**RECENT ADVANCES IN COSMECEUTICALS**

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**ABSTRACT :**

The fast-expanding natural personal care market segment known as "cosmeceuticals" is a new topic in the cosmetics industry today. Cosmeceuticals are the future of skin care; they are the advances in the world of dermatological products and the new backbone of skin care. All cosmeceuticals claim to contain functional ingredients with therapeutic, disease-fighting, or healing properties. Raymond Reed coined the term cosmeceutical, but the concept was pioneered in the late 1970s by Dr. Albert Kligman and further popularized. Cosmeceuticals are applied topically as cosmetic-pharmaceutical hybrids to enhance beauty through ingredients that provide additional health-related functions or benefits. They are applied topically as cosmetics but contain ingredients that affect the biological function of the skin. Currently, cosmeceuticals serve as a bridge between personal care products and pharmaceuticals; cosmeceuticals are also the fastest-growing segment in the skincare market. This review paper aims to provide up-to-date insights into the latest trend in the cosmetics industry – cosmeceuticals.

**INTRODUCTION :**

Consumers worldwide are looking for personal care products that offer multiple benefits with minimal effort. Not only women but also more and more men use cosmetics to enhance their facial features. Cosmetics are products designed to be applied to the body to cleanse, beautify or alter the appearance and enhance attractive characteristics [1]. The U.S. Food and Drug Administration (USFDA) defines cosmetics as a formulation intended to be applied to the human body to cleanse, beautify, enhance attractiveness, or alter the appearance without altering body structure or - impairing functions. This broad definition includes any material suggested for use as a cosmetic article component, although soap does expressly excluded from this class[2]. However, under this law, the word cosmeceutical has no definition. According to the Federal Food Drug and Cosmetic Act (FD&CAct), there is no word like cosmeceutical. This word is only used for commercial purposes to designate cosmetic products with therapeutic effects. EUCD defines cosmetics as any substance or preparation intended to come into contact with the various external parts of the human body (epidermis, hair system, nails, lips, and external genitalia) or with the teeth and mucous membranes of the human. To be brought into contact with the oral cavity solely or primarily for cleaning, perfuming, changing its appearance, correcting body odors, or protecting it or keeping it in good condition[3]. The Drugs and Cosmetics Act 1940 and Rules 1945 define a cosmetic as any article intended to be rubbed, poured, sprinkled or sprayed or inserted into, or otherwise applied to the human body or any part thereof to cleanse, beautify, enhance attractiveness or change the body's appearance and includes any article will not to intended used as a component of cosmetics [4]. Despite these definitions, the legal meaning of cosmetics is broader in many nations. In some western countries, cosmetics are usually interpreted only as beautifying products, such as lipstick, mascara, eyeliner, highlighter, and other items[5]. Cosmeceuticals can describe preparations containing therapeutically active ingredients that have healing effects, mainly when applied topically with traditionally used cosmetics. These products have quantifiable restorative effects on skin and hair and treat various conditions such as damaged hair, wrinkles, photoaging, skin dryness, light spots, and hyperpigmentation. They promise to act as a bridge between pharmaceuticals and beauty care products to improve the appearance[6,7]. Cosmeceuticals do currently recognized as one of the fastest growing segments of the personal care industry, and the market for individual consideration is growing massively [8].

**CLASSIFICATION OF COSMECEUTICALS:**

The term cosmeceuticals have used with different terms. The definition remains the same for all terms, i. H. Cosmeceutical formulations that are neither pure cosmetics like lipsticks nor pure medicinal products like corticosteroids. It is a hybrid product category in the spectrum between pharmaceuticals and cosmetics. The terms substituted for cosmeceuticals are active cosmetics, nutricosmetics, performance cosmetics, functional cosmetics, and dermaceuticals. Cosmeceuticals are going categorized into the following categories:

1) Cosmeceutical products for the skin - antiaging creams, moisturizers, facial products, and lotions.

2) Cosmeceutical hair products - gels and creams, hair dyes and dyes, shampoos, growth stimulators, and conditioners.

3) Other - lipstick, nail polish, toothpaste, and powder

**COSMECEUTICAL PRODUCTS FOR THE SKIN:**

Cosmetics and skin care products are part of daily care. Protecting and maintaining the skin is essential to good health. Our skin, the body's largest organ, separates and protects the internal environment from the outer. U.V. rays from sunlight penetrate the skin and accelerate free radical damage, including inflammation, wrinkling, and hyperpigmentation. Due to prolonged exposure to U.V. rays, the skin's collagen and elastin fiber does break down by the enzymes collagenase and elastin, and the skin's texture deteriorates. Collagen and elastin are responsible for maintaining skin elasticity and integrity. Several plant extracts and antioxidants derived from natural sources can prevent skin aging and improve the skin's appearance[9]. Cosmeceuticals are cosmetic products with medical or drug-like benefits and can affect the biological function of the skin due to the nature of the functional ingredients they contain. There are skin care products that go beyond coloring and decorating the skin. These products improve skin function/texture by promoting collagen growth by fighting the harmful effects of free radicals, thereby keeping keratin structure in good condition and skin healthier [10-12]. Essential botanicals for dermatological applications such as cosmeceuticals include teas, soy, pomegranate, dates, grape seeds, pycnogenol, horse chestnut, German chamomile, curcumin, comfrey, allantoin, and aloe; only green and black tea, soy, pomegranate, and dates have studied to the point of publishing clinical trials treating parameters of extrinsic aging. Potential cosmetic ingredients in this category include green tea, grape seed extract, vitamin E, and beta-carotene[13].

**COSMECEUTICAL HAIR PRODUCT:**

Hair appearance is a feature of the body over which humans, unlike all other land mammals, have direct control. Hair care, color, and style play an important role in one's physical appearance and self-image. The earliest forms of hair cosmetics in ancient Egypt included setting the hair with mud and dyeing the hair with henna. In ancient Greece and Rome, countless ointments and tonics did recommend for beautifying the hair and remedies for scalp disorders. In comparison, shampoos were primarily hair and scalp cleansing products; current formulations adapted to the differences associated with hair quality, hair care habits, and specific issues such as treating oily hair, dandruff, and androgenic alopecia[14,15,16] and related to the external condition of the scalp. Hair cosmetics are used topically on the scalp and hair.A hair cosmeceutical product contains conditioning agents, unique nourishing ingredients, and hair growth stimulants. Conditioning agents impart softness and shine, reduce flyaways and improve detangling. Many ingredients, mainly fatty ingredients, hydrolyzed proteins, quaternized cationic derivatives, cationic polymers, and silicones [17]. Accordingly, the current ingredients in antidandruff are virtually all effective antifungal agents zinc pyrithione, ciclopirox, and ketoconazole [18]. Hair growth stimulants do not expect to impact hair growth due to the short exposure time and water dilution. A compound related to minoxidil (2,4-diaminopyrimidine-3-oxide) is a cosmetic that claims to act as a topical hair growth stimulant [19]. The prevention of inflammation and perifollicular fibrosis does propose as a target[20]. A certain level of effectiveness of 2,4-diaminopyrimidine-3-oxide claims the prevention of seasonal alopecia [21]. The recent approval in the United States of two new products, Propecia and Rogaine Extra Strength (Minoxidil) 5%, indicated in men to promote hair growth on the scalp, adds a new dimension to the treatment options available to physicians treating androgenetic alopecia added [22].

**NANOCOSMECEUTICLES :**

Nanotechnology does widely studied in the field of cosmetology and cosmetology [8,23]. Incorporating nanotechnology has led to advances in cosmetic science, leading to increased consumer demand worldwide [24]. Nanomaterials are currently attracting attention as they offer tremendous advantages over conventionally used cosmetic products. In addition, the amalgamation of nanomaterials has dramatically contributed to the global increase in pharmaceuticals and cosmetics market share. In 2019, the international market size of nanomaterials was estimated at US$8.5 billion and expected to increase by up to 13.1 billion% compound annual growth rate from 2020 - 2027 [25]. Although the term nanomaterials (gold and silver nanoparticles) has to use in cosmetics for several years, the range of applications has intensified in recent years. Using nanotechnology to manipulate materials at the atomic level has excellent potential in the field of cosmeceuticals and opens up new avenues for the cosmetics industry.

Incorporating different nanomaterials during the development of cosmetic/cosmetic products leads to nanocosmetics and nanocosmetics. Some benefits of nanotechnology-based cosmetics are the prolongation of action, increased bioavailability, and improved aesthetic appearance of products. These products offer several other advantages over commonly used cosmeceuticals, such as: In addition, the inclusion of nanoparticles in cosmetic formulations does not alter the properties of cosmeceuticals but improves their appearance, coverage, and adhesion to the skin. Cosmetic manufacturers use nano-sized ingredients to enhance U.V. Protection, skin penetration, color, fragrance release, finish quality, antiaging effect, and many other properties. They extend the duration of action by either controlling drug delivery, imparting site-specificity, enhancing biocompatibility, or increasing drug-loading capacity. These factors make them more popular with consumers, necessitating clinical trials in this area to address their safety concerns. They are successfully marketed as skin care, hair care, and nail care products, among others, and claim to stimulate their growth, protect their structure and increase hydration power, enhancing their effectiveness as cosmetic products [26,27]. Although they have several advantages, they also have stability, scalability, toxicity, and cost limitations.

Furthermore, the safety and toxicity profiles of nanomaterials are still controversial. The small size, increased surface area, and positive surface charge of nanoparticles enhance their ability to interact biologically with the microenvironment. On the other hand, they have dose-dependent toxicity with different administration routes—the drug's bioavailability does influence by the dosage rather than the physicochemical properties of the drug [28]. Therefore, in the case of cosmetic products, a significant concern in the advancement of nanoformulations is that they can increase the concentration of active ingredients reaching the blood and affect toxicity [29].

**Figure 1:** Visual representation of positive aspects of nano cosmeceutical

**MAJOR CLASSES IN NANOCOSMECEUTICALS :**

Cosmeceuticals do consider to be the fastest-growing segment of the personal care industry. A wealth of nanocosmeceuticals integrated into nail, hair, lip, and skin care. The main classes of nanocosmetics are shown in Figure 2 [30].

**Nanocosmeceutical**

**Skincare**

**Nail care**

**Hair care**

Lip care

**Lipstick**

**Nail lacquer**

**Moisturizer**

**Hair serum**

**Shampoo**

Lip balm

**Sunscreen**

**Lip gloss**

**Antiaging**

**products**

**Hair growth**

**stimulators**

**Skin cleanser**

**Conditioner**

**Lip**

**volumizer**

**Antiacne**

**products**

**Hair styling**

**gel**

**Eye cream**

**Hair Color**

**Figure 2:** Major classes in nanocosmeceuticals.

**Skincare** **-:** Skincare cosmeceuticals improve skin structure and function by stimulating collagen formation and fighting free radicals damaging effects. They make the skin healthier by keeping the keratin structure in good condition. In sunscreen, zinc oxide and titanium dioxide nanoparticles are the most effective minerals that protect the skin by penetrating the deep layers of the skin, making the product less greasy, smelly, and transparent [31]. S.L.N.s, nanoemulsions, liposomes, and niosomes are used extensively in moisturizing formulations because they form a thin film of humectants and retain moisture for extended periods. Marketed antiaging nanocosmetic products assimilating nanocapsules, liposomes, nanosomes, and nanospheres show benefits such as collagen renewal, skin rejuvenation, and skin tightening and firming [32].

**Hair Care -:** Nanocosmetic hair products include shampoos, conditioners, hair growth stimulants, coloring, and styling products. Hair follicles, shaft targeting, and increased drug delivery going achieved through the intrinsic properties and unique size of nanoparticles. Nanoparticles in shampoos seal moisture in the cuticle by optimizing the residents' contact time with the scalp and hair follicles by forming a protective film [33]. Conditioning nanocosmetic actives have the intended function of imparting softness, shine, silkiness, shine, and enhancing hair detangling. Novel carriers such as niosomes, microemulsions, nanospheres, and liposomes have the primary function of repairing damaged cuticles, restoring texture and shine, and making hair non-greasy, shiny, and less brittle [34].

**Lip care -:** Lip care products in nano cosmetics include lipstick, lip balm, lip gloss, and lip volumizer. A variety of nanoparticles can be incorporated into lip gloss and lipstick to soften lips by preventing transepidermal water loss [35] and also prevent the pigments from migrating from the lips and maintaining color over time. Lip volumizer with liposomes increases lip volume, moisturizes and contours the lips, and fills wrinkles in the lip contour [36].

**Nail care -:** Nail care products based on nanocosmetics are superior to conventional products. The nail polishes based on nanotechnology have advantages such as improved toughness, fast drying, durability, chipping resistance, and easy application due to elasticity [37]. New strategies like amalgamating silver and metal oxide nanoparticles have antifungal properties in nail polishes to treat toenails due to fungal infections [38].

**APPLICATIONS OF NANOTECHNOLOGY :**

1. **Nanoparticles in cosmetics as U.V. filters:** The use of nanoparticles such as titanium dioxide and zinc oxide are the main compounds used as U.V. filters.
2. **Nanoparticles in cosmetics delivery agents:** Liposomes, transferosomes, and niosomes used in the cosmetics industry. Newer particles and nanostructured lipid carriers have proven to perform better than liposomes and can use in skin creams and lotions.
3. In certain skin creams (antiaging), the use of fullerenes as an antioxidant to fight oxygen free radicals, which, together with other factors, contribute to the formation of wrinkles. These fullerenes, also known as buckyballs, have a diameter of about 1 nm, are spherical, and consist of non-biodegradable carbon elements that can also use in cosmetics.
4. Fullerol, the fullerene derivative, is a water-soluble and degradable compound used in cosmetics and other industries.
5. Nanoparticles from volcanic ash can use in eye cosmetics, e.g., with mascara.
6. **Nanoparticles in Skin:** The particles with a size of 500-1000 nm, theoretically beyond the realms of nanotechnology, can penetrate and reach the lower layers of the human skin. At the same time, 128nm and smaller particles are likely to penetrate deeper into the skin [39,40].

**MEDICINAL MACROFUNGI AS COSMECEUTICALS :**

In recent years, growing consumer demand for natural, organic products with low toxicity and effective skin and hair repair effects has led the cosmetics industry to seek alternative ingredients. Macro fungi recognize as bioactive compound sources as cosmetic ingredients. Scientific data has shown that medicinal, edible. Inedible mushrooms contain resources of crude extracts, extract fractions, and bioactive molecules, i.e., H. fatty acids, phenols, peptides, polysaccharides, terpenoids, vitamins, and volatile organic enzyme-inhibiting compounds. A broad spectrum of bioactive natural sources possesses significant antiaging, anti-inflammatory, antioxidant, anti-pigmentation, antimicrobial, anti-wrinkle, moisturizing, and skin lightening effects, act as inhibitors of collagenase, elastase, hyaluronidase, and can be used to regulate tyrosinase activity; therefore they can potentially be used as natural cosmeceuticals.

Macrofungi-derived compounds such as p-coumaric acid can reduce oxidative stress and inflammation as antiaging and skin-lightening agents[41]. Previous studies have shown that p-coumaric acid inhibits melanin synthesis in murine melanoma cells, human epidermal melanocytes efficient transdermal delivery, and functional effectiveness in reducing the development of erythema and UV-induced pigmentation of the skin and therefore has the potential to be used as a skin lightening ingredient [42]. Phenolic compounds and tocopherols derived from edible mushrooms Boletus edulis, Lentinula edodes, and Xerocomus badius are responsible for their A.O.A. [43]. Polysaccharides, triterpenes, and fungal immunomodulatory proteins (F.I.P.s) found in Ganoderma species have been exploited for potential ingredients in the cosmetics industry to develop new cosmeceuticals and nutracosmetics with antioxidant, antibacterial, anti-inflammatory, and anti-melanin effects [44]. Extracellular polysaccharides from the medicinal Mushroom Grifola frondosa (GF-EPS) were suitable for developing functional cosmeceuticals. The GF-EPS and the mycelial extract of G. frondosa (GF-MPS) A.O.A. showed a stimulating effect on collagen biosynthesis and anti-melanogenesis activities without significant cytotoxicity. GF-EPS and GF-MPS have shown promise as cosmetic ingredients [45]. Chemical components isolated from the medicinal mushroom Phellinus igniarius could also be used as ingredients to develop anti-inflammatory cosmetic products [46]. The ethanol extracts from Sch. Commune also showed strong A.O.A. and can be used as cosmeceuticals [47]. Macrofungi are also producers of bioactive compounds with antiaging tyrosinase, hyaluronidase, collagenase, and elastase enzyme inhibitory effects, as shown in Table no. 1.

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| **TABLE 1:** Medicinal macrofungi-derived bioactive compounds and their cosmetic effects on Mushroom |

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| --- | --- | --- | --- | --- |
| Serial no. | Mushroom species | Bioactive compounds | Cosmetic effects | Refs. |
| 1 | *Agaricus bisporus* (J.E. Lange) Imbach | Caffeic, chlorogenic, cinnamic, ferulic, gallic, *p*-hydroxybenzoic, *p*-coumaric, and protocatechuic acids, alkaloids, polyphenols | A.O.A., A.I.A., A.B.A., anti-tyrosinase | 48,49,50,51,52 |
| 2 | *Abortiporus biennis* (Bull.) Singer | Exopolysaccharides | A.O.A. | 53 |
| 3 | *Agaricus subrufescens* Peck | Polysaccharides, benzenoid aromatic compound | A.O.A., anti-pigmentation | 54 |
| 4 | *Amanita muscaria* (L.) Lam. | β-D-Glucan, FMG | AIA | 55 |
| 5 | *Antrodia cinnamomea* T.T. Chang & W.N. Chou. | Benzenoid aromatic compound coenzyme Q0 | A.B.A., A.I.A. | 56 |
| 6 | *Auricularia polytricha* (Mont.)Sacc*.* | Phenolics, glucans | Anti-hyaluronidase, anti-tyrosinase, A.I.A. | 57 |
| 7 | *Agaricus subrufescens* Peck | Polysaccharides, benzenoid aromatic compound | A.O.A., anti-pigmentation | 54 |
| 8 | *Boletus edulis* Bull. | Ergothioneine, glutathione | A.O.A. | 58 |
| 9 | *Calocybe gambosa* (Fr.) Donk | Ascorbic acid (vitamin C) | Anti-radiation, stimulating collagen synthesis | 59 |
| 10 | *Clitocybe aurantiaca* (Wulfen) Studer-Steinhäuslin [= *Hygrophoropsis aurantiaca* (Wulfen)  Maire] | Clitocybin A, D | Anti-elastase, stimulation procollagen synthesis, AOA | 60,61 |
| 11 | *Cyclocybaegerita* (V. Brig.) Vizzini | Ergothioneine, glutathione | A.O.A. | 58 |
| 12 | *Flammulina velutipes* (Curtis) Singer | Glycosides | A.I.A., AOA | 62,63,64 |
| 13 | *Ganoderma lucidum* (Curtis) P. Karst. | Polysaccharides, triterpenes, F.I.P.s | Anti-tyrosinase, melanin inhibitory, AIA | 65,66,67,68,54,50,69 |
| 14 | *Cyclocybe aegerita* (V. Brig.) Vizzini | Ergothioneine, glutathione | A.O.A. | 58 |
| 15 | *Coprinus comatus* (O.F. Muller) | Tocopherols (vitamin E) | Reducing U.V. damage to the skin | 59 |
| 16 | *Ophiocordyceps Sinensis* (Berkeley) G.H. Sung et al. | Cordycepin | Anti-pigmentation, anti-collagenase, anti-tyrosinase, anti-elastase, photoprotective | 70,71 |
| 17 | *Grifola frondosa* (Dicks.) Gray | Extracellular polysaccharides, β-glucan, gallic, and tannic acids | A.O.A., stimulation of collagen biosynthetic, anti-melanogenesis | 45,52 |
| 18 | *Grifola gargal* Singer | Ergothioneine | Suppressed TNF-α-mediated activation of NF-κB | 72 |
| 19 | *Inonotus sanghuang* Sheng H. Wu, T. Hatt. & Y. C. Dai | Chlorogenic acid, icarisid II, isorhamnetin, quercetin, quercitrin, rutin | A.O.A. | 73 |
| 20 | *Laccaria amethystina* Cooke | Laccaridiones A, B | Anti-collagenase | 74 |
| 21 | *Laetiporus sulfurous* (Bull.) Murrill | Phenolic acids | Anti-hyaluronidase, anti-tyrosinase | 75 |
| 22 | *Lentinula edodes* (Berk.) Pegler | Polysaccharides, β-glucan lentinan, eritadenine, phenolics, tocopherols | Anti-tyrosinase, A.I.A., A.O.A., A.B.A. | 49, 43 |
| 23 | *Macrocybe lobayensis* (R. Heim) Pegler & Lodge | Phenolic compounds (cinnamic acid, p-coumaric acid, p-hydroxybenzoic acid, pyrogallol) | A.O.A., A.B.A. | 76 |
| 24 | *Macrolepiota procera* (Scop.) Singer | Lanostane triterpenoids | Inhibition of NO production | 77 |
| 25 | *Neolentinus lepideus* (Fr.) Redhead & Ginns | 1,3- Dihydroisobenzofuran-4,5,7-triol,5-methoxy-1,3-  dihydroisobenzofuran-4,7-diol, lepidepyrone | Anti-tyrosinase, anti-hyaluronidase | 78 |
| 26 | *Pleurotus eryngii* (D.C.) Quél. | Cinnamic, *p*-coumaric, and *p*-hydroxy-phenylacetic acids, ergosterol | A.O.A. | 79 |
| 27 | *Pleurotus eryngii* var. *ferulae* (Lanzi) Saccardo | Ergosterol, nicotinic acid,  pleurone, (24*E*)-3β-hydroxycucurbita-5,24-diene-26-oic acid | Anti-elastase | 64,80 |
| 28 | *Pleurotus ostreatus* var. *Florida* | Phenolics, gallic acid | A.B.A., A.O.A., anti-pigmentation | 64 |
| 29 | *Pleurotus ostreatus* (Jacq.) P. Kumm. | Alkaloids, phenolics, gallic acid | A.M.A., A.O.A., A.I.A., anti-pigmentation, anti-tyrosinase | 62,49,54,64 |
| 30 | *Phellinus igniarius* (L.) Quél. | Nepetidin, betulic acid | NF-κB inhibitory | 46 |

Abbreviations

**A.B.A**., antibacterial activity; **A.I.A**.: anti-inflammatory activity; **A.M.A**., antimicrobial activity; **A.O.A**., antioxidant activity; **F.I.P.s**, fungal immunomodulatory proteins; **F.M.G**., fucomannogalactan; **NF-κB**, nuclear factor-κB; **SIRT1**, Sirtuin 1; **SPF**, sun protection factor; **U**.V., ultraviolet.

**CONCLUSION :**

Cosmeceuticals persist in being a growing segment of the personal care market. In the last decade, nanotechnology has been widely used and beneficial in dermatology, cosmetics, and biomedical applications. With the increasing use of cosmeceuticals, the traditional delivery systems do replace by the new delivery systems; also, the assessment of the natural resources of macrofungi will encourage their use in the cosmetics industry. Advances in fungal biology and biotechnology, genomics, proteomics, metabolomics, and systems pharmacology and molecular cosmetology, studying the molecular mechanisms of the medicinal and cosmetic effects of macrofungi will support the discovery of new species that are going used in the formulation of organic cosmetic products and cosmeceuticals. Various mushroom-derived cosmeceuticals and nutracosmetics with different properties are currently available in the multi-billion dollar cosmetics market. Despite the availability of several products, the industry is largely unregulated, and consumers should consult a healthcare professional before using these products.

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