ABSTRACT

Background: Cosmeceuticals are defined as products that bridge the gap between cosmetics and pharmaceuticals. They are intended to affect the biology of the skin, and as such, their effects often go beyond the simple improvement of the appearance of the skin. The bioactive elements in cosmeceuticals may include traditional pharmaceutical ingredients, herbal extracts, or other biologically active agents. The end user's needs drive the choice of bioactive elements in a cosmeceutical product.

Objectives: In this review, we discuss the various bioactive elements used in cosmeceuticals and their potential disadvantages or benefits for skin health.

Methodology: The most relevant literature was retrieved by using different electronic databases.

Results: Safety is a feature that is frequently valued when categorizing these cosmeceuticals, and the prevalence of cosmeceuticals exhibited a rising trend due to the expanding beauty business. As the market expands and therapeutic possibilities continue to become realistic options for component selection, the desire for cosmeceuticals is clear.

Conclusion: These cosmeceuticals may reduce the effects of aging or even out skin color, but their protective qualities will always make them the preferred choice.

Keywords: Cosmeceuticals, Pharmaceuticals, Bioactive, Cosmetics
INTRODUCTION
Cosmeceuticals lie on the spectrum between pharmaceuticals and cosmetics. Pharmaceuticals have a biological effect on living tissue, while cosmetics have no such effect and are only used for beautification. Cosmeceuticals are a hybrid product with both these effects. In other words, cosmeceuticals are cosmetic products that also have a useful biological activity. However, it’s important to note that cosmeceuticals are not regulated by the Food and Drug Administration (FDA). They can be marketed without proof of safety or efficacy. The testing of cosmeceuticals is typically done on silicone replicas on the skin. A few clinical trials that may be carried out are often conducted by the companies that make the cosmeceuticals (1).

Typical cosmeceuticals are marketed as dermatological products. Most are applied topically, while a few are sold as oral supplements. Cosmeceuticals taken orally are also often called nutraceuticals. Anti-aging cosmeceuticals are the most popular, with a large market share. The scientific research behind these anti-aging cosmeceuticals is most often sound, but the evidence of clinical benefits may not be very strong (2).

Despite a relatively small amount of research done to examine their benefits, cosmeceuticals have an industry worth billions. They are often advertised by celebrities and influencers and are crucial to the health and wellness industry. However, they usually have no alarming side effects and the public can safely use them even without a guarantee by regulatory bodies such as the FDA. This is also because they contain known ingredients that have been deemed safe. It’s rare for cosmeceuticals to contain a novel ingredient that hasn’t been used in the past few years. Cosmeceuticals mainly consist of botanical ingredients such as aloe vera, green tea, etc. They may also contain herbal extracts from plants with known health benefits. Other ingredients include vitamins, which may be synthetic, and antioxidants which may be purified from herbs, fruits, vegetables, or other plant sources (3).

Personal care products that contain cosmeceuticals include cleansers, moisturizers, toners, serums, exfoliants, sunscreens, and more. Figure 1 illustrates the potential benefits based on classification. Incorporating novel cosmeceuticals and highlighting them in marketing strategies makes skincare and beauty products attractive to customers and convinces them that they are worth the price. In recent years, personal care companies have started several trends around the names of cosmeceuticals, and they are an essential part of their branding strategies (4). This review covers the recent advances in cosmeceutical research as well as their significance in the global market.

**Figure 1. Classification of cosmeceuticals**

**Objectives**
The current study was designed as a narrative review to analyze the use of cosmeceuticals in the global industry and the potential benefits or harms associated with these products.

**METHODOLOGY**
Up until 2023, the literature was searched for this narrative review. The pertinent studies were retrieved using a variety of electronic databases, including Google Scholar, PubMed, and Medline etc.
EFFICACY, SAFETY, AND REGULATION OF COSMECEUTICALS
The term cosmeceutical was coined by Dr. Albert Kligman in the 1980s as a combination of the words, cosmetic and pharmaceutical. They are accessible as over-the-counter products and do not require a prescription. Cosmeceuticals are not regulated by the FDA and similar regulatory bodies because their biological activity is milder than a drug. A criterion suggested by Pandey et al. for a bioactive ingredient to be called a cosmeceutical is that it should have a pharmaceutical activity that has an impact on normal to near-normal skin, a very low-risk profile, and a defined benefit for minor skin concerns (5).

Most cosmeceuticals have a good safety profile; however, they are not without potential adverse effects. Negative implications include irritation, allergic reactions, infection, comedogenicity, dermatitis, photosensitive reactions, undesirable pigmentation, etc. A systemic reaction may also occur as the cosmeceutical is absorbed by the skin into the bloodstream (6).

Since cosmeceuticals are not tested through the robust trials required by the FDA, their efficacy remains ambiguous. The research studies conducted on cosmeceuticals are typically in vitro. These studies are useful, but it is difficult to extrapolate complete information about a cosmeceutical’s complete biological activity from them. For instance, a cosmeceutical’s efficacy is dependent on many factors such as the delivery vehicle, compound stability, the adequate amount of dosing, absorption and penetration, etc. Information on these factors often cannot be obtained from in vitro studies. The efficacy of a cosmeceutical product can be gauged by analyzing both in vitro studies and clinical trials with a significant cohort of participants. The clinical trials on the cosmeceutical ought to be peer-reviewed, statistically significant, double-blind, and placebo-controlled (7).

COSMECEUTICALS WIDELY USED IN THE PERSONAL CARE INDUSTRY
Most cosmeceuticals are plant-based, particularly the ones used in emerging personal care products, since labels like “organic,” “vegan,” and “cruelty-free” have become important selection criteria for consumers. However, some cosmeceuticals are also manufactured synthetically and are of animal origin as well. The following cosmeceuticals are found predominantly in emerging beauty or personal care products.

Antioxidants
The way oxidative stressors directly contribute to the breakdown of collagen is evident from their characteristic features. These stressors relay the production of inflammatory molecules that ultimately produce free radical species. The unpaired electron in these free radical species makes them highly reactive molecules. This reactivity element gears them to cause cellular damage to the cell membranes, proteins, lipids as well as DNA. This damage to the DNA itself leads to the breakdown of collagen (8). This is not the only detrimental effect of free radical formation. They can also cause possible photo damage, carcinogenesis, and inflammation. Therefore, there is an imperative need for there to be an antioxidant supply before irreversible damage is caused (9). These antioxidants help neutralize the damaging effects of these free radicals by quenching the molecules. In this way, the cells are protected from several exogenous stressors such as smoke from a cigarette, ultraviolet light, and pollution as well as endogenous stressors such as the byproducts of cellular energy.

The diverse range of molecules that are categorized as antioxidants includes alpha lipoic acid (ALA), Vitamins (A, B, C, E), kinetin, idebenone, and polyphenols. These characteristic properties range from protection against inflammation to potential chances of carcinogenesis (10).

Beta-carotene
An herbal color found in tomatoes and carrots. Found in many plants and fruits, beta-carotene is a reddish-orange pigment. The inactive form of Vitamin A is beta-carotene. The algae Dunaliella salina is also used to extract this beta-carotene (11).

Polyphenols
These antioxidants that are exclusively derived from plants have photoprotective, anticarcinogenic, and anti-inflammatory properties. Their subgroup flavonoids have been known to be popular ingredients in many pharmaceuticals. Some of the extracts present in
these ingredients include green tea extract, soya isoflavones, and grape seed extract. The ways each of these ingredients helps build up the skin vary concerning their characteristic properties. Epigallocatechin 3-allate is a green tea extract that prevents DNA damage, erythema, sunburn, and UVB damage (12). Other than that, soy isoflavones have daidzein and genistein which are antioxidant in nature while also presenting anticarcinogenic and anti-inflammatory properties. The main function of these isoflavones is dependent on them being phytoestrogens as it is through this means that they effectively increase the thickness of the skin (13).

Bowman-Birk inhibitor (BBI) and Soybean trypsin inhibitor (STI) are serine protease inhibitors that are present in fresh soy milk. The BBI enables the inhibition of hair growth by inhibiting ornithine decarboxylase while STI has an inhibitory effect on the transfer of melanosome to keratinocytes which subsequently lightens the skin. Lastly, the grape seed extract has a pivotal role in dermal wound healing enhancement as it can induce vascular endothelial growth factor expression in keratinocytes (14).

Ellagic acid polyphenol is derived from plants such as pomegranates and it causes tyrosinase activity inhibition by chelating the active copper center of the enzyme itself. However, it is known to cause selective inhibition of melanin synthesis by only acting on UV-activated melanocytes (15).

The pigment lightening effects in cosmeceuticals range in other compounds as well such as Vitamins C and E, which are also known to be able to decrease tyrosinase activity. Not only these, even pycnogenol helps reduce UV-induced pigmentation and Niacinamide (B3) can inhibit the transfer to epidermal keratinocytes by melanosomes. Even serine inhibitors which include BBI and STI can diminish the chances of melanin transfer (16).

**Peptides**

Peptides are used as cosmeceutical because it is believed that they can repair collagen and elastin by stimulating positive feedback mechanisms, hence encouraging their synthesis. This has earned them enormous success in the cosmeceutical industry. Therefore, many studies are being conducted to further study their effect on the skin (17).

Some of the commonly used peptides are pal-KTTS also known as matrixyl, Ac-EEMQRR commonly called argireline, and Cu-GHK. Out of these pal-KTTS is used to heal wounds and repair damaged skin since it's a fragment of dermal collagen hence it can stimulate its biosynthesis. In addition to this, they have the potential to reduce the sign of aging by improving the appearance of skin when applied regularly in low concentrations (18).

Similarly, Cu-GHK is also a fragment of dermal collagen, while the copper molecule acts as an essential cofactor in the production of collagen. Moreover, certain peptides have been found to hold the potential to relax the muscles by inhibiting signals that stimulate the neurotransmitters. The effect is pretty similar to botulinum. An example of such a peptide is Ac-EEMQRR (19).

However, a study comparing the effect so botulinum a toxin with that of non-prescription topical products that contained peptides, found that the former was more efficient in treating glabellar frown lines (20). A challenge that comes with peptides as cosmeceutical is that if certain peptides have low potency, then they need to be used in higher concentrations to get the same result which can be detrimental to the cost (21).

**Growth factors**

Growth factors are substances that stimulate cell proliferation by regulating the cell signaling pathway. Because of this property, it can play a role in the healing of wounds and delay aging. A plant growth factor kinetin, also referred to as N-6 furfuryladenine has been studied in human skin fibroblast culture (22). The in vitro study revealed that N-6 furfuryladenine delays aging while reducing the appearance of signs of aging too. N-6 furfuryladenine does this by changing cell size, and shape and delaying cell growth at the molecular level. They also act like superoxide dismutase by attracting reactive oxygen species (23).

Other studies on N-6 furfuryladenine have also proven there to be effective in reducing hyperpigmentation and toning the skin, retaining moisture, and improving skin texture. However,
there is still a need for more studies to support these results (24).

**Alpha, beta, and poly hydroxy acids**

This is a class of compounds whose cosmetic benefits cannot be denied. From erasing the signs of aging to creating the perfect glass skin, hydroxy acids play an essential role. The most commonly used hydroxy acids are α-hydroxy acids, β-hydroxy acids, bionic acids, and polyhydroxy acids (25). The most popular out of hydroxy acids is α-hydroxy acids, also commonly known as glycolic acid. It has shown remarkable results as an antiaging chemical that also tends to combat acne-prone skin and reduce the appearance of hyperpigmentation.

Whereas α-hydroxy acids and β-hydroxy acids together have been proven to reduce and sometimes even completely remove hyper keratinized skin while restoring the epidermis. Along with this, they are often used for treating dryness, verrucas growths, and ichthyosis (26). Hydroxy acids have been found to reduce wrinkles and fine lines by encouraging the production of collagen (protein for enhancing skin elasticity), glycosaminoglycans (promote repair and growth of cells), and elastic fibers (increases extensibility of skin) resulting in dermal thinning. While bionic acids and polyhydroxy acids are recent addition as cosmeceuticals (27). They have similar benefits as α-hydroxy acids and β-hydroxy acids however these bionic acids do not cause any irritation or burning of the skin. In addition to this, they offer advantages such as antioxidants, and skin barrier properties for retaining moisture. Their gentle effect on the skin has made them popular for sensitive skin (25).

Another very famous and widely used hydroxy acid is gluconolactone. It exhibits characteristics that protect the skin from UV radiation. They do so by trapping free radicals. Hydroxy acids have also found application in peeling masks. Glycolic acid and lactic acid are broadly used as peeling agents. They are added to masks in high concentrations so they can be used for short periods. They are used to enhance exfoliation and revitalize the skin, hence creating more even-toned and smooth skin (28).

**Biopolymers**

In emerging fields like fields of skin, hair, lips, and dental care research, biopolymers like chitosan, collagen, and its derivatives have opened many other areas of research. The drug-loaded chitosan micro- and nanoparticles for diverse cosmeceutical applications have recently undergone exponential advances (29). Chitosan can enhance the FGF-7 protein in in-vitro situations which is necessary for the regeneration of long and silky hair and are essential for hair restoration and shine. By using nanotechnology, applications, cyclosporine was delivered by chitosan nanoparticles to promote hair development (30). In another study, herbal weed extract was delivered with the help of chitosan-based nanohybrids that increased hair growth and gave a smooth and sleek appearance (31). Hybrids of chitosan have also been used in shampoos and conditioners for hair treatments. For instance, the topological and mechanical properties of chitosan combined with collagen and hyaluronic acids aid in hair restoration. Hyaluronic acids also contributed to the chitosan hybrids that increased water stability, which slowed down the rapid breakdown of hairs and nails. Overall, these chitosan hybrids considerably enhanced the thickness, firmness, and structure of hair, demonstrating their suitability as shampoo additives and conditioning lotions (32).

**Marine extracts**

The primary ingredients that determine the activity of cosmeceuticals include anti-tyrosinase (kojic acid), anti-acne (sargafuran), whitening (chrysophanol), UV protection (scytosamin, mycosporine-like amino acids (MAAs)), antioxidants, and anti-aging properties can also be marine-derived molecules (astaxanthin and PUFAs) (33). Even though marine fungi and other molds have produced several novel secondary metabolites during the past ten years, they still offer a largely unexplored bioresource for the discovery of novel natural products. There are many Anti-aging and anti-acne cosmetics available in these reservoirs. Additionally, a variety of chemicals from marine fungi have been discovered and are being developed into the cosmeceuticals branch (34).
Table 1. Types of cosmeceuticals and their mechanism of action. (35-44)

<table>
<thead>
<tr>
<th>Type of cosmeceutical</th>
<th>Mechanism of action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salicylic Acid</td>
<td>Increase exfoliation</td>
</tr>
<tr>
<td>Retinoids: Tretinoin, Retinol</td>
<td>Activate a receptor</td>
</tr>
<tr>
<td>Moisturizers based on Petrolatum, Silicone, etc.</td>
<td>Enhance barrier function</td>
</tr>
<tr>
<td>Hexapeptides</td>
<td>Regulate cellular communication</td>
</tr>
<tr>
<td>Copper peptides</td>
<td>Normalize cellular repair</td>
</tr>
<tr>
<td>Lactobionic acid, Vitamin E</td>
<td>Inhibit oxidation</td>
</tr>
<tr>
<td>Pentapeptides</td>
<td>Provide a cellular messenger</td>
</tr>
<tr>
<td>Green tea</td>
<td>Decrease inflammation</td>
</tr>
<tr>
<td>Avobenzone, micronized titanium dioxide</td>
<td>Module inflammation</td>
</tr>
<tr>
<td>Avobenzone, micronized titanium dioxide &amp; microfine zinc oxide</td>
<td>Deliver photo-protection</td>
</tr>
</tbody>
</table>

RECENT TECHNIQUES TO PRODUCE COSMECEUTICALS
The following emerging techniques are being applied to produce cosmeceuticals for use in beauty and personal care products.

Nanotechnology
In the cosmeceutical industry, nanoparticles are used in the form of liposomes, nanospheres, gold nanoparticles, non-structured lipid carriers, nanoemulsion, solid lipid nanoparticles, niosomes, dendrimers, carbon nanotubes, polymersomes and cubosomes that are involved in the formation and delivery of the cosmeceutical compounds. Nanoparticles can penetrate more easily into the skin increasing efficacy, providing greater UV protection, enhancing color, and more (45).

Production through transformation in plants
Transformation in plants using of Agrobacterium tumifaciens and Agrobacterium rhizogenes is a widely used technique to produce a large amount of desired protein product in a limited time. Certain cosmeceuticals-producing genes are transformed in the plants for effective and high-rate production (16). After their expression and production, they are purified. A common cosmeceutical active compound of betuligenol is being produced by Atropa belladonna hairy root mediated transformation (46).

High-Grade Extraction from Plants
Certain cosmeceuticals are directly derived from plants, but high-grade extraction is required because other impurities may cause infection or can disturb the functioning of cosmeceutical compounds. Nowadays very high-performance special techniques are being used which include enzyme-assisted extraction (EAE), pressurized liquid extraction (PLE), microwave liquid extraction (MLE), and superficial liquid extraction (SLE) (47).

ORAL HYGIENE PRODUCTS
Herbal Mouthwash
Tea tree oil
The terminal branches and leaves of Melaleuca alternifolia undergo distillation to get this essential oil. Its chemical constituents include alpha-terpineol, terpinene-four-ol, linalool, p-cymene, 1,8-cineole, limonene, alpha-terpinene, alpha-phellandrene, myrcene, sabinene, beta-pinene, and alpha-pinene. Tea tree oil has been widely used in the oral cavity as a natural anti-inflammatory and anti-bacterial agent (48).

Tulsi oil
Ocimum sanctum has been used for the extraction of this oil. In the extraction of this oil, both dry as well as fresh leaves can be used. The properties of this oil include cleaning action, elimination of bad breath, and antibacterial action (49).

Peppermint oil
Mentha piperita when distilled gives this oil. Both Mentha piperita and Ocimum sanctum belong to the circle of relatives of Labiatae. The chief materials in Peppermint Oil include 60-70% menthol, limonene, inactive pinene, cineole, menthone, isovalerate, and methyl acetate. To counter bad breath, Peppermint Oil is considered a very powerful agent (50).

Wintergreen oil
The dried leaves of Gaultheria procumbens when distilled give this oil. Gaultheria
procumbens belong to the family Ericaceae. Nowadays, this oil is extracted by distillation of the bark of the Betula lenta which belongs to the family Betulaceae (51). On hydrolysis of gaultherin, the main constituent obtained is methyl salicylate, inside the presence of water using the enzyme gaultherase. The properties of Wintergreen Oil include antibacterial action, and killing agents that cause bad breath and gingivitis (52).

**COSMECEUTICALS IN GLOBAL MARKET**

During the last decade, the figures of research papers on cosmeceuticals have mounted in the Pubmed depository. Despite this surge, there is still a lot of controversy regarding cosmeceuticals because there has not been any consensus on the definition and regulation of cosmeceutical products (53). Even though scientists are unable to regularize cosmeceuticals yet, the consumer market for them is flourishing day by day. Skincare companies use them extensively in their labels to attract clients for purchasing their merchandise (54).

The cosmeceutical market peaked at USD 55.4 billion in 2020 and is projected to reach USD 70.0 billion by 2025. During the last decade, it was noticed that the number of filed patents had expanded to roughly 20,000 patents per year. A decline in this practice was detected in 2019, probably due to a reduction in filings by Chinese originators and companies. Cosmeceuticals have become a major part of the skincare industry and their market share is expected to go as far as 73.73 billion dollars by 2026 (55).

**APPLICABILITY OF MODERN COSMECEUTICALS**

**Cosmeceuticals in hair skin and dental research**

Chitosan is an extensively used biopolymer and it has different applications including drug delivery and other metabolites. It showed great progress in skin, hair, dental care, and many other fields. Chitosan plays a vital role in hair growth. Research shows it increases the FGF-7 and sonic hedge in the in vitro condition. This different protein can help in the regrowth of hair with the help of nanotechnology. Nanoparticles of chitosan were used for cyclosporine delivery regarding for hair improvement. In wound dressing, chitosan-based scaffolds have been widely used. In skin generation, electrospun nanoafibrillar is used for the healing process. Nanohybrids based on chitosan were used to store and deliver herbal extract (56).

**Cosmeceutical in shampoo conditioner**

Hybrids of Chitosan have been also used for different hair treatments in shampoo, hair repairment lotions, and conditioners. Chitosan is blended with different polymers like collagen and hyaluronic acids and their mechanical property help in hair repair. In addition, hyaluronic acid increases aqueous stability and interacts with the retention time of hair. These hybrids improved hair strength, quality, and thickness and confirmed their best application in shampoo and conditioner (57).

**Cosmeceuticals (essential oil) uses as fragrances**

Many different valued-based oils are used for fragrances like citrus, lavender, eucalyptus, tea tree, and many more. Other oils like linalool, citronella, geraniol, and citral has more attraction as fragrance compound used in different products (58). Many essential oils are used as age-controlling, anti-pathogenic, and act as a protective covering for UV rays from the sun and enhance skin brightness. The concept of “Back to nature” has increased the attention of researchers to use botanical extracts as

<table>
<thead>
<tr>
<th>Countries</th>
<th>Global market value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Europe</td>
<td>USD 79.8 billion</td>
</tr>
<tr>
<td>USA</td>
<td>USD 73.7 billion</td>
</tr>
<tr>
<td>China</td>
<td>USD 54.9 billion</td>
</tr>
<tr>
<td>Japan</td>
<td>USD 32.6 billion</td>
</tr>
<tr>
<td>Brazil</td>
<td>USD 23.4 billion</td>
</tr>
<tr>
<td>India</td>
<td>USD 12.0 billion</td>
</tr>
<tr>
<td>South Korea</td>
<td>USD 10.3 billion</td>
</tr>
</tbody>
</table>
compared to the synthetic derivatives that are considered unhealthy for humans (59).

**Cosmeceutical use as anti-aging products**
These products contain phytochemicals that are mostly obtained from different plants including fruits, roots, leaves legumes, and other parts of plants that control aging and act as antiaging components. In the cosmeceutical industry, marine life plays a great role by acting as renewable sources for the vast amount of compounds like agar and carrageenan. Marine-based components like kogic acid, chrysophanol, antioxidants, and anti-aging (astaxanthin and PUFAs) act as active ingredients for cosmeceuticals like in anti-acne and whitening creams (60).

**Cosmeceuticals use in anti-dandruff lotions**
Egonol is a photochemical which is produced by Styrax officinalis that has cytotoxic and anti-dandruff properties and is used in many lotions. Compounds like 1,8-Cineole, sabinene transsaminenehydride, and borneol which are produced by Achillea millefoliumL have antidandruff, astringent, anti-diabetic, and antispasmodic aspects. L-Hyoscyamine is formed by Datura stamonium L. L-scopolamine is a major component of anti-dandruff products (61).

**Cosmeceuticals use in body slimming drinks**
Tea has alkaloid properties, this property made its best use in the production of anti-cellulite cosmetics. The best component is caffeine which promotes microcirculation and increases the oxygen uptaking capacity of the cell as a result burning of fats in skin cells occurs at an exponential rate. In cosmetics treatments alcoholic or glycolic tea extracts are used that make the body slender, and slim and excrete toxins from the body. Polyphenols and alkaloids both work to lessen cellulite. Cellulite which is a sign of aging skin, can be prevented by catechins that is the key components found in tea extracts, which have been shown to reduce the protein glycation and oxidation process (62).

**Cosmeceutical use as Anti-Acne ointments**
Marine fungus is a huge untapped bio-resource for the discovery of novel natural cosmeceutical products. They have recently been identified as a reservoir of a huge number of new secondary metabolites. Anti-aging and anti-acne ointments are available that depict their best activity in the field of medicine. In addition, a number of marine fungi that contain lead compounds have been identified for further development as cosmeceuticals (63).

**Cosmeceutical (Aloe vera gel) uses as skin cleanser**
*Aloe vera* is a member of the Liliaceae family and is only found in cultivation. None of its specie is found growing naturally. It is a common ingredient in cosmeceutical products because of its softening, brightening healing, hydrating, deep cleansing, and moisturizing properties. Its mature leaves are a rich source of calming gel. *Aloe vera* contains different vitamins like A, C, E, B choline, B12, and folic acid that involve antioxidant properties. In addition, major amino acids like leucine and isoleucine are also present (64).

**Nanotechnology in cosmeceuticals**
There are many polymers that are used to increase the functional group availability of the compound. Dendrimers are one of them, these are organic compounds that have structural similarities with the semi polymeric compounds. These are extremely small particles of 10nm in diameter (65). Dendrimers are exciting molecules and use in the treatments of many skin problems by the nanotechnology base cosmeceuticals industry. Many brands hold patents for hair care and nail care products for the application of dendrimers compounds of which L’Oréal and Dow Company are at the top of the list. There is a Cosmeceuticals patent which is a Nanoparticle base with a formulation that contained carbosiloxanedendrimer, claimed that it can provide hair strength, sweat-resistant sebum, tactile sensation, and sticky properties for skin improvement processes (66).

**DISCUSSION**
Many different bioactive elements can be used in cosmeceuticals, and the end-users needs often drive the choice of which one to use. This review discusses some of the most common bioactive elements used in cosmeceuticals and their potential benefits for skin health. One of the most popular bioactive elements used in cosmeceuticals is aloe vera. Aloe vera has long been used for its medicinal properties, and it is also known to be effective in skincare products. A recent study found that aloe vera can
help to reduce the appearance of wrinkles and improve skin elasticity.
Another popular bioactive element used in cosmeceuticals is green tea. Green tea is rich in antioxidants, which can help the skin in many aspects i.e. from damage caused by many ions and free radicals. A recent study found that green tea can also help to reduce inflammation and improve skin barrier function.
Vitamins are also commonly used in cosmeceuticals. Vitamins are essential for optimal health, and they can also be beneficial for the skin. A recent study found that vitamin C can help to improve the appearance of wrinkles and skin texture. Antioxidants are another popular ingredient in cosmeceuticals. Antioxidants can help to protect the skin from many harmful sun rays. A recent study found that antioxidants can also help to reduce inflammation and improve skin barrier function.
Botanical extracts are another common ingredient in cosmeceuticals. Botanical extracts are often used for their medicinal properties, and they can also be beneficial for the skin. A recent study found that green tea extract can help to improve the appearance of wrinkles and skin elasticity. This review has discussed some of the most common bioactive elements used in cosmeceuticals and their potential benefits for skin health. Cosmeceuticals are an important part of the global skincare industry, and they are often used to improve the appearance of the skin. Cosmeceuticals can be found in a variety of skincare products, and they are an essential part of many personal care companies' branding strategies.
There are a lot of controversy surrounding cosmeceuticals because there is no consensus on the definition or regulation of these products. However, despite this lack of clarity, the consumer market for cosmeceuticals is booming. The cosmeceutical market is projected to reach USD 70.0 billion by 2025. This change is driven by the increasing demand for products that improve skin health and appearance. Scientists are still working to understand cosmeceuticals better and regulate them, but in the meantime, skincare companies benefit from the confusion surrounding these products to sell more cosmetics.

CONCLUSION
The increasing prevalence of cosmeceuticals is attributed to the growing beauty industry that continues to change its course with the advancements in technology. While safety is a factor that is often prioritized when categorizing these cosmeceuticals, the challenges faced in ensuring regulation are quite evident. The toxicity of these bioactive chemical compounds is often not considered while making these active ingredients in beauty products. Some of the most harmful cosmeceuticals have been steroidal in nature with retinoids also exhibiting some detrimental properties. The unfavorable consequences are often ignored to shed light on the superficial beneficial properties such as skin lightening and anti-aging. Nonetheless, the demand for these cosmeceuticals is evident as the industry continues to grow and therapeutic choices continue to become viable options for ingredient selection. These cosmeceuticals may counteract the signs of aging or even out the pigmentation on the skin, they will always be preferred for their protective features such as prevention from photodamage and decreasing the chances of erythema.

Acknowledgements
The authors are grateful to the University of the Punjab, Pakistan for its academic assistance.

DECLARATIONS
Authors’ Contributions
JR contributed to study concept, study design and data collection. MFS and ZG contributed in data analysis and interpretation. UM did the literature review and SF and SA critically reviewed the manuscript. All the authors read and approved the final manuscript.

Ethical Approval
Not applicable

Conflict of Interest
The authors declared no conflict of interest among them.

Funding
None
REFERENCES

7. Alessandrinii A, Starace M, Piraccini BM. Piraccini, hair cosmetics and cosmeceuticals, in techniques in the evaluation and management of hair diseases. CRC Press. 2021;137-149.
40. Panariello L, Vannozzi A, Morganti P, Coltell MB, Lazzeri A. Biobased and eco-compatible beauty films coated with chitin nanofibrils, nanolignin and vitamin E.


Online Research Publications by Authors is licensed under a Creative Commons Attribution-Non Commercial-No Derivatives 4.0 International License.