



# Exploring The Bioactive Properties Of Mushrooms In Cosmetic Application: A Comprehensive Review

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## Abstract:

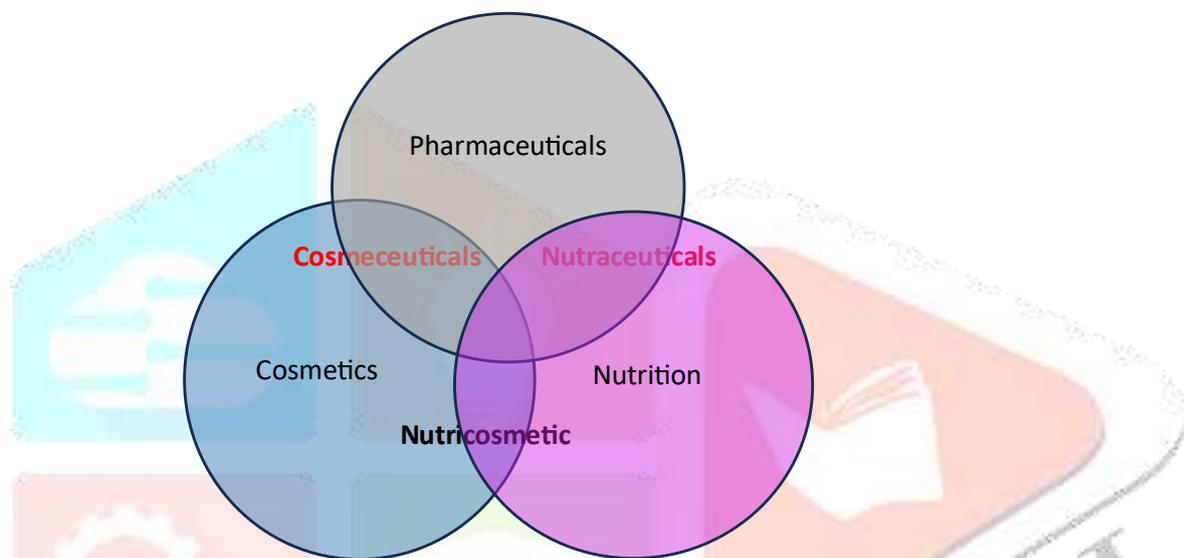
Although mushrooms have long been valued for their culinary and medicinal qualities by many cultures, more recent scientific discoveries have revealed the amazing potential of mushrooms in the cosmetics industry. An overview of the newly emerging topic of mushroom cosmetics is given in this abstract, which also highlights the mushrooms' exceptional qualities, sustainability, and prospective advantages for skincare and attractiveness. Cosmetics made from mushrooms offer a fresh take on environmentally friendly and sustainable beauty products. Bioactive substances found in mushrooms, such as polysaccharides, beta-glucans, and antioxidants, have several positive effects on skin health. Because of their proven anti-inflammatory, hydrating, and anti-aging qualities, these natural substances are perfect for use in skincare products. Furthermore, mushrooms can improve the skin's natural brightness and shield it from external assaults. Mushrooms are used in cosmetics in response to consumer demand for natural and eco-friendly goods. Because they can be grown in regulated conditions, mushrooms have less of an environmental impact than traditional cosmetic materials. Additionally, they can be composted and biodegraded, which supports sustainable beauty practices. A number of mushroom species have become well-known in the cosmetics sector; shiitake, chaga, and reishi mushrooms are among the more well-known varieties. With their wide variety of advantages, these fungi are utilized in serums, creams, masks, and other skincare products, providing a comprehensive approach to skincare.

Mushroom cosmetics represent a viable path for innovation as the beauty industry moves toward more environmentally friendly and naturally inspired products. In order to meet the increasing demand from consumers for natural, eco-friendly, and potent skincare products, this abstract introduces the idea of mushroom cosmetics and highlights their potential to transform the beauty business.

**Keywords:** Mushroom, Beneficial Components, Bioactive properties, Commercial Status.

## Introduction:

As fungi, mushrooms are classified into the higher phyla Ascomycota and Basidiomycota. They have gills (lamellae, sing. lamella) on the underside of the cap, a stem (stipe), and a cap (pileus) [1,2]. Actually, the term "mushroom" describes a fruiting body made up of many hyphae that develop upward and release spores (basidiospores). In addition to its culinary qualities such as flavor, texture, and nutrition, mushrooms are also known for their medicinal properties that have tonic and pharmacological properties [3]. Though the projected number of mushroom species on Earth is presently 150,000, only around 10%, or about 15,000 recognized species, have been identified thus far [4,5]. Rich in protein, vitamins, and minerals, mushrooms are also a great source of thiamine,  $\beta$ -glucan, selenium, riboflavin, niacin, panthothenic acid, and folic acid [6, 7]. It has reported that mushrooms provide beneficial effects as invigorating vital energy, maintaining one's optimal weight, favoring longevity, and avoiding unnecessary aging [8,9]. Recently mushrooms have drawn worldwide attention as the most interesting natural sources with diverse and unique bioactivities, including immunomodulatory, antioxidant, anti-inflammatory, antidiabetic, antibacterial, antifungal, antiviral, antitumor, hepatoprotective, reducing glucose and lipidic levels [10,11]. They make up a vast, and yet largely untapped, source of powerfully new pharmaceutical products.



In addition to being a delicious side dish, mushrooms can provide a natural supply of components for cosmeceuticals. Many types of mushrooms have traditionally been utilized as dietary supplements for skincare, especially in Asian nations including China, Japan, and Korea [12]. A large amount of amino acids, carbs, lipids, dietary fiber, proteins, phenolic compounds, and other vital minerals and vitamins can be found in mushrooms [13, 14]. In addition to its nutritional value, compounds obtained from mushrooms are currently used as medicinal agents. Many biological actions, including as antibacterial, antiviral, anti-cancer, anti-inflammatory, anti-aging, anti-oxidant, anti-wrinkle, moisturizing, skin-whitening, and immunomodulatory effects, are found in mushroom components and their secondary metabolites [15–19]. For skincare purposes, biologically active chemicals found in mushrooms have been the subject of ongoing research. This analysis looks at the production practices of some potential mushrooms for the beauty business as well as reviews chemicals derived from mushrooms that have been found to have benefits for the skin.

The term "cosmeceuticals" refers to products that combine medications and cosmetics. They are made up of topically applied products such as ointments, lotions, and creams that contain biologically active ingredients with properties similar to those of pharmaceuticals [20]. These products are known to have chemicals that improve the appearance, vibrancy, texture, and anti-aging properties of the skin while also influencing the biological function of the skin by providing the nutrients required for healthy skin [21]. Modern skin care practices heavily favor the use of natural elements such as minerals, dairy products, microbial metabolites, phytonutrients, and animal protein components [24, 22, 23]. Because of their proven ability to effectively treat a variety of skin conditions, extracts from coconut, jasmine, lemon grass, longan, and other medicinal plants have been studied and used extensively worldwide, including in Africa [25], where they are utilized extensively in skin health care practices. Fungi, particularly mushrooms and their byproducts, are increasingly being utilized in cosmetics, either as pure compounds

or as raw materials, to cure a wide range of ailments that are typically skin-related. The idea of inner beauty has gained popularity among customers globally with the introduction of nutricosmetics and skincare products. The value of the worldwide cosmetics business is estimated to be in the hundreds of billions of dollars [26]. Companies in this sector are always looking for novel, organic, and natural components that can provide competitive skincare products that are low in toxicity [27, 28]. Several plant and animal extracts, including those from aloe vera, blueberries, cherries, coconuts, cucumbers, ginseng, lemons, longans, pomegranates, rice, and tamarind, as well as bee venom, cocoons, goat milk and placenta, honey, pearl, royal jelly, and snail slime, are now frequently found on cosmetic store shelves [29–34]. The usage of mushrooms in cosmetics and wellness products is a relatively new trend.

#### Mushroom used in cosmeceuticals applications:



A) *cyclocybe aegerita* (35)



B) *Agaricus bisporus* (36)



C) *Pleurotus ostreatus* (37)



D) *pleurotus eryngii* (38)



E) *Schizophyllum commune* (39)



F) *Tremella fuciformis* (40)

## BENEFICIAL MUSHROOM COMPONENTS FOR COSMETIC PRODUCTS:

Mushrooms are edible fungi that contain high amounts of essential nutrients. Different varieties have diverse nutritional compositions, with value in several applications. Polysaccharides are a significant component in mushrooms followed by proteins, anti-oxidants, minerals and vitamins [41, 42]. Besides being a food source, bioactive constituents in mushrooms have been intensively studied as therapeutic agents for many diseases, and to delay the signs of skin aging [43,44]. Mushrooms contain high anti-oxidants, skin smoothing, moisturizing, and brightening substances [45]. These components are potential sources of novel natural cosmeceutical ingredients.

1. Polysaccharides
2. Phenolic Compound
3. Vitamins
4. Terpenoids
5. Selenium

### 1. Polysaccharides:

Long-chain carbohydrates called polysaccharides are made up of repeating monosaccharide units joined by glycosidic linkages. They can have very branching or linear structures. Mushroom polysaccharides have the ability to interact with various chemical and inorganic substituents and can be either homopolysaccharides (mostly  $\beta$ -glucans) or heteropolysaccharides [42]. The majority of the polysaccharides found in mushroom cell walls are chitin, glucan, hemicellulose, and polymers made of mannose residues [46]. Many polysaccharides, including lentinan from *Lentinula edodes* [47] and schizophyllan from *Schizophyllum commune* [48], have been isolated from mushroom fruiting bodies and mycelia cultures., *Agaricus bisporus*, *Agaricus subrufescens*, *Ganoderma lingzhi* (Ling-zhi), and *Grifola frondosa* [49], galactomannan from *Morchella esculenta* and *Morchella conica* [50], krestin (polysaccharide-K) from *Trametes versicolor* [51], and  $\beta$ -(1-3)-D-glucan from *Pleurotus* spp. [52] have been found to exhibit anti-aging, anti-oxidative, antitherapeutic, and immunomodulating properties. The elevated concentration of polysaccharides found in mushrooms has sparked a growing interest in skin benefits by augmenting the moisture content of the stratum corneum and epidermis, strengthening the skin's ability to retain moisture, and limiting moisture release. Applying mushroom polysaccharides to topical cosmetic products makes them potent moisturizers similar to hyaluronic acid [53].

### 2. Phenolic compounds:

Natural sources of phenolic compounds include fruits, grains, nuts, spices, and herbs. They are prevalent in mushrooms as well and offer defense against germs, insects, and UV radiation [54]. Numerous research endeavors have endeavored to measure or even isolate phenolic components from diverse mushroom species in order to serve as potential sources for the manufacturing of dietary supplements and anti-aging creams or lotions. Several species of edible mushrooms, including *A. bisporus*, *Boletus edulis*, *Calocybe gambosa*, *Cantharellus cibarius*, *Craterellus cornucopioides*, *Hygrophorus marzuolus*, *Lactarius deliciosus*, *L. edodes*, *Pleurotus eryngii*, *Pleurotus ostreatus*, and *Tropicoporus linteus*, have been found to contain phenolic compounds and their derivatives with documented anti-oxidant potential, such as caffeic, ferulic, gallic, p-hydroxybenzoic, homogentisic, protocatechuic acid, and myricetin [55,56,57]. Additionally, commercial phenolic compounds found in mushrooms, such as caffeic acid, cinnamic acid, p-coumaric acid, gallic acid, kojic acid, and p-hydroxybenzoic acid, have been shown to help lighten skin by lowering melanin concentration and blocking tyrosinase activity [58,59,60,61].

### 3. Vitamins:

Vitamins are a class of chemical compounds that are required in little quantities for healthy body operations. In addition to vitamin B1 (thiamine), vitamin B2 (riboflavin), vitamin B3 (niacin), vitamin B7 (biotin), vitamin B9 (folic acid or folate), vitamin B12 (cobalamins), vitamin C (ascorbic acid), and vitamin D (calciferols), mushrooms can also create a wide range of other vitamins [62–64]. Rich sources of vitamin D2 (ergocalciferol) that assist the skin's immune system include *Agaricus bisporus*, *L. edodes*, *P. ferulae*, and *P. ostreatus* [65–69]. When exposed to sunshine, the ergosterol on the surface of mushrooms can be converted into vitamin D2. In addition to successfully enhancing skin hydration and moisture content, vitamin D is linked to strong teeth and bones [70]. The fruiting bodies of lion's mane (*Hericium erinaceus*), golden chanterelle (*Cantharellus cibarius*), shiitake (*L. edodes*), and black trumpet (*Craterellus cornucopioides*) were shown to contain high quantities of vitamin B12 [71–73]. All fungus contain B

vitamins, which are most frequently found in skin, hair, and nail care products due to their moisturizing and anti-aging properties.

#### 4. Terpenoids:

Terpenoids, sometimes referred to as isoprenoids, are a class of lipids that are widely distributed in essential oils derived from a variety of plants. Numerous biologically active compounds, such as vitamins, hormones, and medications, are terpenoids and are crucial components of nutritional and cosmetic goods. Terpenoids, which are employed topically for various cosmetic uses, can be found in significant amounts in mushrooms. Numerous mushrooms have been found to contain triterpenes, especially *Ganoderma* spp. [74]. Isolated from either the spores or fruiting bodies of *G. lingzhi*, ganoderic acids, ganodermanondiol, ganodermanontriol, ganolucidic acids, ganolucidoles, ganoluciduones, lucidadiols, lucidenic acids, lucidumols, methyl ganoderates, and methyl ganolucidates showed anti-inflammatory, anti-HIV-1 protease, anti-cancer, and anticholinesterase qualities. [75–77], However, lanostane triterpenoids from the *Hypholoma fasciculare* mushroom, such as sublateriol C, fasciculic acids, and fasciculols, shown cytotoxic activity against human cancer cell lines and anti-inflammatory effects on nitric oxide generation [78]. Sesquiterpenoids from the solid culture extract of *Flammulina filiformis*, such as 2,5-cuparadiene-1,4-dione, enokipodins, sterpurols A and B, and sterpuric acid, demonstrated antitumor effects, antibacterial activity against *Bacillus subtilis*, and antioxidant activity as determined by the DPPH scavenging assay [79]. Strongly anti-aging, revitalizing, and strengthening the skin is canthaxanthin, a reddish-orange keto-carotenoid pigment found in the edible mushroom *Cantharellus cinnabarinus* [80]. The most prevalent tetraterpenoids are carotenoids, which also have UV protection and free radical scavenging properties [81]. Carotenoids are traditionally employed as natural cosmetic components, food colorants, animal feed supplements, and nutraceuticals because of their health- and color-related qualities [82–84].

#### 5. Selenium:

For mammals, selenium (Se) is an ultra-trace element that is necessary for several selenoproteins and/or selenoenzymes. Edible mushrooms that collect selenium in their bodies are *Agaricus bisporus* and *Lentinus edodes* [85,86]. Potent anti-tumor agents, such as  $\gamma$ -glutamyl-Se-methylselenocysteine and Se-methylselenocysteine (MeSeCys), are found in selenium-rich garlic [87]. Shampoos often include selenium, which is known to strengthen teeth, hair, and nails as well as improve bone health.

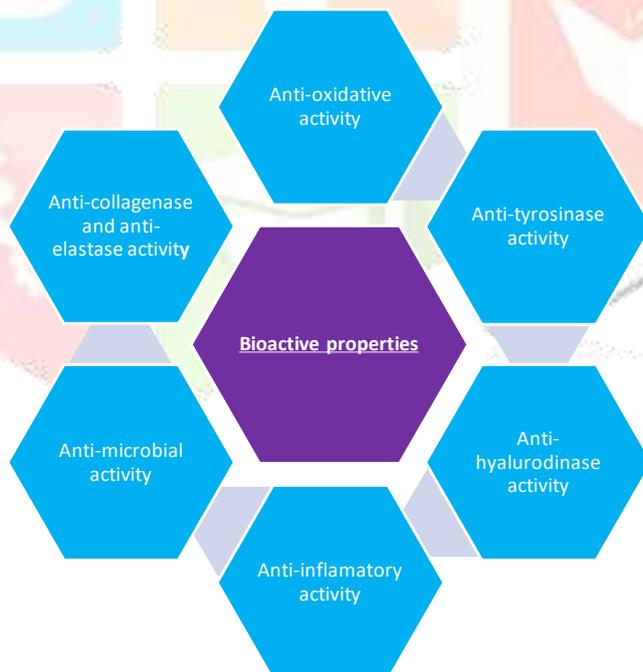
**Table 1.** Mushrooms applied in cosmetic products.

Mushroom	Product	Function /Unique benefits	Source
Albatrellus confluens	REN Clean Skincare Evercalm Ultra Comforting Rescue Mask	Skin feels smooth with even tonic	<a href="https://www.renskincare.com">https://www.renskincare.com</a>
Ganoderma lingzhi	- Eminence Organic Skin Care Birch Water Purifying Essence	Anti-aging and provides hydration	<a href="https://eminenceorganics.com">https://eminenceorganics.com</a>
	- Yves Saint Laurent Temps Majeur Elixir De Nui	Anti-aging	<a href="https://www.yslbeautyus.com">https://www.yslbeautyus.com</a>
	- Dr. Andrew Weil for Origins™ Mega-Mushroom Skin-Relief Micellar Cleanse	Anti-aging	<a href="https://www.origins.com">https://www.origins.com</a>
	- Tela Beauty Organics Encore Dri Styling Cream	Hair protection from sun damage and color fading	<a href="https://www.nordstrom.com">https://www.nordstrom.com</a>

Inonotus obliquus	Supermood - The Perfect Day Cream	Antioxidant and provides hydration.	and skin <a href="https://www.supermood.fi">https://www.supermood.fi</a>
Lentinula edodes	Griffin+row naturally effective skincare	Anti-inflammatory, brightening	<a href="https://www.griffinandrow.com">https://www.griffinandrow.com</a>
Pleurotus ostreatus	Hankook Sansim Firming Cream	Enhances elasticity, skin tight and vitalized	<a href="https://www.sansim.co.kr">https://www.sansim.co.kr</a>
Polyporus umbellatus	iS Clinical Active Serum	Brightens and revitalizes skin	<a href="https://isclinical.com">https://isclinical.com</a>
Schizophyllum commune	Alqvimia Eternal Youth Maximum recovery face cream	Brightens and unifies skin tone	<a href="https://alqvimia.com">https://alqvimia.com</a>
Tremella fuciformis	Eminence Organic Skin Care Birch Water Purifying Essence  Dr. Dennis Gross Skincare Alpha Beta® Pore Perfecting Cleansing Gel	Antioxidant, enhances elasticity  Enhances elasticity with skin firming	<a href="https://eminenceorganics.com">https://eminenceorganics.com</a>  <a href="https://drdennissgross.com">https://drdennissgross.com</a>

### Bioactive properties of mushrooms:

Mushrooms are a reservoir of biological compounds that provide various therapeutic effects. These biological compounds are important nutritional constituents that have various health benefits. They perform biological functions some of which have been depicted .



#### 1. Anti-oxidative activity:

All living things, notably human life, depend on oxygen to survive. The body's oxidative damage can be lessened by using mushrooms, which are high in anti-oxidative chemicals [88]. Glutathione (GSH) [92], phenolic acids [89], polysaccharides, organic compounds, vitamin C and E [91], and polysaccharides [90] are only a few examples of the possible uses of mushrooms as anti-oxidant components suggested by numerous research. *Coriolus versicolor*, *Ganoderma applanatum*, and *Pleurotus citrinopileatus* have all been shown to have possible anti-oxidative qualities, and a thorough investigation into the scavenging ability of ROS in mushrooms has been conducted [93, 94, 95]. These mushrooms are rich in bioactive substances with potent anti-oxidant qualities, including minerals, vitamins,

carotenoids, polyphenols, and polysaccharides. Because of these qualities, their extracts are now a crucial component of cosmeceutical formulas such as wrinkle- and anti-aging treatments [96]. Long-term sun exposure typically produces reactive oxygen species (ROS), which cause sunburn, wrinkles, and aging of the skin. Cosmetics rich in these kinds of organic antioxidants scavenge reactive oxygen species and offer photoprotective benefits.

## 2. Anti-tyrosinase Activity:

The crucial enzyme for the manufacture of melanin is known to be tyrosinase. Skin that is overproduced in melanin appears dark [97]. Strong anti-tyrosinase action is demonstrated by mushrooms including *Ganoderma lucidum* [98], *Euphorbia characias* [99], and *Pistacia atlantica* subsp. *mutica* [100], which are being thoroughly studied for use in skin-whitening products. According to research by Angelini et al. [101], phenolic compounds taken out of the edible wild mushroom *Tricholosporum goniospermum* have the ability to block tyrosinase activity. While the *Pleurotus* species have been the subject of the most research due to their propensity to inhibit tyrosinase, the bioactive compounds responsible for this activity have not been identified in any of the investigations conducted on these mushrooms. Additionally, as naturally occurring bioactive substances with potential uses in cosmetic and nutraceutical fields, mushrooms are a source of tyrosinase inhibitors. *Neolentinus lepideus*, which contains 1,3-dihydroisobenzofuran and 4,5,7-triol-5-methoxy-1,3-dihydroisobenzofuran-4,7-diol, was shown to have tyrosinase inhibitory properties [102]. Its IC<sub>50</sub> values were 173 and 263 µg/ml, respectively.

## 3. Anti-hyaluronidase activity:

Hyaluronic acid (HA), alternatively referred to as hyaluronan, is a polymer made up of repeating disaccharides connected by β-linkages to β-1, 3-N-acetyl glucosamine and β-1, 4-glucuronic acid [103]. The cosmetic industry is moving away from the topical administration of HA resulting from inflammatory reactions generated by anti-aging skin cosmetics and toward the application of bioactive substances with excellent anti-hyaluronidase activity. A member of the Polyporaceae family of macrofungi, *Trametes lactinea* (Berk.) Sacc, has been shown to be able to block the hyaluronidase enzyme when hyaluronic acid is present as a substrate [104]. *Auricularia polytricha*, *G. lingzhi*, *N. lepideus*, *P. citrinopileatus*, *P. ostreatus*, *S. commune*, and *Tra. lactinea* are among the mushroom species whose extracts and specific bioactive compounds have been shown to inhibit hyaluronidase in very few investigations [105–107]. The hyaluronidase enzyme was shown to be inhibited by an extract from the cultured mycelium of the Japanese mushroom *Neolentinus lepideus* [107]. *Pleurotus citrinopileatus* and *Trametes lactinea* are two examples of mushrooms that are utilized in cosmetic compositions because their extracts have anti-hyaluronidase activity.

## 4. Anti-inflammatory activity:

Increased production of inflammatory mediators, including interleukins, tumor necrosis factor, intercellular adhesion molecule-1, inducible cyclooxygenase-2-type, nuclear factor-AB, and prostaglandin E<sub>2</sub>, can lead to inflammatory disorders [108]. According to a number of studies, the ability of isolated mushroom compounds, including polysaccharides, terpenes, phenolic compounds, sterols, fatty acids, polysaccharide–protein complexes, and other bioactive metabolites, to lower the production of inflammatory mediators indicates that they may have anti-inflammatory properties. displays the mushrooms that have been linked to anti-inflammatory action. According to Javed et al. [109], the polysaccharide obtained from the wild fungus *Echinodontium tinctorium* was primarily made up of β-glucan, which shown the capacity to impede the synthesis of TNF-α and nitric oxide (NO). In the Willow Bracket mushroom *Phellinus igniarius*, Jiang et al. [110] identified two bioactive compounds: nepetidin and betulinic acid. These compounds demonstrated the ability to inhibit nuclear factor-κB (NF-κB) as the transcription factor for inflammatory mediator expression, leading to a decrease in the synthesis of pro-inflammatory cytokines. Meanwhile, Ványolós et al. [111] investigated steroids from the edible mushroom *H. lateritium* that demonstrated anti-inflammatory properties by inhibiting cyclooxygenase-2 (COX<sub>2</sub>).

## 5. Anti-microbial Activity:

Antimicrobial components are essential for preventing skin infections and ensuring safety when using and producing cosmetics. The problem facing the cosmetics business is to find new natural bioactive ingredients that can withstand the effects of traditional antimicrobials. The antibacterial activity of phenolic compounds linked to numerous wild mushrooms was investigated by Alves et al. [112]. It has been observed that phenolic acids, including vanillic, p-coumaric, protocatechuic, and 2,4-dihydroxybenzoic acids, have strong antibacterial activity against both

Gram-positive and Gram-negative bacteria. The antibacterial activity of fruiting body extracts from *Inonotus andersonii* and *Inonotus clemensiae*, two wild mushrooms found in Nepal, was investigated [113]. The most intriguing species against gram-positive and gram-negative bacteria was found to be *Lentinula edodes*, which was followed by species belonging to the genera *Boletus*, *Ganoderma*, and *Lepista*.

## 6. Anti-collagenase and anti-elastase activity :

Major proteins found in the outermost layer of the skin include collagen and elastin, which are crucial for maintaining plumpness, elasticity, flexibility, and integrity in young, healthy skin [114]. The most prevalent protein in the human extracellular matrix (ECM) is collagen, which gives skin its strength and suppleness. Elastin, on the other hand, is an important protein that appears as a fiber network in the connective tissue of the ECM and gives skin its elasticity [115]. Elastase, an enzyme belonging to the chymotrypsin family, has the ability to break down elastin and other ECM proteins such as collagen and fibronectin [116]. In the process of looking for naturally occurring HNE inhibitors, a number of active chemicals were found in mushrooms. From the fruiting bodies of *P. eryngii* var. *ferulae* mushrooms, ergosterol, nicotinic acid, pleurone, and (24E)-3 $\beta$ -hydroxycucurbita-5,24-diene-26-oic acid were isolated and showed significant HNE-inhibitory activity (IC<sub>50</sub>, 49.4, >100, 61.5 and 59.1  $\mu$ g/ml, respectively) [117]. On the other hand, isodeoxyhelico-basidin, which was extracted from the culture broth of *Volvariella bombycina*, inhibited HNE activity with an IC<sub>50</sub> value of 9.0  $\mu$ M [118].

**Table 2.** Cosmetic products containing mushrooms and their ingredients.

Product Name	Mushroom/Extract included	Function
Aveeno Positively Ageless Daily Exfoliating Cleanser, U.S	<i>Lentinula edodes</i>	Lift away dirt, oil and makeup and fight signs of aging
Lift away dirt, oil and makeup and fight signs of aging	<i>Lentinula edodes</i>	Part lightweight moisturizer and part toner
Osmia Organics Luz Facial Brightening Serum, U.S.	<i>Lentinula edodes</i> extract	Skin looking bright and luminous
CV Skinlabs Body Repair Lotion, U.S.	<i>Ganoderma lucidum</i>	Wound-healing and anti-inflammatory
Kat Burki Form Control Marine Collagen Gel, U.K.	<i>Ganoderma lucidum</i>	Boost collagen, improve elasticity and provide hydration
Menard Embellir Refresh Massage, France	<i>Ganoderma lucidum</i>	Skin anti-aging
Tela Beauty Organics Encore Styling Cream, U.K	<i>Ganoderma lucidum</i>	Provide hair with sun protection and prevent color fading
Vitamega Facial Moisturizing Mask, Brazil	<i>Agaricus subrufescens</i> (also known as <i>A. brasiliensis</i> )	Renew and revitalize skin
Kose Sekkisei Cream, Japan	<i>Cordyceps sinensis</i>	Moisturizer and suppress melanin production
Root Science RS Reborn Organic Face Mask, U.S	<i>Inonotus obliquus</i>	Anti-inflammatory to help soothe irritated skin
Alqvimia Eternal Youth Cream Facial Máxima Regeneración, Spain	<i>Schizophyllum commune</i>	Anti-aging and lifting
Sulwhasoo Hydroaid, Korea	<i>Schizophyllum commune</i> extract	Hydrating cream promoting clear, radiant skin
La Prairie Advanced Marine Biology Night Solution, Switzerland	<i>Tremella fuciformis</i>	Moisturizer which nourishes, revitalizes and hydrates skin
BeautyDiy Aqua Circulation Hydrating Gel, Taiwan	<i>Tremella polysaccharide</i>	Moisturizing gel

Surkran Grape Seed Lift Eye Mask, U.S.	Tremella polysaccharide	Improve skin around eyes
La Bella Figura Gentle Enzyme Cleanser, Italia	Ganoderma lucidum and Lentinula edodes extracts	Antioxidants and vitamin D
Pureology NanoWorks Shineluxe, France	Ganoderma lucidum, Lentinula edodes, and Mucor miehei	Anti-age and anti-fade
Snowberry Bright Defense Day Cream No. 1, New Zealand	Mushroom extract	Hydrate and illuminate dull skin, along with anti-bacterial properties to help prevent acne
Murad Invisiblur Perfecting Shield, U.S.	Mushroom peptides	Diminish fine lines and wrinkles by aiding regulation of collagen and elastin

(6)

### Commercial status :

The demand for mushrooms and their products is high on the international market. Despite still being in their infancy, mushroom-based skin and hair care products have already established themselves in the market thanks to the introduction of several commercial products by well-known cosmetic brands like Bio Botanica Inc. (U.S.), Bristol Botanicals Limited (U.K.), Qirines Brand (Korea), Menard Brand (Japan), etc. A variety of commercial mushroom-based cosmetic products are listed in Table 1 [119, 120]. The mushroom industry's noticeably high compound annual growth rate (CAGR) in the global market is indicative of the growing demand for the product. The global mushroom industry, which was anticipated to be worth US\$45.3 billion in 2020, is expected to increase at a compound annual growth rate (CAGR) of 7% throughout the analysis period of 2020–2027, reaching a revised value of US\$72.5 billion by 2027 notwithstanding the COVID-19 problem [121]. Based on the estimated compound annual growth rate (CAGR) for mushrooms, China has the highest CAGR at 36%, followed by Canada at 21%, Europe and Germany at 15%.

The demand for different species of mushrooms varies on the international market. With a volume share of 61.8%, button mushrooms lead the market and are extensively grown all over the world. With the highest CAGR of 11.2%, oyster mushrooms are primarily used in Chinese, Japanese, and Korean cuisine due to their mildly savory flavor and delicate texture. Because of their numerous health and skincare benefits, shiitake mushrooms are primarily consumed in South Korea, China, and Japan [122]. The Asia Pacific area is at the forefront of the reishi mushroom business. Shiitake mushrooms are the third most sought-after type of mushroom overall, behind button and oyster (black, yellow, pink, and other varieties). The global market for shiitake mushrooms was valued at USD 362.7 million in 2020 and is expected to reach USD 447.7 million by 2026, growing at a healthy rate of more than 3.6% because of their high demand in the pharmaceutical and cosmetics industries. Shiitake mushroom is frequently used in hair cosmetics because it helps to control the structural characteristics of hair and preserve scalp hygiene [123]. Furthermore, the size of the reishi mushroom extract market is anticipated to increase at a compound annual growth rate (CAGR) of 4.68% from 2020 to 2025, reaching \$560.78 million. In the market for mushroom extracts, organic Reishi mushroom extract had the biggest share in 2019 [124]. Because shiitake and reishi have so many health and skincare benefits, we can conclude that they are dominating the mushroom cosmetic market.

### Conclusion:

Mushrooms are a classic source of naturally occurring bioactive chemicals that are currently being used as possible elements in cosmetics. Bioactive characteristics of mushrooms and their extracts include antioxidant, anti-tyrosinase, and anti-hyaluronidase activities that, in turn, counteract free radical damage, regulate skin hyperpigmentation, and stop hyaluronic acid from breaking down. highlighting their antibacterial, anti-pathogenic, and anti-inflammatory properties as well. More mushroom species will be found, confirmed, and grown; the species now known and used only make up a small portion of the total. Everything in this case contributes to the growth of the cosmetics sector.

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