gene have been found to produce significant yields of resveratrol.

The manufacture of transgenic resveratrol by microbial fermentation addressed issues such as low yield, the existence of many isomers in plant-derived resveratrol, and the development of hazardous intermediates in complex chemical synthesis pathways (Pandey et al., 2015).

Stem cells *(uttwiler Spatlauber)*

A stem cell is a sort of undifferentiated cell that may self-replicate or give rise to a variety of specialized cell types (Gomes et al., 2020). Antioxidant substances such as polyphenols, phenolic acids, flavonoids, triterpenes, carotenoids, and peptides are abundant in plant stem cell extracts, giving them anti-aging capabilities (Miastkowska and Sikora, 2018). Mibelle Biochemistry, a Swiss firm, developed the PhytoCellTec Malus Domestica product, which contains stem cells from the Uttwiler Spatlauber apple tree. The extract produced through the above-mentioned biotechnological procedure underwent a variety of tests and studies aimed at determining its anti-aging potential in human skin and hair (Moruś, et al., 2014).

According to different research, kinetin, a cytokinin found in high quantities in stem cells from citrus fruits and raspberries, is one of the most powerful inhibitors of the human cell aging process. Kinetin is a naturally occurring antioxidant that protects proteins and nucleic acids from oxidative degradation. In comparison to other compounds, kinetin has little or no photoprotective action, according to the research, and should not be utilized in sunscreens (Gomes et al., 2020).

Glycerin extracts from stem cells derived from ginger (Zingiber officinale) leaf cell extracts obtained by Naolys firm also have anti-aging characteristics. Anti-aging effects are also found in tomato stem cell extract produced from Lycopersicon esculentum cell liquid cultures. The stem cell extract of *Syringa Vulgaris* (lilac leaf) may be utilized to treat inflammatory, acne, aging, and photo damaged skin problems (Moruś et al., 2014). Despite this, cosmetic arbutin (*Catharanthus roseus* L.) is used as a whitening agent, safflower and saflorin derived from coloring safflower (*Carthamus tinctorius* L.) are used as a pigment, and safflower and saflorin obtained from coloring safflower (*Carthamus tinctorius* L.) used as a pigment (Miastkowska, and Sikora, 2018).

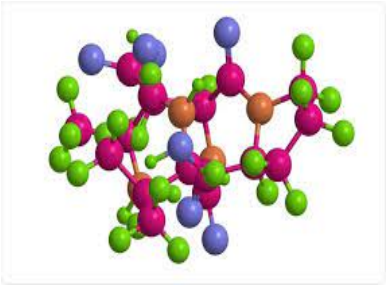

Figure 5. Peptides.

Peptides *(Bacillus spp)*

Peptides are amino acid chains that are short in length. Some are found in the human body naturally and are known to have a variety of biological purposes (Lima, Pedriali Moraes, 2018). Signal peptides, carrier peptides, and neurotransmitter-inhibiting peptides are the three types of peptides (Gomes et al., 2020).

Signal peptides are a kind of peptide that stimulates skin fibroblasts, resulting in enhanced collagen and elastic fiber synthesis (ETC Group, 2014).

Palmitoyl oligopeptide and Palmitoyl tetrapeptide-7 are the two forms of signal peptides most commonly utilized in cosmetics. Dermic cells will be stimulated to produce more collagen by palmitoyl oligopeptide. Many users have reported firmer and tighter skin after using palmitoyl tetrapeptide-7 twice a day for at least six months. Palmitoyl tetrapeptide-7 is used to reduce inflammation in the skin in conditions such as sun damage, internal stress, or even pollution. As a result, this peptide inhibits premature wrinkles and skin damage, both of which are caused by inflammation; Matrixyl®-3000 is a relatively new cosmetic product on the market (Gomes et al., 2020).

Peptides have been utilized to improve the condition of skin, hair, and nails since ancient times. Peptides (protein digests) have also been frequently employed in cosmetic formulations. Insoluble peptides are utilized in face masks, while soluble peptides are employed in gels, emulsions, powders, and lotions. For commercial purposes, these peptides are produced by the controlled action of proteases, which are primarily released by Bacillus spp. Pentapeptides are also commonly used to reduce wrinkles and roughness on the face (Gupta et al., 2019).

Biomimetic peptides, on the other hand, are biotechnologically synthesized molecules with the same amino acid sequence as physiological peptides. The activity of peptidases released by microbes during the fermentation process in the presence of proteins; hydrolysis employing vegetal, animal, and microorganism peptidases; and gastrointestinal enzymatic activities are all ways to generate bioactive peptides (Cabral, 2021).

Growth factor (*P. pastoris*)

A growth factor is a secreted, physiologically active substance that can influence cell growth. Growth factors may bind to certain cell surface receptors, which then send signals to other intracellular components (Sharma, 2018). Growth factors' potential to stimulate growth, differentiation, and/or cell division has piqued the interest of not just the pharmaceutical but also the cosmetics industries (Crommelin et al. 2008). Our bodies create these signaling proteins known as growth factors from birth to maturity (Gomes et al., 2020). Because of their importance in skin care, human growth factors are regarded as remarkable chemicals in the cosmetics business (Pandey et al., 2015). These proteins communicate with cells and convey repair and rejuvenation instructions (Gomes et al., 2020). The use of these molecules for skin rejuvenation is thought to be an emerging and promising strategy. Advances in knowledge of the role of growth factors in wound healing and regeneration have aroused great interest in the role that these molecules may play in the repair of skin structures. Growth factors can be applied topically or injected (Husein el Hadmed and Castillo, 2016).

Several clinical studies have shown that topical application of animal growth factors, or the injection of autologous growth factors, can also increase collagen synthesis in the dermis. The purpose of administering topical or injectable growth factors is to increase the activity of the cells responsible for the remodeling of the dermis and to delay or reverse the aging of the skin (Fabi and Sundaram, 2014). Platelet-derived growth factor, vascular endothelial growth factor (VEGF), epidermal growth factor (EGF), granulocyte-colony stimulating factor, keratinocyte growth factor, and hepatocyte growth factor are all known to directly alter collagen production (Aldag Teixeira and Leventhal, 2016). Human epidermal growth factor (hEGF) has been discovered to be useful

in the treatment of wrinkles, age spots, and freckles, as well as speeding up the healing process (Eissazadeh et al., 2017).

Through genetic engineering, pure hEGF might be generated on a massive scale. E. coli and *S. cerevisiae* were among the host systems that generated HEGF (Rettberg et al., 1999). Because the hEGF cytoplasm tends to form inclusion bodies, which can be rapidly destroyed by proteases when E. coli is utilized as the host, the yield is not suitable for industrial requirements. As a result of the additional manufacturing procedures necessary to release hEGF from inclusion bodies, the overall production cost rises. Furthermore, the amount of hEGF generated by prokaryotic systems is smaller than that of eukaryotic systems. As a result, using eukaryotic systems like P. pastoris to generate the growth factor on a big scale is possible (Eissazadeh et al., 2017). Skin Actives (USA) sells EGF that has been heterologously produced in E. coli for use as a skin conditioner (Pandey et al., 2015).

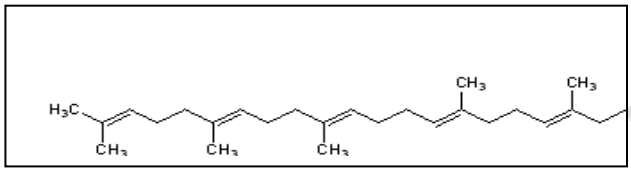

Figure 6. Squalene.

Amyris squalene (Saccharomyces cerevisiae)

Squalene is a physically unusual triterpene molecule that makes up one-third of skin surface lipids (around 13%). It got its name since it was first isolated from shark liver oil (Squalus spp.) (Huang et al., 2009). Cosmetics (69.2 %), food (22.8 %), and pharmaceuticals (8 percent) make up the majority of the squalene market (Rosales-García et al., 2017). Squalene, one of nature's greatest emollients, has been shown to have antioxidant capabilities (Huang et al., 2009).

As previously said, the cosmetic sector in Europe required SLO because lotions, eyeliner, eye shadows, eye makeup remover, and perfumes contain 0.1-10% squalene, while foundation, lipsticks, and other face preparations have up to 50% squalene. Squalene is found in abundance in the livers of abyssal sharks. Fishing shark trade volumes are currently approaching sustainable levels (Rosales-García et al., 2017). To make one tonne of squalene, an estimated 3,000 sharks' livers are required. To supply the global demand of 1,000-2,000 tonnes per year, up to 6 million deep-sea sharks were killed each year. Squalene must be extracted from renewable sources from now on. Olive oil is a well-known source of squalene. Olive oil is now one of the most economically utilized vegetable squalene sources, although its content is insufficient to meet demand (Rosales-García et al., 2017).

To enable the commercial scale synthesis of squalane from fermentable sugars, a new technique based on the isoprenoid route has been established. Farnesene, the natural biosynthetic precursor of squalene, is manufactured on a large scale utilizing the non-pathogenic yeast *Saccharomyces cerevisiae*. After that, the yeast is eliminated, and a simple chemical coupling is used to simulate natural processes (McPhee et al., 2014). Amyris, a California-based synthetic biology startup, partnered with Soliance, a French cosmetic ingredient producer, in February 2010 to sell significant amounts of its NeossanceTM squalane to the cosmetic industry. Amyris had previously modified yeast's metabolic route to make farnesene, an important building block for a variety of chemical compounds, including squalane (ETC Group, 2014).

Shiseido bio-Hyaluronic acid (*S. zooepidemicus*)

In cosmetic compositions, HA is one of the most commonly utilized active components. Both industry professionals and consumers are interested in how people think about skin regeneration in general. It is obvious that the skin is a reflection of an individual's health, and HA is one of the most important aspects of maintaining healthy skin. Hyaluronic acid is used as a viscosity modifier and/or a skin conditioning ingredient in cosmetic compositions. HA is mostly found in anti-aging cosmetics (Juncan et al., 2021).

D-glucuronic acid (GlcUA) and N-acetylglucosamine (GlcNAc) disaccharide repeats are connected alternately by b-1, 3, and b-1, 4 glycosidic linkages in hyaluronic acid (HA). HA is used in the cosmetic, biomedical, and food industries because of its unique moisturizing retention capacity and viscoelasticity, as well as its lack of immunogenicity and toxicity. To correspond to polysaccharide nomenclature, it was renamed in 1986. HA was isolated from a variety of sources during the 1930s and 1940s, including the vitreous body, umbilical cord, rooster comb, and streptococci. Shiseido was the first to accomplish industrial-scale microbial HA synthesis in the 1980s. *S. zooepidemicus* is the most often utilized strain for HA generation, and it can produce 60.7 g/L HA under the right culture conditions. The formation of microbial HA by *S. zooepidemicus* is a viscous process and thus mixing performance and oxygen mass transfer rate significantly influence HA production (Liu et al., 2014).

Ambrofix by Givaudan

Ambergris, often known as Baltic amber, is a well-known smell derived from marine animals. It's a waxy fluid from the sperm whale Physeter macrocephalus's intestine that smells like seaweed, wood, and moss, but with a sweet yet dry undertone of unrivaled tenacity.

Table 1. Brands that uses biotech beauty.

S. N.	Brand name	Active ingredient	Manufacturer	Use	Species
1.	Squalene oil	Squalene	Biossance	hydrates and locks in essential moisture.	*Saccharomyces cerevisiae* (ETC Group , 2014)
2.	Benefiance Overnight Wrinkle Resisting Cream	Hyaluronic acid	Shiseido	works to improve the appearance of wrinkles	*S. zooepidemicus* (Liu et al., 2014)
3.	Revitalizing treatment softener	Hyaluronic acid	Shiseido	Balance and brighten skin complexion.	*S. zooepidemicus* (Liu et al., 2014)
4.	TNS Essential Serum	Growth factor	TNS	It works by improving the tone and texture of the skin, fading and decreasing the appearance of wrinkles and fine lines.	*Pichia pastoris* (TransformMe, 2021)
5.	Givaudan	Ambrofix	Givaudan	Perfumes, fragrance	*Physeter macrocephalus's* (Meyer and Werbitzky, 2020)
6.	Multi peptide 10% serum	Matrixyl 3000 peptide	Minimalist	Hydrating serum, boost skin moisturization, reduce wrinkles	*Bacillus spp* (Gomes et al., 2020)
7.	Phyto cell Tec malus domestica	Stem cell	Mibelle biochemistry group	Rejunivate hair follicle route	*Uttwiler Spatlauber* (Moruś et al., 2018)

Ambergris has two major chemical components: 40–60 percent fecal steroids (mostly cholestanol type steroid) and 25–54 percent ambrein, a triterpenoid. The olfactory characteristics of ambergris result from oxidative decomposition and are obtained under the impact of environmental exposure to sunshine, seawater, and air, and they are obtained under the influence of environmental exposure to sunlight, seawater, and air. The oxidative breakdown produces odorous chemicals known as ambroxide, which are highly appreciated in perfumery. Ambroxides are odorous chemicals that are highly prized in perfumery as a result of oxidative breakdown (Riad et al., 2021).

A Givaudan research team in Kemptthal looked at ways to make Ambrofix, a popular and frequently used perfume ingredient, in a sustainable and carbon-efficient manner. Using sugar cane as a starting point, the researchers devised a revolutionary biotechnological technique. Givaudan's commercial name for ambroxide, a terpenoid initially identified in the 1950s as one of the major ingredients responsible for the odor of ambergris, is ambrofix (Premium Beauty News, 2019).

Ambrofix, one of the most extensively used biodegradable fragrance compounds, is now made with Givaudan's breakthrough biotechnology, which has the same olfactory attributes as the previous process while being the most sustainable and carbon efficient on the market. This innovative biotechnology begins with the fermentation of sustainably sourced sugar cane to make Ambrofix, which is easily biodegradable, 100% organically derived, and contains 100% renewable carbon. When compared to the previous manufacturing method, producing one kilogram of the new ingredient requires a hundred times less land (Meyer and Werbitzky, 2020).

This breakthrough exemplifies how Givaudan is responding to consumer demand for safe, high-quality, and responsibly created products by forging new ground in the development of future sustainable fragrance compounds (Science industries Switzerland, 2022).

Biotechnological alternative to palm oil to save rainforest

The beauty products we put on our faces and the meals we consume have a terrible truth: many are made with palm oil, which is responsible for the fast deforestation of some of the world's most biodiverse ecosystems. However, the biotech sector claims to have devised a solution - a synthetic substitute that would not require the destruction or removal of any rainforest. According to the company, this might someday replace natural palm oil in shampoos, soaps,

detergents, and lipsticks (Premium Beauty News, 2019). Palm oil is a prominent ingredient in up to 50% of all daily-used items, including lipsticks, shampoo, and deodorant. Malaysia dominated palm oil output till the end of 2007, and Indonesia took over at the beginning of 2008, with a steady increase until now (Kaniapan et al., 2021). Palm oil, which accounts for 41% of global vegetable oil output, has been frequently chastised for its negative environmental implications, which include large-scale deforestation, significant carbon emissions, and biodiversity loss (Beyer et al., 2020).

C16 Biosciences was formed to disrupt the present market by developing an environmentally conscientious and sustainable palm oil alternative. The company's palm oil alternative production uses yeast-fermented bacteria in specialized bioreactors to manufacture oil intracellularly, using sustainable and traceable raw ingredients (Ahmad, 2019) for further information. At C16 Biosciences, this entails employing genetically modified bacteria to transform food waste and industrial by-products into a chemically comparable product to natural palm oil (Saragosa, 2020). Revive Eco, a Scottish firm, is converting coffee grounds into a palm oil substitute: a new business in Glasgow Revive Eco believes there is a better purpose for those discarded coffee grounds, one that could help to solve another major environmental issue: palm oil. The company is working on a method to extract and purify oils from used coffee grounds, which it claims have the same components as palm oil, which is extensively used but widely reviled (Resource, 2019).

CONCLUSION

Nowadays, the cosmetics market has attracted worldwide interest, thanks to the more active and consistent participation of consumers, who have begun to use these products more often. The cosmetic industry, through biotechnological processes, has contributed to the acquisition of a wide variety of cosmetic active ingredients. Thanks to these processes, it is possible to create active substances. Thus, biotechnology, cosmetics, and aesthetic medicines have been closely intertwined, allowing for new effective and safe formulations of active ingredients.

For example, kojic acid, hyaluronic acid, and resveratrol, among other biotechnological active ingredients, have been found in various types of cosmetic products, especially for skin care. Despite that this is a very promising area. Thus biotech beauty plays very crucial role in the cosmetic industry.

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