International Journal for Multidisciplinary Research (IJFMR)
E-ISSN: 2582-2160 ● Website: www.ijfmr.com ● Email: editor@ijfmr.com

Review On: Nanotechnology in Cosmetics and Dermatology

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Abstract:
Nanotechnology is a cutting-edge technology that involves the manipulation of atoms and molecules on a microscopic scale. The cosmetic industry was the first to embrace this technology in their product development, and it has since become one of the most widely-used and capable technologies of the 21st century. It is a safe and effective method for creating innovative drug delivery systems.
Nanomaterials, which contain active substances, carriers, and aids, are used in the development of haircare, oral care, and dermatological products that aim to enhance the user's appearance. The cosmetic industry uses various types of nanomaterials, such as nanosomes, fullerenes, liposomes, ectosomes, and solid lipid nanoparticles. Due to the superior qualities of atoms at the nanoscale level, nanotechnology is increasingly being utilized in the fields of cosmetics and dermatology.
Overall, nanotechnology is an excellent option for improving the quality of cosmetic products. Its effectiveness and safety have been proven, making it an indispensable tool in modern product development.

Keywords: - Nanomaterials, Nanoparticles, Cosmetics, cosmeceuticals, Nano cosmetics , Nanotechnology, care.

Introduction: -
Cosmeceutical Systems is an innovative field of science that involves the design, characterization, manufacturing, and application of methods, devices, and systems at the nanoscale level (1-100 nm) [1][2]. The global nanomaterials market was $8.5B in 2019 and is predicted to grow 13.5% compound annual growth rate from 2020 to 2027. This widespread use of nanoscale materials in cosmetics is due to the development of unique properties that differ from those of larger particles [3][4]. Nano dermatology is the application of nanotechnology in the prevention, diagnosis, and treatment of various skin disorders, as well as in the field of cosmetology. It Is important to consider the potential skin absorption of nanoparticles when examining their safety. Some nanomaterials may have increased bioavailability or toxicity, which can lead to safety concerns.[5][6] However, there are also doubts about the long-term toxicity of these materials and concern about whether they truly offer advantages in product performance. These factors have led to a general mistrust of nanomaterials [7][8].
Cosmetics that contain nanomaterials offer several advantages over micro-scale cosmetics.[9] The cosmetic industry primarily uses nanomaterials to improve the stability and longevity of their products. [10][11][12] Due to the high surface area of nanomaterials, the ingredients can be transported more

efficiently through the skin. The main objective of using nanomaterials in cosmetics is to ensure that the ingredients penetrate the skin effectively, thereby improving the quality of drug delivery. [15]This can be seen in the form of new color elements, such as lipsticks and nail polishes, transparency, for example, in sunscreen, and long-lasting effects, such as makeup (Figure-1).[7][8]. The various types of nanomaterials that are used in cosmetic products, including nano emulsion, nano capsules, solid lipid nanoparticles, nanocrystals, nano silver, nanogold, nanospheres, dendrimers, customers, and noisome[16][20][21].

Here are the different types of nanomaterials commonly found in cosmetics:

Organic and Inorganic Nanoparticles:

The nanoparticles are basically divided into two types which is organic and inorganic nanoparticles as given in (fig no. 2). [10][12] Organic nanoparticles are mainly uses in the formulation of active ingredients. And inorganic nanoparticles are often use for those formulations which are sit or act on the surface of the skin such as antimicrobial products or sunscreens.[24][26]

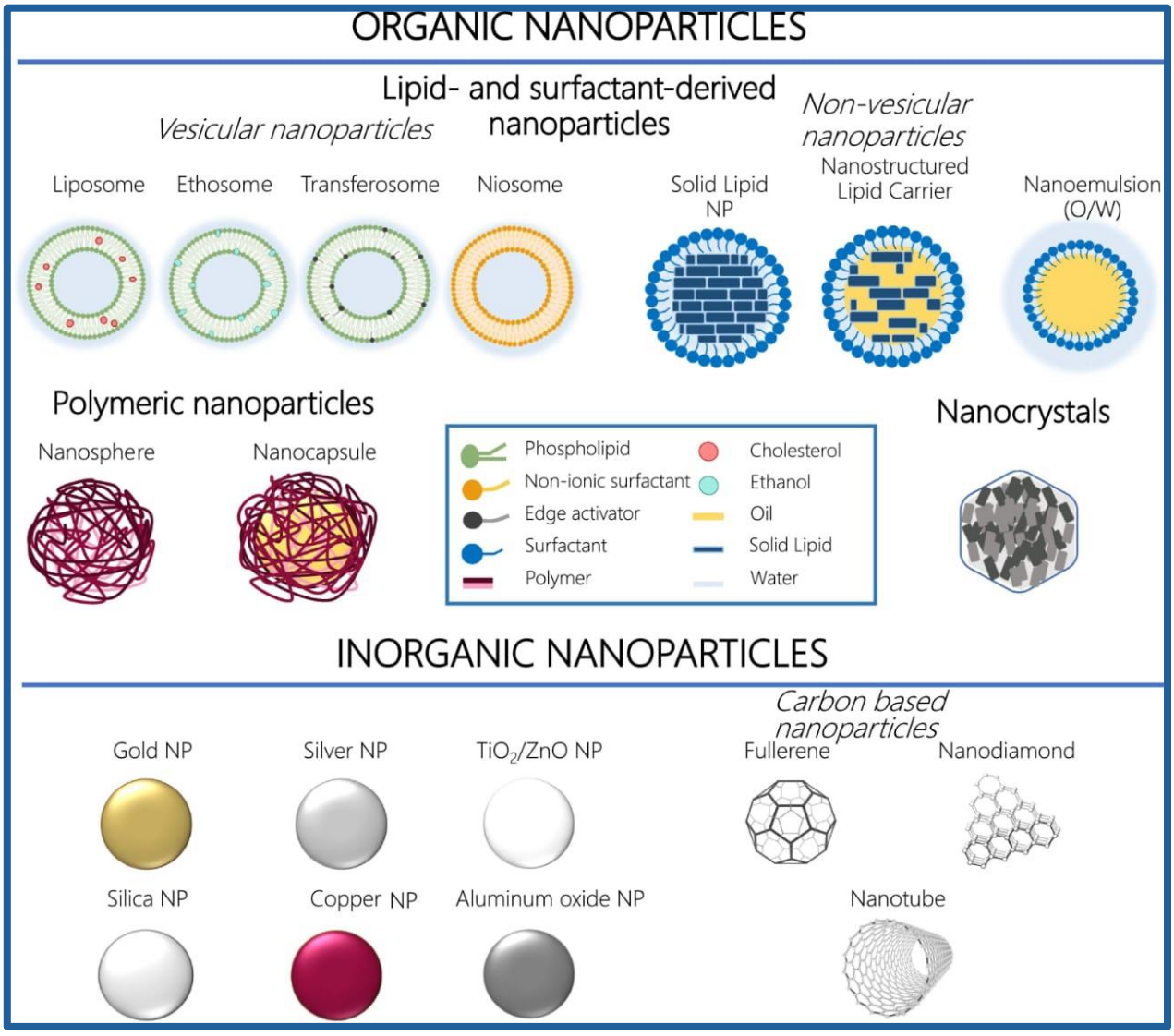

Figure No 2 – Classification of Organic and Inorganic Nanoparticles

1) Liposomes:-

Liposomes are tiny nano-sized vehicles that are used to transport bioactive compounds in cosmetics. They

are very effective in delivering these compounds to targeted areas.[9][19] Nanoliposomes are small spherical structures composed of phospholipids and cholesterol, with a similar structure to cell membranes [12]. Liposomes are spherical vesicles consisting of phospholipids and lipids with a bilayer structure that self-assemble in an aqueous solution. Liposomes can trap cosmetic ingredients, hydrophilic or hydrophobic, and release them at designated spots. Vitamins A, E, and carotenoids have been encapsulated in liposomes to improve stability and refresh the skin's epidermis. Liposomes are commonly found in moisturizers for skincare and shampoos for hair care but have limitations in physical stability and large-scale production[6][15].

2) Nano emulsion:-

Nano emulsions are ultrafine emulsions with droplets ranging from 50 to 1000 nm in size. Their smaller particle size provides greater stability and increased suitability for carrying active ingredients, which also extends the product's shelf life.[6]. Nano emulsions have various uses in cosmetics and materials science due to their liquid-liquid affinity, small size, and large surface area. They can be used to create polymers, as demonstrated in several studies, and have been applied in different ways, such as creating protein shell structures, incorporating silica nanospheres, and suspending magnetic nanoparticles [8].

3) Nano capsules:-

Nano capsules are tiny particles composed of a polymeric capsule that encloses an aqueous or oily core. Recent studies have shown that the application of nano capsules reduces the penetration of UV filter octyl methoxycinnamate into pig skin, as opposed to traditional emulsions.[6][8]

4) Solid Lipid Nanoparticles :-

SLNs are a superior carrier system for ingredients and an excellent choice for skin hydration. They have a single-layer shell and an oily or lipoidal core that allows for deep penetration into the skin. The small size of SLNs ensures optimal delivery of active ingredients. [8]

5) Niosomes :-

Niosomes are the superior alternative to liposomes, composed of nonionic surfactants.[5] They offer unparalleled chemical stability, require no special conditions for preparation and storage, and have zero purity issues.[6] In cosmetic and skin care applications, niosomes deliver exceptional benefits. They significantly improve the stability of entrapped drugs, enhance the bioavailability of poorly absorbed ingredients, and substantially improve skin penetration. Niosomes are the ultimate choice for outstanding results in cosmetic and skin care.[8][9]

6) Nanosilver and Nanogold :-

Nanosilver has strong antibacterial properties and is used in many personal care products. Silver nanoparticles can resist various bacteria, and their unique antimicrobial action is due to the release of silver ions. Scientists extensively researched Nanosilver to fully harness its beneficial characteristics.[5][12]

7) Dendrimers:-

Dendrimers are a new class of macromolecules with a unique architecture that are increasingly being used in the development of nanotechnology-based cosmetics. The term "dendrimers" comes from two Greek words - "dendron" means tree, and "meros" means part.[8] These extremely small molecules range from 2 to 20 in size, making them highly versatile for use in various cosmetic products such as shampoos, sunscreens, hair styling gels, and anti-acne formulations. Therefore, it's safe to say that dendrimers are a crucial ingredient in the modern cosmetic industry.[13][20]

Advantages :-

1. The nanotechnology is used in cosmetics to make fragrances last longer, sunscreens more effective and anti-aging creams.
2. To improve the manufacturing conditions for a skincare product, a multi-component system is required.
3. To improve biocompatibility, bioavailability, and biodegradability in cosmeceuticals.
4. To prevent grey hair and hair loss, use this to preserve active ingredients and maintain lightness and transparency.

Disadvantages :-

1. Smaller particles are more reactive, chemically active, and produce more reactive oxygen species.
2. Inhaled ultrafine particles such as quartz, minerals, dust, coal, silicate, and asbestos can cause pulmonary inflammation and lead to pulmonary fibrosis, cytotoxicity, and malignancy.
3. Nanomaterials have been found to be toxic to both human tissue and cell cultures. This toxicity results in an increase in oxidative stress and cell death.

Applications of nanoparticles is cosmetics :-

The nanoparticles are widely uses in cosmeceuticals for manufacturing of many products. Like skin care [ex., sunscreen, moisturizers] and hair care.[25] They are also used to preserve active ingredients such as vitamins and antioxidants, and their lightness and transparency.[17][23]

Figure No:- 3 Applications of nanoparticles in cosmetics

Conclusion:

This review outlines that nanotechnology is a promising field with various applications in cosmetics, cosmeceuticals, dermatology, and biomedical applications. The use of nanotechnology in skincare products has enhanced its acceptance worldwide. Despite the ongoing controversies, nanomaterials will

have a significant role in the future of the cosmetic industry. Dermatologists should educate their colleagues and play an active role in evaluating this technology for safe and fruitful use.

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