

## Exploring Cosmeceuticals: A Comprehensive Review of Skin-Boosting Science

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**ABSTRACT:** Cosmeceuticals, a fusion of cosmetics and pharmaceuticals, have gained significant attention for their ability to provide both aesthetic and therapeutic benefits. Unlike traditional cosmetics, cosmeceuticals contain bioactive ingredients that influence skin function and appearance. This review provides a comprehensive analysis of cosmeceuticals, including their classification, commonly used ingredients, formulation techniques, and the role of nanotechnology in enhancing product efficacy. Cosmeceuticals are categorized based on their functional benefits, such as anti-aging, skin brightening, moisturization, sun protection, and hair care. Key ingredients include antioxidants (vitamin C, vitamin E, coenzyme Q10), peptides, botanical extracts, hyaluronic acid, retinoids, and natural skin-lightening agents like kojic acid and arbutin. Additionally, pigments play a crucial role in decorative and therapeutic formulations, with natural and synthetic pigments being used in products like foundations, lipsticks, and sunscreens. Advancements in formulation techniques, including microencapsulation, liposomes, and nanotechnology, have significantly improved the stability, penetration, and bioavailability of active ingredients. Nanotechnology, in particular, has revolutionized cosmeceuticals by enabling controlled delivery of bioactive compounds, increasing product efficiency, and enhancing consumer satisfaction. However, concerns regarding the potential toxicity and regulatory challenges associated with nano-based cosmeceuticals remain a topic of ongoing research. This review aims to provide insights into the evolving landscape of cosmeceuticals, highlighting their formulation strategies, key ingredients, and the impact of nanotechnology. Additionally, it discusses regulatory considerations and safety concerns to ensure the responsible development and use of these products.

### I. INTRODUCTION:

The purpose of the intentional portmanteau of these two names, "cosmeceuticals," is to suggest that an otherwise cosmetic product has drug-like properties. Kilgman may be credited with popularizing the word "cosmeceuticals" (Kilgman, 2005), yet the product actually had its debut on the global market in 1996 (Draelos, 1997)[1]. Cosmetics are chemical substances applied to the human body to enhance its appearance or fragrance. They include creams, lotions, powders, lipsticks, perfumes, and nail polishes for both fingers and toes, as well as facial and eye makeup. Additionally, various other products fall under cosmetics, such as wipes, colored contact lenses, hair dyes, gels, sprays, deodorants, hand sanitizers, baby care items, bubble baths, bath oils, salts, and body butters. A specific category within cosmetics is "makeup," which primarily consists of colored products designed to modify or enhance a person's look.[3,7] Pharmaceuticals, also referred to as drugs, are compounds that possess the ability to combat diseases and promote healing. Medications are formulated to modify the body's structure or functions to diagnose, treat, cure, alleviate, or prevent illnesses.[4,7] The term "cosmeceuticals" refers to products that blend medicinal and cosmetic properties. These are substances that provide both therapeutic and aesthetic benefits. Cosmeceuticals contain biologically active ingredients and are claimed to have drug-like or therapeutic effects while also enhancing appearance[5,7] A cosmeceutical is a pharmaceutical agent that provides beneficial topical effects while protecting against degenerative skin conditions. It bridges the gap between pharmaceuticals and personal care products by incorporating cosmetic ingredients with therapeutic, healing, or disease-fighting properties[6,7].

**1.1]Classification:**

Cosmetics categorization Different people use the term "cosmeceuticals." All phrases refer to the same idea: cosmetic compositions that are neither pure medications, such as corticosteroids, nor pure cosmetics, such as lipsticks. This product category lies in the middle of the pharmaceutical and cosmetics industries. There are numerous names for cosmetics, including performance cosmetics, nutricosmetics, active

cosmetics, dermaceuticals, and functional cosmetics. Cosmetics are often classified into the following categories: Lotions, moisturizers, anti-aging creams, and facial products are examples of skin cosmeceutical goods. Shampoos, conditioners, growth promoters, gels, and lotions are examples of hair cosmeceutical products. Other: lipstick, toothpaste, nail polish, and powders [8]

**Table 1: Cosmetic Vs Cosmeceuticals**

Cosmetics	Cosmeceuticals
FD& C ACT defines a cosmetic product by its intended use meaning, cleansing, beautifying, promote attractiveness or altering appearance.	Cosmeceuticals products on the other hand have pharmaceutical benefits to the skin.
cosmetic products only deliver their ingredient at a very superficial level into the skin.	Cosmeceutical products contain active ingredients that act on the skin cellular structure through topical application with either therapeutic, disease-fighting or healing properties.
Cosmetics do not delay your skins aging process because they work at the uppermost layer of the epidermis which is topmost layer of the skin.	Cosmeceuticals are more concentrated , pure and more effective giving pharmaceutical benifits.

**1.2]Mechanisms of Action - Cosmeceuticalsworkby:**

Modulating collagen production (e.g., retinoids, peptides). Reducing oxidative damage (e.g., antioxidants). Inhibiting melanin synthesis (e.g., skin brighteners). Exfoliating dead skin cells (e.g., AHAs, BHAs). Hydrating and repairing the skin barrier (e.g., hyaluronic acid).

Safety and Clinical Effectiveness - Even though a lot of cosmeceuticals have scientific support, formulation, component stability, and concentration all affect how effective they are. Among the difficulties are: Potential for Irritation: Acids and retinoid may make you red or sensitive. Problems with stability: When exposed to light or air, peptides and vitamin C deteriorate. Regulatory Gaps: Cosmetics are not subject to the same stringent regulations as medications, which causes variations in their effectiveness. Upcoming Developments and Trends - 1AI-driven formulas tailored to each person's unique skin requirements are known as personalized skincare. 2Cosmetics that preserve the healthy flora on the skin are known as microbiome-friendly cosmetics. 3Encapsulation technology increases the stability

and penetration of ingredients. 4Nanotechnology: Improves targeted delivery and bioavailability.

**1.3]Techniques:**

Natural Cosmetics: Cosmetics are the next wave of skin care products. They are the latest advancements in dermatological goods and the new cornerstone of skincare. Cosmetic-pharmaceutical hybrids are typically used to enhance the appearance and health of the skin. All cosmetics contain beneficial compounds that have the ability to treat, prevent, or cure illnesses; some are made synthetically, while others come from natural sources. [10] American dermatologists popularized the term "cosmeceutical," which was first used by Raymond Reed, the founder of the American Society of Cosmetic Chemists. It's possible for synthetic makeup to irritate your skin and cause acne. By blocking your pores, they could make your skin oily or dry. When using natural cosmetics, one need not worry about themcan make use of the natural components since they promise no adverse effects. anytime, anyplace. For example, herbal cosmetics do not contain parabens,

the most prevalent preservative in cosmetics, which can penetrate the skin. [9]

## 2]SKIN CARE:

1.Coconut oil: Derived from the fruit or seed of the *Cocos nucifera* palm tree, coconut oil belongs to the *Arecaceae* family. The dried copra kernel, which has an oil content of 60–65%, is crushed to make it. It is commonly used in baking and cooking due to its melting point of 24 to 25°C (75 to 76°F), which allows it to be used easily in both liquid and solid phases. [11].



2. Sunflower oil: This non-volatile oil is extracted from the seeds of *Helianthus annuus*, a plant in the *Asteraceae* family. Sunflower oil contains carotenoids, lecithin, tocopherols, and waxes. Carotenoids, waxes, and hormones are believed to be affected (endocrine disruption). It is believed to have smoothing properties and non-comedogenic properties. Simple yet reasonably priced oil that has been used for many generations in a variety of face and body emulsions [12]



3.Olive oil- it is taken from the *Oleaceae* family, namely olive *opaea*. Triplein, tripalmitin, trilinolein, tristearate, monosterate, triarachidin, squalene,  $\beta$ -sitosterol, and tocopherol are the main components. In cosmetics like lotions and

shampoos, it serves as a skin and hair conditioner. It is an effective promoter of fatty acid penetration.[9].



## 3]Pigment used –

1.Niacinamide: A water-soluble part of the vitamin B complex group, niacinamide is often referred to as nicotinamide. Nicotinamide is integrated into the coenzymes nicotinamide adenine dinucleotide (NAD) and nicotinamide adenine dinucleotide phosphate (NADP) in vivo. These coenzymes are necessary for enzymatic oxidation reduction processes, such as lipid metabolism and tissue mitochondrial respiration. Melanine transport to keratinocytes is inhibited by niacinamide. Niacinamide was shown by Bissett and colleagues 7–10 to improve skin suppleness and decrease the appearance of fine lines and wrinkles, red blotchiness, skin sallowness, and hyperpigmented macules. Additionally, by promoting hydration, decreasing transepidermal water loss, and enhancing the stratum corneum's barrier function, niacinamide helped reduce some of the symptoms associated with rosacea.

2.Kojic acid: 5-hydroxymethyl-4H-pyran-4-one, often known as kojic acid, is a hydrophilic fungal derivative that comes from *Aspergillus* and *Penicillium* species. It works biologically by preventing copper from binding to tyrosinase. One of the most widely used over-the-counter skin-lightening products available worldwide is this one. In Japan, however, kojic acid was recently taken off the market because of its sensitizing qualities.

3 .Salicylic acid: Grimes found that four out of six patients with skin types V and VI who received a course of 20% to 30% salicylic acid (SA) peels every two weeks along with HQ (given for two weeks prior to the start of the SA series) experienced moderate to considerable improvement in their melasma. There were no reports of post-

inflammatory dyschromia, and the treatment regimen was well tolerated. A higher incidence of hyperpigmentation was linked to SA peels that were not preceded with HQ therapy

4. Topical azelaic acid is an FDA-approved treatment for acne vulgaris and rosacea. It also helps with acne-induced PIH [13].

#### 4] Commonly used in skin cosmeceutical - frequent SKIN COSMECEUTICALS

1. Hydroxy Acid: Commonly found in many cosmetic products, hydroxy acid is also referred to as fruit acids. Examples include citric acid, lactic acid, and malic acid. AHAs improve skin texture and reduce the appearance of aging by rehydrating the skin and promoting cell seeding in the outer layers of the epidermis. One theory states that AHAs produce desquamation by chelating calcium ions out of cell adhesions and reducing their concentration in the epidermis. This is improved by the cleavage of the capillarin's native stratum corneum chymotryptic enzyme, which protects them from proteolysis by conjugating with calcium ions. The outcome of cell differentiation is that calcium ion levels tend to appear younger. [15]

2. Botanicals: Botanicals comprise the largest class of cosmeceutical additives now on the market. Among the botanicals that may benefit the skin are green tea extract, ferulic acid, and grape seed extract. Ferulic acid: This compound, which comes from plants, is believed to be a potent antioxidant and has been shown to provide photoprotection for the skin. Furthermore, it provides a considerable amount of UV protection for human skin. Furthermore, Murray et al. claimed that because of its unique mode of action, ferulic acid could be expected to improve the UV protection provided by sunscreens. Grape Seed Extract: This herbal remedy is a potent antioxidant and has been shown to hasten wound contraction and closure [15].

3. Agent for depigmentation: Skin-lightening substance. These goods are in high demand, and the use of ingredients in product formulations has increased. Common depigmenting chemicals include hydroquinone, licorice extract (glabridin), ascorbic acid (vitamin C), and kojic acid. Hydroquinone: This chemical has been the go-to option for skin lightening. The US Food and Drug Administration has recommended skin lighteners with doses ranging from 1.5% to 2%. A recent study claims that the majority of the research supporting this concern has been conducted on animal models, which demonstrate that long-term

exposure to high dosages can result in cancer. Compared to quantities seen in normal diets, regular topical application could not provide a greater danger.

4. Exfoliants: Exfoliants promote skin turnover by removing adhering cells from the stratum corneum. Common exfoliants in cosmeceutical products include salicylic acid (SA), lactic acid, and glycolic acid formulations. There are worries regarding possible harm to the dermis and epidermis when SA and AHAs are used often [14].

5. Antioxidants: Vitamin C (Ascorbic Acid) – Helps in skin brightening and collagen synthesis.

Vitamin E (Tocopherol) – Protects against oxidative stress

Coenzyme Q10 – Reduces wrinkles and signs of aging. [16]

6. Skin Brightening Agents Kojic Acid – Acts as a melanin inhibitor, helping to reduce dark spots. Arbutin – A naturally derived compound that promotes skin lightening. Niacinamide (Vitamin B3) – Helps in minimizing pigmentation and evening out skin tone. [17]

7. Moisturizing and Hydrating Agents

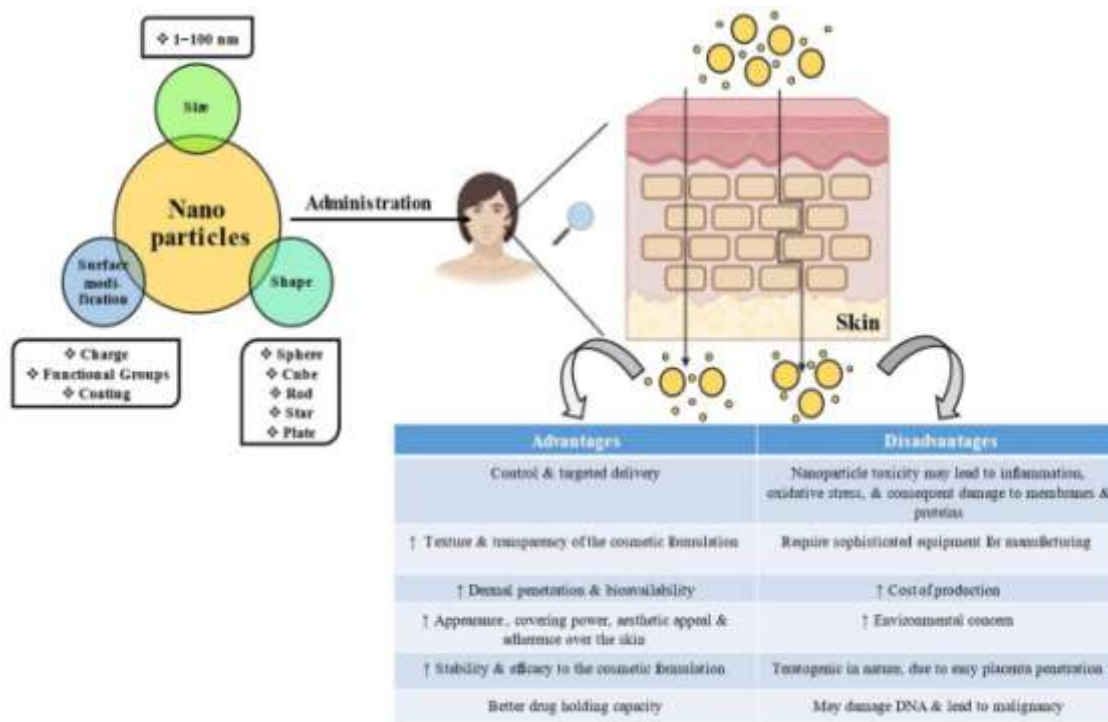
Hyaluronic Acid – Enhances skin hydration by attracting and retaining moisture. Glycerin – A highly effective humectant that helps maintain skin moisture levels. Ceramides – Strengthen the skin's protective barrier and prevent moisture loss. [18].

#### 5] Nanotechnology in cosmeceuticals:

The integration of nanotechnology into cosmetics has helped overcome the limitations of traditional formulations while enhancing their effectiveness. Nanocosmetics and nanocosmeceuticals have been widely developed for applications in skin, hair, nails, lips, and teeth, leading to improved product performance and consumer satisfaction. As a result, many conventional cosmeceuticals are being gradually replaced by their nano-based counterparts. However, concerns have been raised regarding the potential health risks associated with nanocosmeceuticals, particularly due to their ability to penetrate the skin and cause toxic effects. Various nanotechnology-based strategies used in the formulation and delivery of cosmetic and cosmeceutical products, including relevant patents. It discusses both the advantages and potential health and environmental concerns associated with these innovations. Additionally, it examines the regulatory landscape of nanocosmeceuticals, comparing guidelines and recommendations established by regulatory authorities in India, Europe, and the USA. Ultimately, this article aims

to provide a comprehensive understanding of nanocosmetics and nanocosmeceuticals, offering insights into their benefits and risks to help

consumers and regulators make informed decisions regarding their responsible use[19].



## II. CONCLUSION:

Cosmeceuticals have emerged as a bridge between cosmetics and pharmaceuticals, offering both aesthetic and therapeutic benefits. Their classification based on functional properties highlights their diverse applications in skin care, hair care, and overall dermatological well-being. The inclusion of bioactive ingredients such as antioxidants, peptides, botanical extracts, and skin-lightening agents has significantly enhanced their efficacy. Additionally, pigments play a crucial role in both decorative and functional formulations, ensuring aesthetic appeal along with skin protection. Advancements in formulation techniques, including microencapsulation, liposomes, and nanotechnology, have further improved the stability, bioavailability, and targeted delivery of active ingredients. Among these, nanotechnology has revolutionized the field by enhancing product effectiveness and consumer satisfaction. However, concerns regarding the potential health risks associated with nanomaterials, such as skin penetration and toxicity, underscore the need for rigorous safety assessments and regulatory oversight. As the cosmeceutical industry continues

to grow, balancing innovation with safety remains a priority. Regulatory frameworks in different regions, including India, Europe, and the USA, play a crucial role in ensuring product efficacy and consumer safety. Continued research and advancements in formulation strategies, along with strict regulatory guidelines, will be essential for the responsible development and long-term success of cosmeceuticals. Ultimately, raising awareness among consumers and industry professionals about both the benefits and potential risks will contribute to the judicious and sustainable use of these advanced cosmetic formulations.

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