



REVIEW ARTICLE

Harnessing the Power of Medicinal Mushrooms into Cosmetics: A Fountain of Youth from Nature

Manisha Mishra, Deepa Srivastava*

Abstract

The kingdom, Fungi, comprises magnificent biodiversity with the most diverse species. They have both cosmetic and therapeutic applications, which is the best composition for any cosmetic product. Cosmeceuticals combine this effect and ideally deliver the active ingredients in a biologically effective form to the skin. They have been in use in East Asia for ages and currently, their demand has increased due to the outlook on safer, cost-effective, and toxin-free organic products. This increase in the demand for sustainable products has led to research on the cosmetic properties of mushrooms. Fruiting bodies of some wild and cultivable mushrooms, rich in medicinal compounds and secondary metabolites, are being harnessed in the cosmetic industry. Various compounds isolated from medicinal mushrooms such as ceramides, omega-3, 6,9 fatty acids, carotenoids, lentinans, and resveratrol exhibit excellent antioxidant properties. Species of medicinal mushrooms widely used in cosmeceuticals include *Agaricus subrufescens*, *Cordyceps sinensis*, *Ganoderma lucidum*, *Grifola frondosa*, *Inonotus obliquus*, *Lentinula edodes*, *Tremella fuciformis* and *Polyporus* species. The topical application of these mushroom extracts offers a plethora of skin benefits that include the prevention of photoaging, providing ample hydration, and antioxidant protection against pollution and UV damage. In the past, most cosmetic formulations have relied upon plant kingdom but with the recent advances in knowledge about the anti-inflammatory, anti-microbial, radical scavenging properties of medicinal mushrooms, therein lies a huge opportunity in their utilization. By fusing the above properties with genomics and pharmacology methods, the evolution of mainstream cosmetics from kingdom fungi can be achieved

Keywords: Anti-aging, Cosmeceutical, Fungi, Medicinal mushrooms, Skincare.

Introduction

“Old age is the most unexpected of all things that happen to a man - Leon Trotsky.” The pursuit of eternal youth has been elusive to humankind throughout history. While the key to immortality remains alluring, the field of anti-aging research has made remarkable strides. One intriguing avenue in this pursuit is the study of medicinal mushrooms, which have been used in traditional medicine for centuries. Medicinal mushrooms have been utilized for ages, especially

among native people, to encourage health and longevity. *Ganoderma lingzhi* and *Fomitopsis pinicola* are woody and are frequently consumed as extracts or decoction (Wachtel-Galor *et al.* 2011; Tai *et al.* 2019). The whole fruiting body of the tender *Hericium erinaceus* is consumed (Friedman, 2015). Recent scientific investigations into these extraordinary fungi have unveiled a treasure trove of compounds that show promise in promoting longevity and combating age-related ailments. In this article, we delve into the world of anti-aging medicinal mushrooms and explore the science behind their potential benefits. In recent years, the use of medicinal mushrooms in traditional medicine and skincare has gained significant popularity. These fungi possess a plethora of health benefits, and one such advantage is their potential to brighten the skin naturally. While the concept of skin brightening through mushrooms might seem unconventional, research and anecdotal evidence suggest that certain medicinal mushrooms can effectively enhance the complexion and promote healthy, radiant skin (Wu *et al.* 2016). In this article, we delve into the world of medicinal mushrooms and explore their cosmeceutical properties. These remarkable fungi have been used for centuries in

Department of Botany Deen Dayal Upadhyaya Gorakhpur University, Gorakhpur, Uttar Pradesh, India.

***Corresponding Author:** Deepa Srivastava, Department of Botany Deen Dayal Upadhyaya Gorakhpur University, Gorakhpur, Uttar Pradesh, India, E-Mail: drdeepasrivastav@gmail.com

How to cite this article: Mishra, M., Srivastava, D. (2024). Harnessing the Power of Medicinal Mushrooms into Cosmetics: A Fountain of Youth from Nature. *J. Indian bot. Soc.*, 104(4):200-209 Doi: [10.61289/jibs2024.06.01.1214](https://doi.org/10.61289/jibs2024.06.01.1214)

Source of support: Nil

Conflict of interest: None.

traditional medicine systems, such as Traditional Chinese Medicine (TCM) and Ayurveda, to treat various ailments and promote overall well-being. One of the lesser-known but equally important properties of medicinal mushrooms is their exceptional hydrating ability, making them a natural elixir for maintaining optimal health.

Understanding Medicinal Mushrooms

In recent years, modern science has begun to unlock the secrets behind these fungi's therapeutic potential. Among their many touted properties, medicinal mushrooms have garnered considerable attention for their potent anti-inflammatory effects. In this article, we dive into the world of medicinal mushrooms and take a look at how they fight aging. Medicinal mushrooms are fungi with potent bioactive compounds that have been used in various traditional healing systems, such as Traditional Chinese Medicine (TCM) and Ayurveda. These mushrooms are rich in polysaccharides, peptides, terpenoids, and other phytochemicals, each contributing to their unique medicinal properties. Medicinal mushrooms have been an integral part of various cultures' traditional medicine systems for centuries. The most notable among these are beta-glucans, polysaccharides, terpenoids, polyphenols, and various other immunomodulating agents (Camassola, 2013). These compounds work in synergy to confer the anti-inflammatory properties that have piqued the interest of researchers and health enthusiasts alike. Mushrooms observed as super food are the utmost nutritious and healthy as they are channels of protein, vitamins, and antioxidants and are less in carbohydrates and fats.

Medicinal mushrooms in cosmetics

Along with enhanced customer interest in clean beauty, a motion that supports the use of natural ingredients, mushrooms are gaining speed as crude ingredients for use in cosmetics. Beauty has been going green in multiple facets with a major focus on more vegan, cruelty-free products. Mushrooms are the new "lit" ingredient in the cosmetic industry. Whether you like them or find them too natural, when it comes to skincare, mushrooms can be mystical. Different varieties of mushrooms have different medicinal properties. Generally, mushrooms are approved in the cosmetic industry because they calm, ease, and provide ample hydration. It's essential to know the extraction method of the mushroom as well as what part is used because products that typically use the whole mushroom are best. They are an important component of many moisturizers, serums, and lotions. The widening of the cosmetic business, jointly with the reasonable enhancement in the progress in cosmetic chemistry, has been prime in increasing workflow with dermatologists (Taofiq *et al.* 2016). This alteration in dermatology has found more growth in cosmetic dermatology as compared to medical dermatology. Hereby, the dermatologist has had to become more familiar

with the concepts and devices in the field of cosmetics. The use of these up-to-date products as an add-on in the cosmetic field corresponds aptly with recent practices and the slogan of the "healthy skin for all" theme. Additionally, in recent years, the wide antimicrobial spectrum of some additives led to their universal use and caused various allergic reactions. Such severe allergies eventually resulted in these complexes (e.g., hexachlorophene, bithionol, mercury compounds, vinyl chloride, zirconium-containing formulations, and halogenated salicylanilides) being prohibited from use. Likewise, less allergic products do not warranty full liberty from allergies (Millikan, 2001). The mushrooms used are primarily known to generate medicinal compounds and thus were the earliest to be integrated with cosmetic applications. There are, although, many more mushroom species that are unproven, unreported, or not cultivable and hold tremendous probability for use in the cosmetic industry. The byproducts of biotransformation methods such as lactic acid and ceramides that are produced by involving fungi could be incorporated into cosmetics (Hyde *et al.* 2010). Notable mushrooms in cosmetics are.

Reishi (*Ganoderma lucidum*)

Reishi mushrooms are renowned for their adaptogenic properties and have been used for centuries in traditional Chinese medicine. They contain triterpenoids and polysaccharides, which possess potent anti-inflammatory and immunomodulatory effects. Reishi is renowned for its adaptogenic properties and is often called the "Mushroom of Immortality." It contains potent polysaccharides and beta-glucans, promoting skin hydration and overall well-being (Yin *et al.* 2019; Li *et al.* 2019). Reishi mushrooms are a storehouse of strong antioxidants, making them a suitable fit in a broad range of products to cure aging.

Cordyceps (*Cordyceps sinensis*)

Cordyceps have been used in traditional Tibetan and Chinese medicine for centuries. They contain cordycepin and other bioactive compounds that possess strong anti-inflammatory properties. *Cordyceps* mushrooms are traditionally used to support energy levels and endurance. By enhancing oxygen utilization and circulation, *Cordyceps* indirectly support hydration at the cellular level (Ashraf *et al.* 2020).

Lion's mane (*Hericium erinaceus*)

This is a famously used mushroom in southeast Asia for culinary purposes. It is rich in phenolics, polysaccharides, and different bioactive compounds. Its water extract has shown the potential for wound healing (Elkhateeb and Elnahas, 2019).

Chaga (*Inonotus obliquus*)

Chaga mushrooms are abundant in antioxidants like melanin and polyphenols, which contribute to their potent anti-inflammatory effects (Alhallaf and Perkins, 2022).

Shiitake (*Lentinula edodes*)

Shiitake mushrooms are not only delicious but also contain beta-glucans that contribute to skin hydration and digestive health. Shiitake mushroom (*Lentinula edodes*) used in cosmetics as an exfoliant, reduces inflammation, promotes skin regeneration, and maintains skin flexibility. Shiitake mushrooms hold the antioxidant L-ergothioneine, which hampers cell damage and exfoliates the skin. They are a vital source of kojic acid and it brightens the skin and treats acne scars. Its anti-inflammatory effects help improve strength, rejuvenate skin, and enhance skin elasticity. Thus, it is often found in skin care products preferably those with anti-aging benefits. *Lentinula edodes* preparations contain kojic acid, a natural substitute to hydroquinone that upgrades skin appearance by lightening age spots and scars (Rahman and Choudhury, 2012).

Turkey Tail (*Trametes versicolor*)

Rich in beta-glucans and polysaccharopeptides, turkey tail mushrooms have shown promising results in managing inflammation and improving immune function (Bains and Chawla, 2020).

Tremella (*Tremella fuciformis*)

Tremella fuciformis (snow fungus), has the power to retain moisture in the skin in surplus to hyaluronic acid. It has anti-inflammatory and antioxidant properties and hastens the wound-healing process. *Tremella* is highly prized for its hydrating effects on the skin (Zhang *et al.* 2013). It is a common ingredient in beauty products for its ability to retain moisture and improve skin elasticity. *Tremella* extracts make a vast addition to extensive skin care products which are relevant in the treatment of skin diseases (DeBaets and Vandamme, 2001). *Tremella* mushroom reported improved skin hydration and elasticity, suggesting its role in anti-aging skincare (Ma *et al.* 2021).

Accordingly, a broad array of edible mushrooms is included in food products, supplements, and cosmetics (Srivastava *et al.* 2020). *Agaricus bisporus*, *Pleurotus ostreatus*, *Hypsizygus ulmarius*, *Fomes fomentarius*, *Agaricus subrufescens*, *Coprinus comatus*, *Hericium erinaceus*, *Mycocleptodonoides aitchisonii*, *Phellinus linteus*, *Schizophyllum commune*, and *Volvareilla volvacea* are some species quite popular (Van Griensven, 2009; Wasser, 2010). Chandrasekaran *et al.* 2012; Lee *et al.* 2011).

Beneficial Compounds that Contain Anti-aging Property

Beta-glucan content of mushrooms offers anti-aging benefits. They have both cosmetic and healing functions, which is the best composition for any cosmetic product. Cosmeceuticals bind together this effect and exquisitely deliver the active constituents in a biologically efficient form to the skin (Choi and Berson, 2006). Diverse compounds

isolated from medicinal mushrooms are ceramides, lectins, polysaccharides, phenolics and polyphenolics, terpenoids, ergosterols, omega-3, 6,9 fatty acids, carotenoids, lentinans, and resveratrol (Chaturvedi *et al.* 2018; Kalač, 2013). Topical usage of these mushroom extracts provides an abundance of skin benefits that include prevention of photoaging, giving hydration, antioxidant act, and prevention UV-damage. Fruiting bodies of some wild and cultivable mushrooms with plenty of medicinal compounds and secondary metabolites are being harnessed in the cosmetic industry. The extracts are often quoted as powerful antioxidants. Cosmetic chemists are concentrating on the mushroom anti-aging benefits. Prominent mushrooms are found in cosmetics ranging from anti-aging serums to moisturizers (Gautier *et al.* 2008).

Some mushrooms are also used in biotransformation and the byproducts could be incorporated into cosmetics (Gao *et al.* 2004). Lactic acid is an alpha hydroxy acid (AHA) used in cosmetics to get rid of dead cells, lighten spots, and treat wrinkles. Ceramides are also used in cosmetics as epidermal hydrating agents preferably for dry, itchy skin. They firm the sagging skin and improve texture. But they are high-priced due to a shortage of supply. A few mushroom extracts are efficient in hastening the skin renewal speed, mending the dermal molecular components that support structure and provide elasticity to the skin (Bowe, 2013). A few mushroom varieties have kojic acid, which is a distinguished skin lightener. Kojic acid is functional as a natural substitute to noxious chemical skin lighteners, such as hydroquinone which has not long ago been linked to skin cancer (Smith *et al.* 2002). Major compounds that attribute to anti-aging are listed below

Polysaccharides

Medicinal mushrooms are rich in polysaccharides, which are long-chain carbohydrates that can hold water molecules. When consumed, the polysaccharides in medicinal mushrooms can help keep the body hydrated at a cellular level, promoting healthy and supple skin, hair, and nails. Polysaccharides, especially β -(1-3)-D-glucan, isolated from *Pleurotus* species inherit anti-cancer properties that have been reported in numerous fungi and are utilized in cosmetics (Synytsya *et al.* 2009).

Beta-glucans

Beta-glucans are a type of soluble fiber found in certain medicinal mushrooms like Reishi and Shiitake (Vaithanomsat *et al.* 2022). These compounds have been shown to improve water retention in the body and enhance the skin's ability to maintain hydration. Additionally, beta-glucans can support the gut's health by promoting beneficial gut bacteria, contributing to better digestion and nutrient absorption.

Trace minerals

Medicinal mushrooms are known to accumulate trace



Figure 1: a). *Ganodermalucidum* b). *Lentinula edodes* c). *Cordyceps sinensis* d). *Tremellafuciformis* e). *Trametes versicolor* f). *Hericiumerinaceus* g). *Inonotus obliquus* h). *Fomitopsispinicola* i). *Fomesfomentarius* j). *Flammulinavelutipes* k). *Phellinus baumii* l). *Schizophyllum commune* m). *Grifola frondosa* n). *Hypsizygosulmarius* o). *Agaricussubrufescens* p). *Cyclocybaeagerita* (adapted from <https://editorialist.com/beauty/mushroom-skincare/>)

minerals from their growing environment. Some of these minerals, such as potassium, magnesium, and selenium, play essential roles in maintaining fluid balance, nerve function, and overall hydration status in the body.

Adaptogenic properties

Medicinal mushrooms, also known as adaptogenic mushrooms, are a diverse group of fungi that contain a unique array of bioactive compounds. These compounds are responsible for the mushrooms' various health-promoting properties, including their hydrating ability. Adaptogens are substances that help the body adapt to various stressors

and maintain a state of balance or homeostasis (Chugh *et al.* 2022). Chronic stress can lead to dehydration as the body diverts resources away from non-essential functions like hydration. Medicinal mushrooms' adaptogenic properties can support stress management, indirectly contributing to better hydration.

Skin Aging

Aging is a degenerative process that embraces the skin and the skin support systems including the bone, cartilage, and subcutaneous compartments. Environmental factors that have an impact on the aging of the skin play a central role.

It is well accepted that oxidative stress commits to extrinsic skin aging, but findings point towards reactive oxygen species (ROS) as one of the major causes and contributors; not only does ROS production increase with age, but human skin cells' ability to repair DNA damage steadily decreases over the years (Poljšak *et al.* 2012). The major sources of reactive oxygen species are i). a mitochondrial source (that has a significant role in aging) and ii). a non-mitochondrial source (that has some role in the pathogenesis of age-related diseases).

Maximum studies propose that a larger part of intracellular ROS generation is procured from mitochondria (Chance *et al.* 1979). To sum up, surplus production of ROS and reduced antioxidant activity with advanced age remarkably contribute to chronological aging. Oxidative damage is the utmost reason and contributor to skin aging. Skin tissues replenish energy mostly using aerobic glycolysis. Regardless of the presence of oxygen, there is the selective conversion of glucose to lactate (Philpott and Kealey, 1991). This results in the production of a considerable quantity of lactate, which is taken to the liver via the bloodstream and converted back to glucose (the Cory cycle). The skin has a strong inclination for the metabolism of glucose in place of fatty acids or ketone bodies, though citric acid cycle intermediates such as glutamine are also actively engaged (Williams *et al.* 1993). Intriguingly, of the remarkably little quantity of oxygen that is metabolized by the skin, the bulk is supplied to the epidermis and upper dermis by diffusion from the atmosphere. The two types of aging are-

Intrinsic Aging

Intrinsic aging, also pronounced as the natural aging process, is an uninterrupted process that begins in the twenties. Inside the skin, collagen building drops down and elastin has a bit less spring. The shedding of dead skin cells comparatively slows down along with a decline in the synthesis of new cells. While these changes usually begin in the mid-twenties, the signs of intrinsic aging are typically not visible for years. The intrinsic aging signs encompass fine wrinkles, transparent skin, loss of fat mass, graying hair, reduction in bone density, dullness, uneven skin tone, loss of underlying fat, sagging skin, dry skin, pores, and age spots. With aging, the extracellular matrix and its major component hyaluronate are slowly lost. They sustain the intracellular structures by establishing a viscoelastic network in which collagen and elastin fibers are embedded. Together, they cause the loss of the skin's mechanical functions. Hyaluronate supplies a cushion effect to the skin structures along with the epidermis. The solidity of the skin is brought by the extracellular matrix and the depletion of hyaluronate and the viscoelastic buffering system which would lead to easy tearing resulting in skin lesions. The prime issue that accelerates wrinkling is dehydration (Yaar and Gilchrist, 1999).

Extrinsic Aging

A vast number of external factors often act collectively and interfere with the ongoing aging process to age our skin before time. External factors that hastily age the skin facial movements, sun exposure, and smoking. Cigarette smoking causes physiological shifts in the body that encourage aging. People who are chain-smokers, do develop wrinkled, yellowish skin not seen in non-smokers. Among detrimental environmental factors that lead to extrinsic aging, long-term exposure to UV radiation is most prominent (Draelos, 2006). It is addressed as photoaging. Photoaging directly corresponds to the amount of UV rays received during the lifespan (Fisher, 2005).

Rejuvenating Benefits of Medicinal Mushrooms

Antioxidant Powerhouse

One of the primary mechanisms of aging is oxidative stress, which leads to cellular damage and accelerated aging. Medicinal mushrooms, such as Reishi (*Ganoderma lucidum*) and *Cordyceps* (*Cordyceps sinensis*), are abundant in antioxidants that neutralize free radicals, reducing oxidative damage and promoting cellular health. Many medicinal mushrooms are rich in antioxidants, which neutralize free radicals and protect the skin from oxidative stress. By reducing cellular damage, these antioxidants can help prevent the formation of dark spots and support a brighter complexion. A potent anti-oxidant, L-ergothioneine, has been located in high concentrations in mushrooms. *Agaricus bisporus* (both juvenile brown and mature white stage) have the most L-ergothioneine (Dubost *et al.* 2007). Ergothioneine shields the skin from oxidative damage, protecting DNA damage. Trehalose is also an antioxidant. Trehalose is widespread in mushrooms such as *Lentinula edodes*, *Grifola fondosa*, *Pholiota nameko*, and *Auricularia auricula-judae* (Kalač 2009).

Anti-Inflammatory Properties

Inflammation is a crucial defense mechanism by which the body responds to injury, infection, or tissue damage. In the short term, it helps the body heal and fight off pathogens. However, chronic inflammation can have detrimental effects on overall health and is implicated in various ailments, such as arthritis, cardiovascular diseases, diabetes, and certain types of cancer. Managing chronic inflammation is, therefore, essential for maintaining overall well-being. Chronic inflammation can lead to skin discoloration and dullness. The anti-inflammatory compounds present in medicinal mushrooms can help calm inflammation, promoting a more even skin tone. Chronic inflammation is associated with age-related ailments, including arthritis, cardiovascular disease, and cognitive decline. Lion's Mane (*Hericium erinaceus*) and Maitake (*Grifola frondosa*) mushrooms possess anti-inflammatory properties that can

help mitigate inflammation and promote overall well-being (Mori *et al.* 2015; Liu *et al.* 2023).

Cellular Regeneration

Some mushrooms, like *Cordyceps* and Lion's Mane, have been found to stimulate skin cell regeneration and collagen production. This regeneration process can help replace damaged skin cells with new ones, leading to a more youthful and radiant appearance. Chaga (*Inonotus obliquus*) and Tremella (*Tremella fuciformis*) mushrooms are known to support skin health by promoting collagen synthesis, improving skin elasticity, and reducing the appearance of fine lines and wrinkles (Kim, 2005; Meng *et al.* 2021).

Immune System Support

A robust immune system is crucial for maintaining health as we age. Medicinal mushrooms like Turkey Tail (*Trametes versicolor*) and Shiitake (*Lentinula edodes*) contain beta-glucans and other compounds that enhance immune function, supporting the body's ability to fight infections and diseases.

Regulation of Immune Response

Medicinal mushrooms have a bidirectional effect on the immune system. They can modulate immune activity, enhancing the body's defense against infections, while also down-regulating excessive immune responses that lead to inflammation. This fine-tuning of immune function helps maintain a balanced inflammatory state and prevents the immune system from attacking healthy cells (Pathak *et al.* 2022).

Inhibition of Pro-Inflammatory Cytokines

Cytokines are small proteins produced by various immune cells that play a pivotal role in initiating and regulating inflammation. Certain medicinal mushrooms have been shown to suppress the release of pro-inflammatory cytokines, such as interleukin-6 (IL-6) and tumor necrosis factor-alpha (TNF- α), thereby preventing excessive inflammation (Rowaiye *et al.* 2022).

Modulation of NF-kB Pathway

The NF-kB (Nuclear Factor-kappa B) pathway is a crucial signaling pathway that regulates immune responses and inflammation (Hilliard, 2020). Some medicinal mushrooms inhibit this pathway, thereby exerting anti-inflammatory effects. Terpenes and terpenoids from *Ganoderma lucidum* can stimulate the expressions of genes coding for proteins in the nuclear factor (NF)-kB pathway and modulate immune system functions (Gao *et al.* 2002).

Melanin Regulation:

Melanin is responsible for skin pigmentation. Excessive melanin production can result in hyperpigmentation and dark spots. Certain mushroom extracts have shown the

ability to regulate melanin production, potentially reducing the appearance of dark spots and promoting an even skin tone.

Tyrosinase inhibitors with skin structure

Tyrosinase inhibitors play an important role in the cosmetic and pharmaceutical industries for their skin-whitening effect and depigmentation after sunburn. They are used in the treatment of certain dermatological diseases related with melanin hyperpigmentation. However, only a few antityrosinase inhibitors are commercially available. As commercially available antityrosinase inhibitors cause cell toxicity and are the least stable, therefore, more naturally derived ones are needed. Naturally derived compounds cure many skin diseases, and hyperpigmentation, and protect the skin from damaging agents (Parvez *et al.* 2007). Tyrosinase enzyme leads to enzymatic browning and its inhibitors may be helpful in the medicinal, cosmetic, and food industries. Madhosingh and Sundberg (1974) isolated, purified, and characterized two inhibitors from mushroom *Agaricus hortensis*. Inhibitor Ia inhibited the enzyme competitively, whereas Ib noncompetitively inhibited the enzyme, as revealed by the Lineweaver-Burk plots. Several naturally derived tyrosinase inhibitors are reported but only some of them are incorporated into the skin-whitening creams due to safety issues. Kang *et al.* (2004) reported a sphingolipid, two tyrosinase inhibitors, and two carboxylic acids for the first time from *Phellinus linteus* fruit bodies. Tyrosinase enzyme catalyzes the first two steps of the melanin biosynthesis pathway, encircling the conversion of tyrosine to L-DOPA and L-DOPA to dopaquinone. Kojic acid, a compound that is commercially used to inhibit melanin synthesis, is a skin-whitening agent. Numerous studies have appeared in the literature demonstrating the inhibition of tyrosinase activity by mushroom extracts (Park *et al.* 2015).

AbdRazak *et al.* (2020) concluded that cold-water extract of *Schizophyllum commune* and hot-water extract of *Ganoderma lucidum* exhibit cosmeceutical potential. The findings suggest that the cosmeceutical properties of their fruit bodies might be attributed to the different types of compounds such as polysaccharides and phenolics found in them.

Skin Brightening

The skin's brightness and radiance are determined by multiple factors, including skin cell turnover, melanin production, and environmental exposure. When the skin is exposed to pollutants, UV radiation, and other harmful agents, it can lead to the accumulation of oxidative stress and free radicals. These factors contribute to an uneven complexion, dark spots, and premature aging. Medicinal mushrooms, however, possess unique bioactive compounds, such as polysaccharides, beta-glucans, triterpenes, and antioxidants, which can help combat these adverse effects

and promote skin health. These compounds can contribute to skin brightening through various mechanisms.

Anti-hyaluronidase activity

Hyaluronic acid is a vital part of skin health. It is present in the extracellular matrix of the dermis with the primary function of moisture locking. It binds to and retains water in the dermis. It also plays an essential role in the strengthening of blood vessels. In its absence, capillary permeability results in edema – an accumulation of fluid underneath the skin in the affected area that manifests itself as swelling. Yahaya and Don (2012) observed the inhibition of hyaluronidase activity by extracts of several mushroom species including *Trametes lactinea*. Meng *et al.* (2011) reported that the fruiting bodies of *Pleurotus citrinopileatus* have the potential to be used as an ingredient in skin cosmetics owing to their anti-hyaluronidase and antioxidant activity.

Skin Whitening

Uneven skin pigmentation may lead to blemishes, brown to grey discoloration that may need cosmetic treatment. Melanin production either fewer or more is a concern of skin pigmentation. Melanocyte cells secrete melanin and are triggered by tyrosinase, which creates the color of skin, eyes, and hair. Maximum skin-whitening treatments cut down melanin production by inhibiting tyrosinase. Skin-lightening products and masks contain *Ganoderma* extracts and tyrosinase inhibitory compounds contained in these mushrooms make them so popular. Chien *et al.* (2008) evaluated the property of some mushrooms to inhibit tyrosinase activity. *Ganoderma lucidum* exhibited significant inhibition of tyrosinase activity as compared to other basidiomycetes. In humans, skin pigmentation results from the biochemical synthesis and accumulation of melanin. Nagasaka *et al.* (2015) studied to find if edible mushrooms are useful for skin whitening and recorded the mechanisms involved in melanin biosynthesis. Their study demonstrated that *F. velutipes* extract repressed melanin synthesis and tyrosinase activity in B16 murine melanoma cells. Their results suggested that the *F. velutipes* extract could contain an efficient component causing skin whitening and could be used as an alternate agent for treating hyperpigmentation. *Phellinus baumii* is a medicinal mushroom used for a long period. Methanol extracts of *P. Baumii* were used to study skin-whitening activity. For the assay of the skin-whitening act, tyrosinase, and DOPA inhibitory activities, activities of B16/F10 melanoma cells treated with the methanol extract were investigated. Results showed that their extract inhibited tyrosinase activity and melanin synthesis in a dose-dependent manner in B16/F10 melanoma cells. Therefore, *P. baumii* methanol extract might be used for the development of skin-whitening, anti-UV, and skin care agents (Lee *et al.* 2013).

Scientific Evidence and Clinical Studies

While traditional use and anecdotal evidence provide valuable insights, modern science has taken a keen interest in studying the anti-aging potential of medicinal mushrooms. Several studies have displayed their effects on cellular health, longevity, and age-related diseases: The researchers at Aveeno, a Johnson & Johnson brand created a natural shiitake complex that is featured in the Aveeno Positively Ageless range of products (www.aveeno.com). According to the researchers, these formulations have been enhancing the youthful appearance of skin. Weil has formulated a mushroom-based skincare routine that asserts to lessen the skin's inflammation and redness. According to them, there is a considerable improvement in dry, flaky skin and rosaceous skin conditions. The skin felt plump and calm after using mushroom-infused products. Famously prized in the nutritional medicines of South Asia, mushrooms are now drawing more interest from researchers and dermatologists. These products support the natural skin and refine its appearance by making it fit. Topical administration of a range of mushrooms, such as shiitake, maitake, and tremella are done for their skin beauty-enhancing qualities. They contain antioxidants as well as anti-inflammatory compounds which help to tend skin problems caused by swelling and surplus free radicals. Zhao *et al.* (2020) highlighted the immunomodulatory effects of various medicinal mushrooms, emphasizing their potential in supporting the immune system and preventing age-related immunosenescence.

Incorporating Medicinal Mushrooms into Skincare

To harness the skin-brightening benefits of medicinal mushrooms, several skincare products are now incorporating these fungi as key ingredients. These products can range from serums and creams to masks and exfoliants. It is essential to look for reputable brands, products that use high-quality mushroom extracts and adhere to ethical and sustainable harvesting practices.

Moreover, individuals can also explore topical mushroom extracts through DIY skincare routines. For instance, brewing mushroom teas and using the cooled liquid as a toner might provide some benefits due to the compounds present in the mushroom extracts. However, it is crucial to remember that individual skin types and sensitivities vary. Before incorporating any new skincare ingredient, especially natural extracts, it is recommended to conduct a patch test and consult a dermatologist or skincare professional.

The Hydration Challenge: Hydration is crucial to maintain a healthy body. Water is essential for numerous bodily functions, including regulating body temperature, supporting digestion, lubricating joints, and transporting nutrients and oxygen to cells. Insufficient hydration can lead

to dehydration, which can manifest as fatigue, headache, dizziness, dry skin, and impaired cognitive function. Many people struggle to maintain proper hydration due to busy lifestyles, lack of awareness, or simply not enjoying the taste of plain water. As a result, there is a need for alternative sources of hydration that can provide additional health benefits beyond water itself.

Incorporating Medicinal Mushrooms into one's routine

There are various ways to incorporate the hydrating benefits of medicinal mushrooms into your daily routine:

Mushroom teas and infusions

Medicinal mushroom teas are a soothing and effective way to enjoy the hydrating properties of these fungi. You can find pre-packaged mushroom tea blends or prepare your own by steeping dried mushrooms in hot water.

Mushroom powders and extracts

Mushroom powders and extracts can be added to smoothies, soups, or other beverages for a convenient and nutritious boost. They are easily accessible in certain food stores or online.

Skincare products: Look for skincare products containing Tremella or Reishi mushrooms to promote skin hydration and maintain a healthy complexion.

Culinary uses

Cooking with medicinal mushrooms like Shiitake can not only add a delightful umami flavor to dishes but also provide potential hydration benefits (Ferreira *et al.* 2005).

Conclusion

Medicinal mushrooms have a rich history in traditional medicine and continue to captivate modern researchers with their potential anti-aging properties. As our understanding of these fungi deepens, we may unlock innovative ways to harness their power for promoting longevity and combating age-related ailments. The world of skincare is continually evolving, and the inclusion of medicinal mushrooms as potent skin-brightening agents is an exciting development. Their antioxidant, anti-inflammatory, and skin-regenerating properties make them valuable assets in achieving a healthy, radiant complexion. As research in this field progresses, we can expect to see even more innovative skincare products utilizing the power of medicinal mushrooms to promote natural skin brightening and overall skin health. Medicinal mushrooms are a treasure trove of bioactive compounds that hold the potential to revolutionize the way we approach inflammation and chronic disease management. While the research on their anti-inflammatory properties is still evolving, the existing body of evidence is promising and warrants further investigation. Before incorporating medicinal mushrooms into our health or dietary regimen, it

is crucial to consult with a healthcare professional, especially if one has any pre-existing medical conditions or is taking medications. When used responsibly and under proper guidance, medicinal mushrooms could offer a natural and effective approach to support the body's inflammatory response and promote overall well-being. With ongoing research and a deeper understanding of their mechanisms, the future of medicinal mushrooms as anti-inflammatory agents looks brighter than ever. With their hydrating properties, adaptogenic capabilities, and rich nutritional content, these fungi have rightfully earned their place as superfoods in the realm of alternative medicine and wellness.

Acknowledgement

We are grateful to the Head, Department of Botany, Deen Dayal Upadhyaya Gorakhpur University, Gorakhpur for his kind support

References

- AbdRazak DL, Jamaluddin A, Abd Rashid NY, Sani NA and Abdul Manan M (2020). Assessment of Cosmeceutical Potentials of Selected Mushroom Fruit body Extracts Through Evaluation of Antioxidant, Anti-Hyaluronidase and Anti-Tyrosinase Activity. *J* **3** 329-342. <https://doi.org/10.3390/j3030026>
- Alhallaf W and Perkins LB (2022). The Anti-Inflammatory Properties of Chaga Extracts Obtained by Different Extraction Methods against LPS-Induced RAW 264.7. *Molecules* **27**(13):4207. doi: 10.3390/molecules27134207. PMID: 35807453; PMCID: PMC9268247.
- Ashraf SA, Elkhalfifa AEO, Siddiqui AJ, Patel M, Awadelkareem AM, Snoussi M, Ashraf MS, Adnan M and Hadi S (2020). Cordycepin for Health and Wellbeing: A Potent Bioactive Metabolite of an Entomopathogenic *Cordyceps* Medicinal Fungus and Its Nutraceutical and Therapeutic Potential. *Molecules* **25**(12):2735. doi: 10.3390/molecules25122735. PMID: 32545666; PMCID: PMC7356751.
- Bains A and Chawla P (2020). *In vitro* bioactivity, antimicrobial and anti-inflammatory efficacy of modified solvent evaporation assisted *Trametes versicolor* extract. *3 Biotech.* **9**(404). doi: 10.1007/s13205-020-02397-w. Epub. PMID: 32903990; PMCID: PMC7447717.
- Bowe WP (2013). Cosmetic benefits of natural ingredients: Mushrooms, feverfew, tea, and wheat complex. *J. Drugs Dermatol.* **12** 133-136.
- Camassola M (2013). Mushrooms—The incredible factory for enzymes and metabolites productions *FermentTechnol*.2.
- Chance B, Sies H and Boveris A (1979). Hydroperoxide metabolism in mammalian organs. *PhysiolRev.* **59**:527-605.
- Chandrasekaran G, Oh DS and Shin HJ (2012). Versatile applications of the culinary medicinal mushroom *Mycoleptodonoidesaitchisonii* (Berk.) Maas G. (Higher Basidiomycetes): A review. *Int J Med Mushrooms* **14**: 395-401.
- Chaturvedi VK, Agarwal S, Gupta KK, Ramteke PW and Singh MP (2018). Medicinal mushroom: boon for therapeutic applications *3 Biotech* **8** (8) <https://doi.org/10.1007/s13205-018-1358-0>
- Chien CC, Tsai ML, Chen CC, Chang SJ and Tseng CH (2008). Effects

- on tyrosinase activity by the extracts of *Ganoderma lucidum* and related mushroom *Mycopathologia* **166**: 117–120.
- Chugh RM, Mittal P, Mp N, Arora T, Bhattacharya T, Chopra H, Cavalu S and Gautam RK (2022). Fungal Mushrooms: A Natural Compound With Therapeutic Applications. *Front Pharmacol* **13**:925387. doi: 10.3389/fphar.2022.925387. PMID: 35910346; PMCID: PMC9328747.
- Draeos ZD (2006). Concepts in a multiprong approach to photoaging *S Th Lett* **11**: 1-3.
- De Baets S and Vandamme EJ (2001). Extracellular *Tremella* polysaccharides: Structure, properties, and applications *Biotech Lett* **23**: 1361–1366.
- Dubost NJ, Beelman RB and Royle DJ (2007). Influence of selected cultural factors and postharvest storage on ergothioneine content of common button mushroom *Agaricus bisporus* (J. Lge) Imbach (Agaricomycetidae) *Int. J. Med. Mushrooms* **9**:163–176.
- Elkhateeb WA, Elnahas MO, Thomas PW and Daba GM (2019). To heal or not to heal? Medicinal mushrooms wound healing capacities *ARC J. Pharm. Sci.* **5**: 28–35.
- Fisher GJ (2005). The pathophysiology of photoaging of the skin *Cutis* **75(2)**: 5-9.
- Kalač P (2009). Chemical composition and nutritional value of European species of wild growing mushrooms: A review *Food Chem* **113**: 9–16.
- Friedman M (2015). Chemistry, Nutrition, and Health-Promoting Properties of *Hericium erinaceus* (Lion's Mane) Mushroom Fruiting Bodies and Mycelia and Their Bioactive Compounds *J Agric Food Chem* **63(32)**:7108-23. doi: 10.1021/acs.jafc.5b02914.
- Gao YH, Zhou SF, Chen GL, Dai XH and Ye JX (2002). A Phase I/II Study of a *Ganoderma lucidum* (Curt.: Fr.) P. Karst. Extract (Ganopofy) in Patients with Advanced Cancer *Int. J. Med. Mushrooms* **4**: 207–214. doi: 10.1615/IntJMedMushr.v4.i3.30.
- Gao JM, Zhang AL, Chen H and Liu JK (2004). Molecular species of ceramides from the ascomycete truffle *Tuber indicum* *Chem. Phys. Lipids* **131**: 205–213.
- Hilliard A, Mendonca P and Soliman KFA (2020). Involvement of NF B and MAPK signaling pathways in the preventive effects of *Ganoderma lucidum* on the inflammation of BV-2 microglial cells induced by LPS *J Neuroimmunol* **345**: 577269. doi: 10.1016/j.jneuroim.2020.577269.
- Hyde KD, Bahkali AH and Moslem MA (2010). Fungi—An unusual source for cosmetics *Fungal Divers* **43** 1–9.
- Ines SM, Mirna Š (2010). Skin Aging *Acta Clin Croat* **49**: 515-519.
- Kalač P (2013). A review of chemical composition and nutritional value of wild-growing and cultivated mushrooms *J. Sci. Food Agric* **93**: 209–218.
- Kang HS, Choi JH and Cho WK (2004). A sphingolipid and tyrosinase inhibitor from the fruiting body of *Phellinus linteus* *Arch Pharm Res* **27**: 742–50.
- Kim YR (2005). Immunomodulatory Activity of the Water Extract from Medicinal Mushroom *Inonotus obliquus* *Mycobiology* **33(3)**: 158-62. doi: 10.4489/MYCO.2005.33.3.158.
- Lee BJ, Park J, Park HJ, Shin S, Kwon M, Yeom B, Sur S, Kim M and Lee H (2011). *Cordyceps militaris* improves neurite outgrowth in Neuro2A cells and reverses memory impairment in rats *Food Sci Biotechnol* **20**: 1599-1608.
- Lee JS, Shin DB, Lee SM, Kim SH, Lee TS and Jung DC (2013). Melanogenesis inhibitory and antioxidant activities of *Phellinus baumii* methanol extract *Korean J. Mycol* **41**: 104–111.
- Li LD, Mao PW, Shao KD, Bai XH and Zhou XW (2019). *Ganoderma* proteins and their potential applications in cosmetics *Appl. Microbiol. Biotechnol* **103**: 9239–9250. doi: 10.1007/s00253-019-10171-z.
- Liu X, Chen S, Liu H, Xie J, Hasan KMF, Zeng Q, Wei S and Luo P (2023). Structural properties and anti-inflammatory activity of purified polysaccharides from Hen-of-the-woods mushrooms (*Grifola frondosa*) *Front. Nutr.* **10** 1078868. doi: 10.3389/fnut.2023.1078868
- Ma X, Yang M, He Y, Zhai C and Li C (2021). A review on the production, structure, bioactivities and applications of *Tremella* polysaccharides *Int J Immunopathol Pharmacol.* **35**:20587384211000541. doi: 10.1177/20587384211000541.
- Madhosingh C and Sundberg L (1974). Purification and properties of tyrosinase inhibitor from the mushroom *FEBS Lett* **49**: 156–158.
- Millikan LE (2001). Cosmetology, cosmetics, cosmeceuticals: Definitions and regulations *Clin. Dermatol.* **19**: 371–374.
- Meng TX, Furuta S, Fukamizu S, Yamamoto R, Ishikawa H, Shimizu ETAK, Ohga S and Kondo R (2011). Evaluation of biological activities of extracts from the fruiting body of *Pleurotus citrinopileatus* for skin cosmetics *J. Wood Sci.* **57**: 452–458. DOI 10.1007/s10086-011-1192-z
- Mori K, Ouchi K and Hirasawa N (2015). The Anti-Inflammatory Effects of Lion's Mane Culinary-Medicinal Mushroom, *Hericium erinaceus* (Higher Basidiomycetes) in a Coculture System of 3T3-L1 Adipocytes and RAW264 Macrophages *Int J Med Mushrooms* **17(7)**: 609-18. doi: 10.1615/intjmedmushrooms.v17.i7.10.
- Nagasaka R, Ishikawa Y, Inada T and Ohshima T (2015). Depigmenting effect of winter medicinal mushroom *Flammulina velutipes* (higher Basidiomycetes) on melanoma cells *Int. J. Med. Mushrooms* **17**: 511–520.
- Park KM, Kwon KM and Lee SH (2015). Evaluation of the antioxidant activities and tyrosinase inhibitory property from mycelium culture extracts *Evid. Based Complement. Alternat. Med.* 616298. doi 10.1155/2015/616298.
- Parvez S, Kang M, Chung HS and Bae H (2007). Naturally occurring tyrosinase inhibitors: mechanism and applications in skin health, cosmetics, and agriculture industries *Phytother. Res* **21**: 805-816.
- Pathak MP, Pathak K, Saikia R, Gogoi U, Mohammad ZA, Patowary P and Das A (2022). Immunomodulatory effect of mushrooms and their bioactive compounds in cancer: A comprehensive review *Biomedicine & Pharmacotherapy* **149**: 112901, <https://doi.org/10.1016/j.biopha.2022.112901>
- Philpott MP and Kealey T (1991). Metabolic studies on isolated hair follicles: hair follicles engage in aerobic glycolysis and do not demonstrate the glucose fatty acid cycle *J Invest Dermatol.* **96**: 875-9.
- Poljšak B, Raja GD and Aleskandar G (2012). Intrinsic skin aging: The role of oxidative stress *Acta Dermatovenerol APA*, **21**: 1-4.
- Rahman T and Choudhury MBK (2012). Shiitake mushroom: A tool of medicine *Bangladesh J Med Biochem* **5(1)**: 24-32.
- Rowaiye A, Wilfred OI, Onuh OA, Bur B, Oni S, Nwonu EJ, Ibeanu G, Oli AN and Wood TT (2022). Modulatory Effects of Mushrooms on the Inflammatory Signaling Pathways and Pro-inflammatory Mediators *Clinical Complementary Medicine and Pharmacology* **2** 4,

- Smith JE, Rowan NJ and Sullivan R (2002). Medicinal mushrooms: A rapidly developing area of biotechnology for cancer therapy and other bioactivities *Biotechnol. Lett.* **24**: 1839–1845.
- Srivastava A, Attri BL and Sharma VP (2020). Status Report On Mushroom Based Cosmetic Products In Market *Mushroom Research* **29**: 650.36036.
- Synytsya A, Mičková K, Synytsya A, Jablonský I, Spěváček J, Erban V, Kovářiková E and Čopíková J (2009). Glucans from fruit bodies of cultivated mushrooms *Pleurotus ostreatus* and *Pleurotus eryngii*: Structure and potential prebiotic activity *CarbohydrPolym* **76**: 548–556.
- Tai SH, Kuo PC, Hung CC, Lin YH, Hwang TL, Lam SH, Kuo DH, Wu JB, Hung HY and Wu TS (2019). Bioassay-guided purification of sesquiterpenoids from the fruiting bodies of *Fomitopsis pinicola* and their anti-inflammatory activity *RSC Adv.* **9(59)**: 34184–34195. doi: 10.1039/c9ra05899k. PMID: 35530004; PMCID: PMC9073629.
- Taofiq O, González-Paramás AM, Martins A, Barreiro MF and Ferreira ICFR (2016). Mushroom extracts and compounds in cosmetics, cosmeceuticals and neuroceuticals—A review *Ind. Crops Prods* **90**: 38–48.
- Vaithanomsat P, Boonlum N, Chaiyana W, Tima S, Anuchapreeda S, Trakunjae C, Apiwatanapiwat W, Janchai P, Boondaeng A, Nimitkeatkai H and Jarerat A (2022). Mushroom β -Glucan Recovered from Antler-Type Fruiting Body of *Ganoderma lucidum* by Enzymatic Process and Its Potential Biological Activities for Cosmeceutical Applications *Polymers* (Basel). **14(19)**: 4202. doi: 10.3390/polym14194202.
- Van Griensven LJ (2009). Culinary-medicinal mushrooms: Must action be taken? *Int J Med Mushrooms* **11**: 281–286.
- Wachtel-Galor S, Yuen J and Buswell JA (2011). *Ganoderma lucidum* (Lingzhi or Reishi): A Medicinal Mushroom. In: Herbal Medicine: Biomolecular and Clinical Aspects, eds. Benzie IFF, Wachtel-Galor S, 2nd edition. Boca Raton (FL): CRC Press Taylor & Francis; Chapter 9.
- Wasser SP (2010). Shiitake (*Lentinula edodes*). In: Encyclopedia of Dietary Supplements, 2nd edn. eds. Coates PM, Betz GM, Blackman MR, Cragg GM, Levine M, Moss J, White JD. New York: Informa Healthcare. 719–726.
- Williams R, Philpott MP and Kealey T (1993). Metabolism of freshly isolated human hair follicles capable of hair elongation: a glutaminolytic, aerobic glycolytic tissue *J Invest Dermatol* **100**: 834–40.
- Yaar M and Gilchrist BA (1999). Aging of skin. In: Fitzpatrick's dermatology in general medicine. 5th ed. eds. Freedberg IM, Eisen AZ, Wolff K. New York: McGraw-Hill 1697–706.
- Yahaya YA and Don MM (2012). Evaluation of *Trametes lactinea* extracts on inhibition of hyaluronidase, lipoxygenase, and xanthine oxidase activities *in vitro* *J. Phys. Sci.* **23**: 1–15.
- Yang M, Zhang Z, He Y, Li C, Wang J and Ma X (2021). Study on the structure characterization and moisturizing effect of *Tremella* polysaccharide fermented from GCMCC5.39 *Food Science and Human Wellness*, **10(4)**: 471–479. <https://doi.org/10.1016/j.fshw.2021.04.009>
- Yin Z, Yang B and Ren H (2019). Preventive and Therapeutic Effect of *Ganoderma* (Lingzhi) on Skin Diseases and Care *AdvExp Med Biol* **1182**:311–321. doi: 10.1007/978-981-32-9421-9_14. PMID: 31777026.
- Y Wu, Choi MH, Li J, Yang H and Shin HJ (2016). Mushroom cosmetics: the present and future *Cosmetics* **3**: 22.
- Zhang K, Meng XY, Sun Y and Guo PY (2013). Preparation of *Tremella*, *Speranskia tuberculata* and *Eriocaulon buergerianum* extracts and their performance in cosmetics *Deterg. Cosmet.* **36**: 28–32.
- Zhao S, Gao Q, Rong C, Wang S, Zhao Z, Liu Y and Xu J (2020). Immunomodulatory Effects of Edible and Medicinal Mushrooms and Their Bioactive Immunoregulatory Products *J Fungi* (Basel). **6(4)**: 269. doi: 10.3390/jof6040269.