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Nanotechnology Based Cosmeceuticals

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ABSTRACT

Nanotechnology manifests the progression within stage of research and development, by increasing the efficacy of the merchandise through delivery of innovative solutions. to beat certain drawbacks associated with the traditional products, application of nanotechnology is escalating within the world of cosmeceuticals. In private care industry, cosmeceuticals are considered the fastest growing segment and thus the use has risen drastically over the years. Nanocosmeceuticals used for skin, hair, nail, and lip care, for conditions like wrinkles, photoaging, hyperpigmentation, dandruff, and hair damage, have inherit widespread use. Novel nanocarriers like nano emulsions, liposomes, microemulsions, niosomes, solid lipid nanoparticles, nanospheres and nanostructured lipid carrier have replaced the usage of conventional delivery system. These novel nanocarriers have advantages of controlled and sustained drug release, enhanced skin penetration, higher stability, high entrapment efficiency and site-specific targeting. However, nanotoxicological researches have indicated concern regarding the impact of increased use of nanoparticles in cosmeceuticals as there are possibilities of nanoparticles to penetrate through skin and cause health hazards. This review on nanotechnology utilized in cosmeceuticals highlights the various novel carriers used for the delivery of cosmeceuticals, marketed formulations, their positive and negative aspects, toxicity, and regulations of nanocosmeceuticals.

Keywords - Liposomes, Nanocapsule, Solid Lipid Nanoparticles, Nanocrystals

I. INTRODUCTION

According to the FDA cosmetics are the products that are meant to be incorporated to the human body or any portion thereof for the purpose of cleansing, embellish, enhancing attractiveness, or modify the appearance. The cosmetics that are available to public does not need to have the legitimate approval from the FDA. On the other hand, it must be secure for consumers and clearly labelled. The cosmeceutical products that are marketed by the companies are legally liable for the well-being and labelling of their

product. A product that includes drugs and a cosmetic are referred as "cosmeceutical". It's a phrase used in the professional skin-care business to describe a substance that show quantifiable biological activity in the skin and it is declared as a cosmetic item due to its nature of improving skin. The FDA does not classify cosmetics as cosmeceuticals, but skin scientists, medical practitioner, and skin care professionals use the term to encourage customer to keep purchasing cosmetic products, explicitly antiaging and sunscreen products, marketed by many manufacturers with scientific declaration and natural recommendation to highlight the benefits and necessary of using these natural products [4]. Among many industries cosmeceutical is one of the diligent fastest flourishing division of the personal care industry. The expansion of cosmeceutical industries is counted from skin to body to hair and other emerging topical treatments for the improvement of skin conditions such as photoaging, wrinkles, hyperpigmentation and hair damage have come into extensive profitable use. Recent studies on cosmeceutical products have revealed promising development prospects in the approaching years. According to them, the worldwide cosmeceutical industry would reach $31.84 billion by 2016, growing at a compound annual growth rate of 7.7%. The global cosmeceutical industry has a lot of allegiance for Asian countries like Japan, China, and India, which are expected to draw a lot of customers eventually. Japan has established a strong astounding position in the global cosmetics industry, and its cosmeceutical stance is steadily increasing. According to a research exposition "Cosmeceuticals Industry to 2018," the worldwide cosmeceuticals market is expected to reach $42.4 billion by 2018. Nanotechnology takes a particular position among the technologies utilized to create efficient cosmeceuticals. Smaller particles are considered to be more easily absorbed by the skin and repair damage more rapidly in the cosmetics industry. In cosmeceuticals, nanotechnology is promoted to make fragrance of the perfumes last longer, sunscreens to preserve the skin make it look younger, antiaging therapies and usage of moisturizers to keep the skin hydrated. Nanotechnology has a wide range of applications. Nanoemulsions which are colloidal particulate and have distinctive perceptible texture properties, nanocapsules which are utilized in skin care product, nanopigments which are transparent and improve the efficiency of sunscreen products, and liposome formulations which consist of small vesicular system made of traditional cosmetic matter and also act as a shield in oxygen or light sensitive products are some of the nanotechnology-based innovations. Usage of these carbon nanotubes niosomes, fullerenes, nanocrystals, solid lipid nanoparticles and dendrimers shows excellent and primary benefits in cosmeceuticals manufacturing. Nanoparticles are predominant in cosmeceutical industries due to its increased stability of cosmetic constituents (e.g., antioxidants, vitamins and unsaturated fatty acids) which are generally encapsulating within these nanoparticles; effective protection of the skin from harmful ultraviolet (UV) rays; visually attractive products(for example, smaller active mineral particles in mineral sunscreens allow them to be applied without leaving a visible white cast); Active chemicals are targeted to the intended place and released in a regulated manner for a long-lasting impact.

II. USE OF NANOPARTICLES IN COSMECEUTICALS:

2.1. LIPOSOMES:

Bangham released the initial study on liposomes in 1963, and Mezei and Gulasekharam demonstrated liposome effectiveness in topical drug delivery administration in the early 1980s. Liposomes are colloidal spherical vesicles in which phospholipid bilayers sequester a portion of the solvent in which they freely float into their interior (Figure 1). Liposomes come in a variety of sizes and shapes. Liposomes range in size from 20 nanometers to a few

hundred micrometers. Liposomes are nontoxic biocompatible, biodegradable and flexible vesicles that may easily encapsulate active substances, they are utilized in a range of cosmeceuticals. Liposomes can preserve the encapsulated medication from the outside environment in a vesicular structure and are useful for delivering hydrophobic and hydrophilic drugs. The drugs which are soluble in aqueous medium is incorporated in the solvent part whereas the drugs which are insoluble in aqueous medium is kept in the lipid part. These properties make them an excellent choice for delivering vitamins and other important compounds to help the epidermis renew. Lipid polymer like Phosphatidylcholine is one of the primary components in liposomes, and it is utilized in skin care products (moisturizers, lotions, creams, etc.) and hair care products (shampoo, conditioner) because of its softening and conditioning qualities. Several active substances (e.g., vitamins A, E, and K) as well as antioxidants (e.g., carotenoids, CoQ10 and lycopene) have been integrated into liposomes, resulting in increased physical and chemical stability when distributed in water. Lipophilic chemicals like cholesterol and ceramides are present in natural skin tissue so they've been utilized in topical skin treatments for a long time. The integrated liposomes in skin improve skin hydration and texture. Dior's first liposomal anti-aging lotion, "Capture," was introduced in 1986.

2.2. NANO CAPSULES:

The possible dermatological application of nano capsules was investigated when the French company L'Oréal launched the first nano capsule-based cosmetic product in 1995 to boost the impact of their cosmetics. "Nano capsules" are vesicular structures formed of a polymeric membrane enveloping an inner liquid cores at the nanoscale (10 nm to 1000 nm).

2.3. SOLID LIPID NANOPARTICLES:

Solid lipid nanoparticles (SLNs) are submicron colloidal carriers whose size ranges from 50-1000 nm and they are composed of physiological lipid, dispersed in water or in aqueous solution of surfactant. SLNs are popular in cosmeceuticals due to various advantages: these are composed of physiological and biodegradable lipids that exhibit low toxicity; the tiny size of SLNs ensures close contact with the corneum and increases the penetration of active ingredients through the skin; SLNs provide occlusive properties that end in increased skin hydration. In October 2005 the products Nano Repair Q10 Serum and Nano Repair Q10 cream (Dr. Kurt Richter Laboratories GmbH, Berlin, Germany) introduced to the cosmetic market revealed the success of lipid nanoparticles in the anti-ageing field. It has been found that SLNs possess characteristics of physical UV blockers on their own, thus offering the selection for developing a simpler sunscreen system with reduced side effects. In vivo study has been shown that by addition of 4% SLNs in a standard cream, hydration of skin can be increased by 31% in 4 weeks. SLNs are also beneficial as topical vehicle for perfumes. By incorporating perfumes/fragrances in SLNs, the discharge are often bogged down to supply prolonged effect.

2.4. NANOCRYSTALS:

Nanocrystals are aggregates composed of several 100 to 1000 of atoms that combine into a cluster and are within the size range of 10 to 400 nm used for the delivery of poorly soluble actives. Nanocrystals appeared first within the cosmeceutical market in 2000 by Juvena with the merchandise Juvedical having rutin. during a study it had been observed that, compared to the water-soluble rutin glucoside (rutin with attached glucose), the nanocrystal formulation of original rutin molecule possesses 500 times higher bioactivity [28]. A rutin nanosuspension containing 5% rutin as a non-dissolved nanocrystals were introduced to the skin of human volunteers and compared to a water-soluble rutin glucoside (5% solution) regarding photoprotection of the skin. within the aqueous nanosuspension, the solubility of

rutin was 500 times lower as compared to the solubility of water-soluble derivative. it had been observed that, despite the five hundred times lower concentration of dissolved rutin within the water phase of the nanocrystal suspension, the nanosuspension was about 25% simpler in photoprotection and thus the concentration of actives formulated as nanocrystals within the skin were much higher compared to water-soluble derivative or using the active in normal powder form.

2.5. DENDRIMERS:

Dendrimers are organic chemical entities which have semi-polymeric tree-like structure. The terminals of the branches provide an upscale source of nanoparticles surface functionality. Their dimensions are extremely small, having diameters within the range of two to 10 nm. Dendrimers are an exciting new class of macromolecular architecture and an important component in the area of nanotechnology-based cosmeceuticals to treat various skin conditions. L'Oréal, Unilever, and therefore the Dow Chemical Company have several patents for the appliance of dendrimers in hair care, skin care, and nail care products. A patent on cosmetic formulation containing carbosiloxane dendrimer claimed that it can provide good water resistance, sebum resistance, glossiness, touch, and/or adhesive properties to the hair and/or skin.

2.6. NANOGOLD AND NANO SILVER:

Gold and silver nanoparticles are studied as a valuable material in cosmeceutical industry for his or her strong antibacterial and antifungal properties. These particles are widely utilized in cosmeceutical products like deodorant, face pack, antiaging cream, then forth. An ointment containing silver nanoparticle was claimed to possess antibacterial activity and will be used for skin inflammation and skin wound disinfection. A study was published in ACS Nano-letters which was conducted by French scientist Dr. Philippe Walter and his team members, describes the synthesis of fluorescent gold nanoparticles inside human hair. It involved soaking white hairs during an answer of a gold compound. The hairs turned straw then darkened to a chocolate. The scientists investigated using an electronic microscope that, the particles were forming inside the hair's core cortex. the color remained even after repeated washings.

2.7. CUBOSOMES:

Cubosomes are submicron, discrete, nanostructured particles of bi-continuous cubic liquid crystalline phase. Recent research activities on the utilization of cubosome in care product areas varied from skin care to hair care and antiperspirants. Researches in association with various cosmetic companies like Nivea and L'Oréal is trying to use cubosome particles as pollutant absorbents and an oil-in-water emulsion stabilizers and pollutant absorbents.

2.8. NIOSOMES:

Niosomes are nonionic surfactant vesicles devised by using nonionic surfactants. These vesicles possess high entrapment efficiency, improved chemical stability, and enhanced penetration, also as lower cost as compared to liposomes. In morphology, a niosome could also be a nanostructure with 100 nm to 2μm in diameter, whose center is an aqueous cavity enveloped by layers of nonionic surfactant in lamellar phase. These are evaluated as vesicular carriers for quite drugs and cosmetics topically. Niosomes are found to be efficient in topical delivery of active ingredients as they go to reinforce duration of the active ingredients within the corneum also as epidermis and also reduce the system absorption. By using niosomes, targeted delivery also can be achieved because the active ingredient is directly delivered to the precise site where therapeutic effect is desired.

2.9. FULLERENES:

Other nanoscale materials like carbon fullerene are utilized in some cosmetic products thanks to their antioxidative properties. They display potent

scavenging capacities against radical oxygen species which they're considered for his or her use within the preparation of skin rejuvenation cosmeceutical formulations. These structures are comprised of carbon rings and contain odd-numbered (like Pentagon and heptagon) carbon rings, conferring a 3dimensional spherical shape. These structures are known as Fullerenes ("Bucky Balls"). Fullerenes are highly hydrophobic and thus aren't soluble in aqueous solutions, which initially limited their applications, but the utilization of surfactants or surface modifications has increased the power of fullerenes to solubilize in water and get more attention to their potential pharmaceutical uses.

III. MAJOR CLASSES OF NANOCOSMECEUTICALS

3.1. MOISTURIZERS:

The primary barrier of the skin is corneum, whose main purpose is to remain inside in and out of doors out. dehydration is leaded because the water from the corneum gets evaporated quickly. This dehydration of skin is often averted by using moisturizers which give flexibility to the skin. When moisturizers are applied to the skin, a skinny film of humectant is made which retains moisture and provides better appearance to the skin. nano emulsions, liposomes, SLNs are widely used moisturizing formulations thanks to their prolonged effects. These are considered to be the foremost useful product for the management of various skin conditions (e.g., psoriasis, atopic dermatitis, and pruritus).

3.2. SUNSCREENS:

Sunscreens are hugely used to give protection of our skin from harmful effects of sun rays on exposure. titanium dioxide (TiO_2) and zinc oxide (ZnO) are the foremost effective approved mineral-based ingredient which protects the skin from sun damage. This mineral forms a materialistic barrier on the skin, reflects both UVA and UVB rays from penetrating right down to the deeper layers of skin, and may be a smaller amount irritating. the most drawback of traditional or conventional sunscreen is that, when applied, it leaves a white chalky layer on the skin [46]. this is often where nanoparticles are available. Improved sunscreens are just one of the varied innovative uses of nanotechnology. Sunscreen products using nanoparticles of TiO_2 or ZnO are less greasy, transparent, and fewer smelly and have increased aesthetic appeal.

3.3. ANTI-AGING PRODUCTS:

Pollution, chemical products, stress, abrasion and irradiation from ultraviolet (UV) & infrared (IR) sources, are involved in skin aging. In skin rejuvenation and wrinkle reversal effect collagen plays and significant role. the quantity of collagen within the skin decreases in conjunction with age. The aging of the skin manifests itself and there are many ways: thinning, drying out, damaged barrier function, loss of elasticity and texture, appearance of spots, wrinkles and modification of surface line isotropy. Most of the cosmeceuticals are developed with claims of firming and antiwrinkle, lifting moisturizing, and whitening and skin toning activity. Antiaging products are the foremost cosmeceuticals within the market currently being made using nanotechnology. L'Oreal has employed nanotechnology in products like nanosomes of Pro-Retinol A contain Revitalift antiwrinkle cream, and claims that it instantly reattunes the skin and reduces the looks of wrinkles. Application of retinol can increase epidermal hyperplasia, epidermal water content, and cell renewal while enhancing the collagen synthesis. Retinol also interferes with melanogenesis and they also inhibit matrix metalloproteinases, which are involved in the breakdown of collagen. The clinical benefits include a discount within the looks of wrinkles, fine lines and lightening of lentigines. Hydra Zen Cream is introduced by Lancôme to renew the skin's healthy look which contains nano encapsulated Trice amide.

3.4. HAIR CARE:

Hair care is another promising field for nanotechnology. Companies are using nanotechnology in hair care products and research is ongoing to get the ways of how nanoparticles are often wont to prevent hair loss and to take care of shine, silkiness, and health of hairs. Unlike ordinary hair straightening products nanoemulsion in hair cosmetics doesn't destroy the outer structure of the hair fibers, called cuticles, to penetrate into the hair strands. Sericin (composed of cationic sericin nanoparticles) is a lively area of hair cosmeceuticals. Studies have shown that sericin nanoparticles in hair cosmeceuticals easily adhere to the surface of earless seal and treat the damaged cuticles.

3.5. SKIN CLEANSER:

A hydrolipid film cover the skin that, counting on the earth of the body, comprises secretions from eccrine and apocrine sweat glands and from sebaceous glands. Decomposition products from cornification and corneocytes (stratum corneum lipids and cellular debris) within the tactic of being shed also are present. This film provides a natural defense against pathogenic organisms but also attracts environmental pollutants and dirt. Sometimes the microorganisms present on the skin surface act on components of the surface film and make undesirable by-products, like those resulting from the metabolism of compounds found in apocrine sweat that make body odor. Thus, periodic cleansing to urge obviate dirt, debris, and odor is significant to need care of skin health. Cleansing is additionally necessary to urge obviate soil (which may include bacteria) from the skin surface that's acquired by incidental contact or by intentional application (medications or makeup and other cosmetic products). Silver nanoparticles are used as skin decontamination and disinfectant. Nano Cyclic Inc. produces Nano Cyclic cleanser pink soap which can be a scientifically balanced blend of nano silver and natural ingredients and claims that it kills harmful bacteria and fungi, fights acne, and diminishes age spots and sun damaged skin.

3.6. LIP CARE:

Lip care is another promising class of cosmeceuticals. Different nanoparticles can be incorporated into lip gloss and lipstick which will soothe or soften the lips by preventing trans-epidermal water loss. Korea Research Institute of Bioscience and Biotechnology holds a patent that described that it's possible to organize pigments exhibiting wide selection of colors using gold or silver nanoparticles by mixing in various compositional ratios and whose color are often maintained for an extended period of your time. For the improvement of the homogenous distribution of pigments silica nanoparticles utilized in lipsticks. Once applied, they prevent the pigments from bleeding or migrating into the fine line of lips.

3.7. NAIL CARE:

Over conventional products nanotechnology-based nail cosmeceuticals have various advantages. A study revealed that nail paints having nano-sized particles improve toughness, impact resistance and mar resistance of the mammalian nails. Nano Labs (a nanotechnology research and development company) was awarded a provisional patent for its original nanonail polish and lacquer having advantages that it dries to a very hard state, resists cracking, shock, scratching, and chipping and its elasticity offers superior simple application without any crack. one among the new strategies which may have great potential within the cosmeceuticals is that the incorporation of nanoparticles having antifungal activity (like silver and metal oxide nanoparticles) in nail enamel to treat fungal toenail infections.

IV. EXPOSURE TO NANOPARTICLES

Latest changes have generated by industries through the use of nanoparticles, nonetheless chances of risks and unpredictability are also there. Escalating

production as well as use of nanoparticles cause demanding quantities of employees and customers for the nanomaterials. Therefore, there should be pronounced demand for the details of exposure of nanoparticles route. Humans exposed to nanoparticles mainly through ingestion, inhalation and dermal routes. Airborne nanoparticles mostly exposed through inhalation. Customers inhale nanoparticles through use of aerosol cosmeceuticals whereas employees inhale during production of nanoparticles. Nanoparticles proceed through the nasal nerves through the brain from where it enters to the nervous system and its deposition in the respiratory system is completely based on the interaction with the respiratory epithelium membrane. Due to their excessive smaller size, the nanoparticles get easy entry to the blood stream and from there spreads to different organs. When cosmeceuticals are applied on near lips or mouth, then ingestion of nanoparticles could happen. Mostly these nanoparticles get swiftly excreted from by different means but there may be few traces of nanoparticles which may lingers into the various organs of body[61]. Exposure of nanoparticles to other routes into the systemic circulation may occur through dermal absorption. Majorly cosmeceuticals are applied on the skin. Intercellular, transfollicular and transcellular are the three pathways of penetration of nanoparticles cosmeceuticals through the skin.

V. SKIN PENETRATION OF NANOPARTICLES

The largest organ of the body is the skin. Skin of human beings are made of three layers, which are the epidermis, the dermis and the hypodermis. The layer which is the outermost of the epidermis is the stratum corneum, which is the external barrier of the skin because of its lipophilicity among cells. Passive paths by which molecules may make their path through the stratum corneum are intercellular, transcellular and appendageal routes.

A vast number of cosmeceutical products containing nanoparticles are present at the market place and are applied all over skin, which may raise possible dangers when exposed to skin penetration. Nanoparticles are mainly classified into two groups, that are soluble biodegradable nanoparticles and insoluble nonbiodegradable nanoparticles. Cosmetics products are meant to apply on the normal skin but it is also applied on skin which is not healthy. In case of that type of conditions the skin may got damaged. Mostly studies showed that nanoparticles contained products are mainly penetrate through the hair follicle and skin pore openings present below the stratum corneum.

VI. TOXICITY OF NANOPARTICLES

Cosmeceutical products containing nanoparticles, when applied on the skin may give toxic effects after reaching the blood stream. Research upon toxicity showed that when TiO_2 nanoparticles are administered into a pregnant mouse, that are been transferred to its offspring and caused severe brain damage also reduction of sperm production in case of male offspring. Accidental inhalation and consumption of nanoparticles or its absorption through skin can cause severe skin and lung damage or organ damage. But silver nano particles are used as an antimicrobial agent. Silver concentration used are lethal for bacteria which is also lethal for keratinocytes and fibroblasts. There are debates by the cosmeceutical industries that their customer risks are less and also there are no proof of such nanoparticles product which penetrate healthy adult skin.

VII. RECENT ADVANCES IN NANOPARTICLES

USFDA has recently published an import alert for skin care products which are labelled as antiaging cream. Reason being availability of numerous creams present in the market place claiming that they control

the aging process. FDA stated those claims as illegal on cosmetic labelling.

The EU also showed concerns over nanoparticles and addresses regulations. Based on those regulations cosmetics and sunscreens present in the market should be individually tested. Containing nanoparticles cosmetic products should be tested by electronic means to the identification, specification, quantity, toxicological profile, safety data, and foreseeable exposure conditions. Those notifications must occur six months before a cosmetic product containing nanomaterials is placed on the market.

VIII.CONCLUSION

The vast spread of nanotechnology in cosmeceuticals have given rise to technical and economic hopes but also arise questions about the significant risks to health and safety of customers. Hence, nanotechnology based cosmeceutical products should be designed and sold, that fully respects the health of consumers and the environment.

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