International Journal of Pharmaceutical Science Invention
ISSN (Online): 2319-6718, ISSN (Print): 2319- 670X
www.ijpsi.org Volume 9 Issue I ǁ Jan 2020 ǁ PP.43-51

Use of Nanotechnology in Cosmeceuticals: A Review

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ABSTRACT : *Nanoparticles-based in cosmetic arena is becoming trending in variety of product segments. Various international and local brands are implementing this nanotechnology as an innovative approach to offer high quality and efficacy of their cosmetic products**.** Cosmeceutical are the latest growing segment to the health care industry and are described as cosmetic product with drug like activities and the use has been risen over the years. In the cosmeceutical arena nanotechnology plays a very important role. Cosmeceuticals which are based on nanotechnology offers various advantages like it increase the bioavailability of the drug and hence it also prolonged the effect of cosmetics. This review outlines the various nanocarrier which are used in Cosmeceuticals, the nanotechnology based Cosmeceutical product which are already in the market and recent advances in the nanotechnology.*

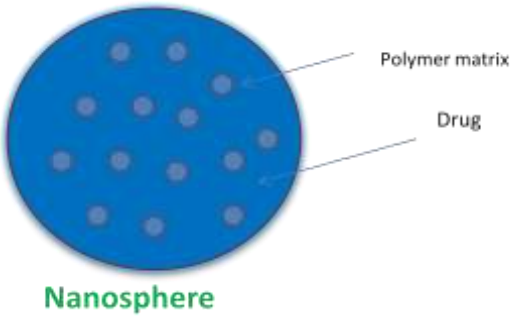
Date of Submission: 25-02-2020 Date of acceptance: 11-03-2020

I. INTRODUCTION

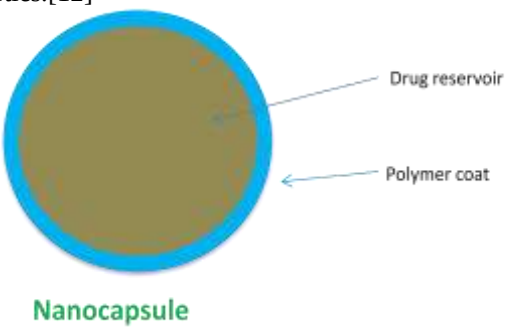
Nanotechnology is that branch of technology which deals with the creating structures that are less than 100nm long[1] It is the manipulation of the matter on the atomic, molecular scale at least one dimension sized from 1 to 100nm. Applied science is incredibly broad because it includes organic Chemistry, surface science, molecular biology etc [2][3] Nanotechnology helps in reversing the aging at various cellular level. Nanotechnology is being used within in the formulation of cosmetics to shield the skin from the harmful sunlight. The different varieties of nanomaterials/nanocarriers which are used in cosmetics include Liposome, Niosome, Solid Lipid Nanoparticle(SLN), Nanosphere, Nanoemulsion, Gold nanoparticles, dendrimer etc. Cosmetics are the product which is used to beautify the skin[4] Cosmetics are the external preparation which are applied on the external parts of the body[5][6]The Food and Drug Administration (FDA) has defined cosmetics as "particles intended to be applied onto human bodies or any part thereof for cleansing, beautifying, promoting attractiveness,or altering the appearance" (U. S. Food, and Drug Administration, 2018)[7]

Nowadays cosmetics are considered as essential parts in life. They are not only attract the people towards it however it conjointly imparts the physiological effect. Within the last 2- 4 decades it has gained tons of recognition in both in males and females [8] The most popular cosmetics are powders and cream. Cosmeceuticals are defined as a cosmetic product which may have medicinal or drug like benefits[9] It may be derived naturally or is also synthesized with chemicals.The term Cosmeceuticals was created in 1990s from cosmetic and pharmaceutics[10]

Nanoparticles are divided into the two categories
1. Nanospheres
2. Nanocapsules
Nanosphere are defined as homogenous matrix systems where in a dispersed or dissolved active compound is absorbed on the surface or entrapped within the polymeric matrix structure through the solid sphere[11]

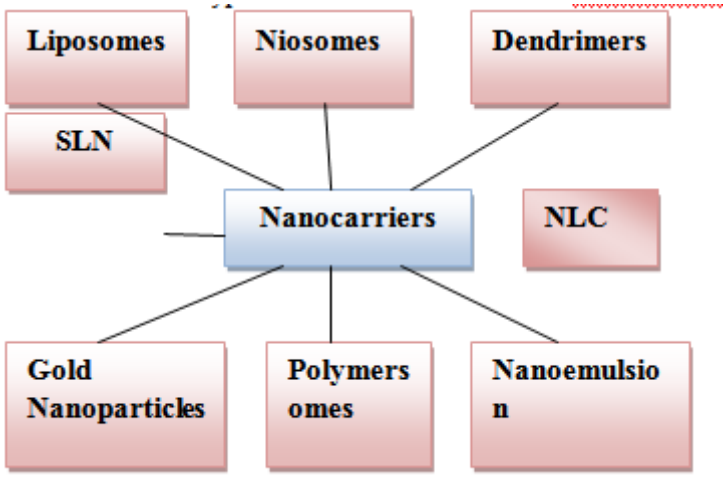


Nanocapsules are colloidal nanobubbles in which the core(Oily or aqueous) is surrounded by a polymeric membrane with specific properties.[12]



Types of Nanocarriers used for Cosmeceuticals

There are various types of novel carriers are used in cosmeceuticals as shown in figure

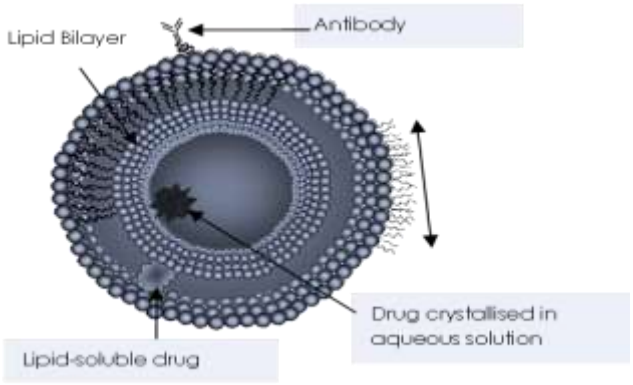


LIPOSOME:

Liposomes

Liposomes

Biodegradable, Non-toxic in nature. Liposome (meaning lipid body) is defined as a vesicle of lipid bilayer enclosing an aqueous compartment.The lipid most commonly used is phospholipid, Sphingolipids, glycolipids and sterols have also been used to prepare liposomes. Their size ranges from 25 – 5000 nm. Liposomes can be prepared by disrupting the biological membrane(such as by Sonication)[13,14]



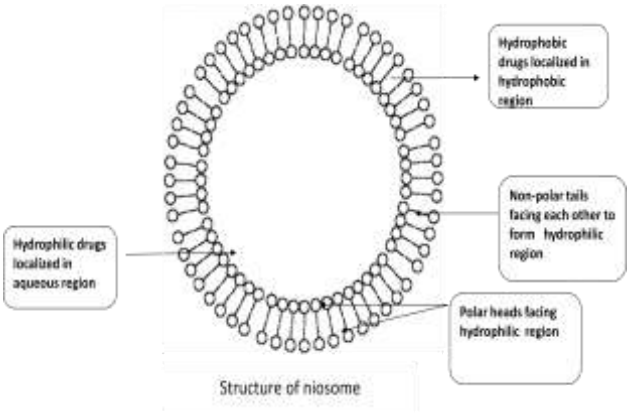
Advantages:

1. Liposomes can encapsulate and transport water-soluble ingredients in their polar cavity and oil soluble ingredients in their hydrophobic cavity[15]
2.Liposomes increased the stability of the medicament by using the process of encapsulation[16]
3. Provides the selecting targeting to the tumor tissues e.g. liposomal doxorubicin[17]

Product name	Marketed by
Moisture Liposome	Cosme decorate
Liposome Day Cream	Janice carol
AzelacRU Liposomal Serum	Sesderma
Herbal Liposomal toner	Arboretum skincare
Dermosome	Microfluidics

NIOSOME:

Niosomes are microscopic lamellar structures which composed of non-ionic surfactants and cholesterol[18] The niosomes have amphiphillic bilayers structure in a way that polar region is oriented outside and inside the vesicles where the hydrophilic drug will be entrapped and non-polar region is formed within the bilayers where hydrophobic drug can be entrapped as shown[19]

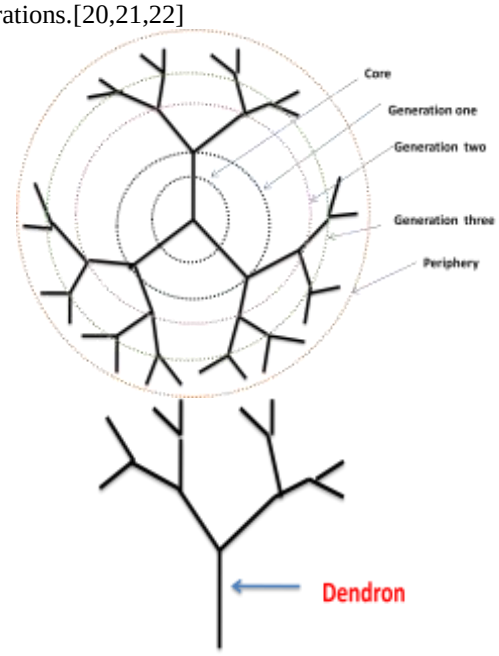


Product name	Marketed by
Identik masque floral repair	Identik
Absolute white cream	Lancome
Niosome +	Lancome

Various Marketed formulations of Niosomes

Dendrimers

Dendrimers are branched , artificial polymers with bedded arthicetures. Their name is derived from the Greek word "dendron" which suggests "tree" and refers to the distinctive organization of polymer units. Because of variety of distinctive features: nanoscale size, monodispersity, manipulable surface modification, water-solubility and multivalency, they has been mainly applied to drug delivery research.The first dendrimers were created by Fritz Vögtle in 1978, R.G. Denkewalter at Allied Corporation in 1981. When the core of a dendrimer is removed, a number of identical fragments found called as dendrons . The quantity of dendrons depending on the multiplicity of the central core (2, 3, 4 or more). A dendron will be divided into completely different regions: the core, branches (interior) and finish groups (periphery). The quantity of branch points that are moving outward from the core of the dendron to its edges defines its generation (G-1, G-2, G-3,G-4,G-5). Dendrimers of upper generations are larger, additional branched and have additional finish groups at their edge than dendrimers of lower generations.[20,21,22]



Solid Lipid Nanoparticles(SLN)

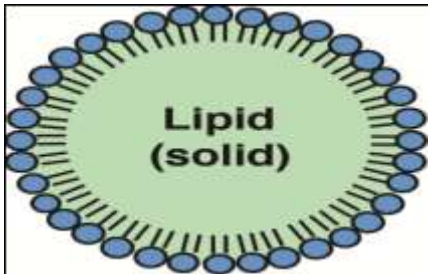
SLN are sub micron colloidal carriers bringing from 50 to 1000nm,which are composed of dispersed in water or in aqueous surfactant solution, Physiological lipid [23,24,25]

Advantages of SLN [26,27]

1. Better control over release kinetics of encapsulated compounds.
2. No additional Solvent required.
3. Very high long term stability.

Disadvantages of SLN[28,29]

1.Unpredicted gelatine Tendency
2. Particle Growth



Gold Nanoparticles

Gold nanoparticles are the small gold particles with the diameter of 1 to 100nm which once dispersed in water are also known as colloidal gold[30] The electronic and optical properties of gold nanoparticles are compatible by changing the size,shape,surface chemistry. Because of their strong antifungal and antibacterial properties Gold nanoparticle has become the valuable material in the cosmetic industries. These nanoparticles

are used in such products like lotions, antiaging creams,Deodrants etc[31] Big company like L'oreal Paris are using gold nanoparticles to obtaining the most effective lotions and creams [32]

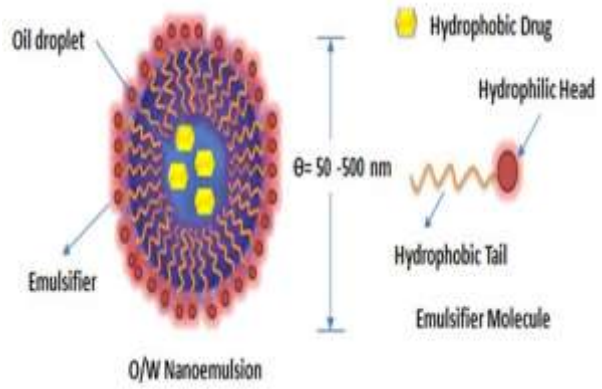
Polymersomes

Polymersomes comes under the category of artificial vesicles, tiny hollow spheres which encloses a solution. Polymersomes are made of using amphiphilic synthetic block copolymers to form the vesicle membrane, and should have radious ranging from 50 nm to 5 µm or more[33,34]They shows more stability in comparison to liposomes because of thick and rigid bilayer. Most reported polymersomes are those which contain an aqueous solution in their core and are very useful for encapsulating and shielding sensitive molecules, such as drugs, enzymes, other proteins and peptides, and DNA and RNA fragments[35,36] A physical barrier is provided by polymersome which isolates the encapsulated material from external materials, such as those which are found in biological systems. Polymerosomes are frequently used in cosmetic industries and several patent has been filed for it[37,38]

Nanoemulsion

Nanoemulsions are isotropic dispersed systems of two non miscible liquids, normally it consist of an oily phase which is dispersed in an aqueous phase, or an aqueous phase dispersed in an oily phase, forming droplets or oily phases of nanometric sizes. Nanoemulsions typically have the next loading capacity for oleophilic active ingredients than microemulsions, which might be beneficial in some applications.[39]

Nanoemulsions are thermodynamically unstable systems, in distinction to microemulsions, because some nanoemulsions need significant energy to be formed[40]Three methods are most frequently used to prepare nanoemulsions: high-pressure homogenization, microfluidization, and phase-inversion temperature methodology[41]



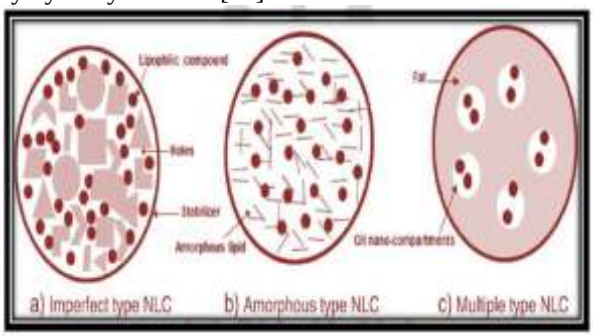
Product name	Marketed by
Vitacos Vita Herb Nano vital whitening cream	Vitacos Cosmetics
Vitacos Vita Herb Nano vital whitening Essence	Vitacos Cosmetics
Vital nanoemulsion A-VC	Marie Housie
Nanocream	Sinerga

Various Marketed Formulation of Nanoemulsion

Nanostructured Lipid Carriers (NLC)

Nanostructured lipid carriers (NLC) are a delivery system in which it consists of partial crystallized lipid particles with the size range of 100 nm and are dispersed in an aqueous phase which contains an emulsifier[42] The main components of NLC are Lipids, Water, Emulsifier. The size ranges of particles are 10 to 1000nm. It can be administered via Oral, Ocular, topical and intravenous route[43] NLC divided into the 3 categories on the basis of structure namely Imperfect Type, Multiple Type, Amorphous Type .

Type 1: Imperfect Type
Solid and liquid lipids are blended.The difference in the structure of lipids and special requirements in the crystallization process lead to a highly imperfect lipid matrix[44]
Type 2: Multiple Type
The multiple oil/fat/water,drug can be accommodated in the solid, but at increased solubility in the oily parts of the lipid matrix.[45]
Type 3: Amorphous Type
Lipids are mixed in a way that prevents them from crystallizing.The lipid matrix is solid but in a amorphous state. Eg. Hydroxy Octscosanylhydroxy Stearate.[46]



Limitation of NLC
1. Poor Drug Loading Capacity.
2. Relatively High water content of dispersions
3. Drug Expulsion afterPolymeric Transition during Storage.

Product name	Marketed by
Regeneration cream	Scholl
Intensive serum Nanorepair Q10	Dr. Rimpler
Iope supervital extra Moist eye cream	Amore pacific

List of Marketed products of NLCsssss

Major Classes of Nanocosmeceuticals
1. Sunscreen
Sunscreen is also known as sunblock, is a lotion, spray, gel, foam (such as an expanded foam lotion or whipped lotion), stick or other topical product that absorbs or reflects a number of the sun ultraviolet (UV) radiation and therefore helps shield against sunburn. Diligent use of sunblock may also slow or quickly stop the event of wrinkles, dark spots and sagging skin[47] On the basis of mode of action, sunblocks can be divided into two parts physical sunscreens (i.e., zinc oxide and titanium dioxide, which stay on the skin surface and mainly deflect the sunlight) or chemical sunscreens (i.e., UV organic filters, which absorbs the UV light)[48]
2. Moisturizer
Moisturizer are available in the form of lotions, creams, ointments, bath oils, or soap substitutes . Petrolatum the most effective emollient. Emollient cosmetics might in addition contain antioxidants , ceramides, emulsifiers, fragrances, humectants, penetration enhancers, preservatives, and solvents. Some products are marketed as having anti-wrinkle and skin improvement effects. Several plant and animal extracts have been claimed to impart the skin benefits, with little scientific proof.[49] .Humectant are the substance which have water attracting properties[50] One important group of humectant is the alpha hydroxyl acids. Other substance used are urea, glycerine, propylene glycol.etc[51]
3.Hair care
Hair care is that the overall term for hygiene and cosmetology include the hair which grows from the human scalp, and to a lesser extent facial, pubic and other different body hair. Hair care routines may be differ according to person's culture and therefore the physical characteristics of one's hair, Hair might be colored, trimmed, shaved, plucked or otherwise removed with such treatments like waxing, sugaring and threading[52] Hair care services are mainly offered in salons, barber shops and day spas, and some products are available commercially for home use. Hair Cosmetics can be categorized into two, which are those that work on the exocuticle (Shampoo,conditioner,serums,hair spray,waxes,gels) and those that work on the cortex(Hair colour,bleaching agents)[53]

4.Lip Balm:

The primary purpose of balm is to provide an occlusive layer on the lip surface to seal wetness in lips and shield them from external exposure. Dry air, cold temp, and wind all have a drying result on skin by drawing wetness removed from the body[54] Lips are significantly vulnerable because the skin is so thin, and thus they are often the first to present signs of dryness. Occlusive materials like waxes and petroleum jelly prevent moisture loss and maintain lip comfort whereas flavorants, colorants, sunscreens, and numerous medicaments will offer extra,specific advantages..Lip balm may be applied wherever a finger is employed to use it to the lips, or in a lipstick-style tube from that it may be applied directly[55] Lip balm was initially marketed in the 1880s by **Charles Browne Fleet** though its origins may be traced to earwax[56]

5. Nail care:

Nair care is the another class which comes under cosmeceuticals. Nailpaints which are made from the technique of nanotechnology have the advantage that it enhance the durability and drying will be fast[57]Care of the fingernails and toenails. Several nail issues are because of poor nail care. Following recommendations are followed for maintaining nail health include keeping nails clean and dry to keep bacteria and other infectious organisms from grouping beneath the nails, cutting nails straight across with only slight rounding at the tip, using a fine-textured file to keep nails shaped and free of snags[58]

6.Skin cleanser

Skin is roofed with the hydrolipid film that completely depends on the area of the body,contains the secretion from the oleaginous glands The term cleanser refers to a product that cleans or removes dirt or other different substances from the skin. Cleansers that have active ingredients are more appropriate for greasy skins to prevent breakouts. However they will overdry and irritate dry skin, this may make the skin appear and feel worse[59]Dehydrated skin might need a creamy lotion-type cleanser. These are normally too mild to be effective on oily or even normal skin,however dry skin needs abundant less cleansing power. It might be a good idea to pick a cleanser that is alcohol-free for use on dry, sensitive, or dehydrated skin[60]

Various nanotechnology based cosmeceutical product in the market

Product Name	**Marketed By**	**Marketing Claim**	**Uses**
Primordiale Optimum Lip	Lancome	It delivers vitamin E via nanocapsule technology to reduce the lip bleeding and feathering due to fine lines and wrinkles	Lip Treatment
Eye contour Nanolift	Euoko	Based on the Nanocapsules technology, it also provide instant smoothness, and gives radiance to the eye area and also dimishes the appearance of dark circle and puffiness	Antiwrinkle antiaging
Hydra Zen Cream	Lancome	Nanocapsules of pure vitaminE provide powerful antioxidant protection. A light touch of self tanner ensure a natural, healthy glowing skin.	Moisturizer
Nano Gold Firming Treatment	Chantecaille	Small nanoparticles of pure gold are bound to silk microfibers to firm and tone skin,while it delivers anti inflammatory healing	Antiaging
Cosil whitening Mask	Natural Korea	It is made with the nanocolloidal silver used for the effect of getting ridof germs from your face, soothing the skin condition and keeping the skin radiant and soft	Facemask
LifePak Nano	Pharmanex	It is a nutritional antiaging program formulated to nourish and protect cells,tissues and organs in the body with the purpose of guarding against the ravages of aging	facegel
DiorSnow PureUV Base SPF 50	Dior	It contains nano Uv filters for Ultraprotection against the damaging effects of UV rays	Sunscreen

RecentAdvancesincosmeceuticals

The development of nanotechnology has become a very important section for ancient industries because of the increasing client demand for improved products[61] Recently USFDA has published a paper on

an Import Alert 66-38, for skin care products[62] This is because there are various skin care products in the market which assert that the products control the aging process. According to USFDA, A claim like "molecules absorb and expand, exerting upward pressure to elevate wrinkles upward" may be a claim for associate inner structural change that will typically cause a product to be a drug. FDA has expressed such claims are unlawful on cosmetic labeling.

The regulation conjointly needs that all marketed cosmetics and sunscreens using nanoparticles can be tested one by one for the safety pupose. Cosmetic product containing nanomaterials should be notified by electronic means to the commission, providing knowledge on identification, specification, quantity, pharmacology profile, safety data, and predictable exposure conditions. Such notification should be occur within six months before a cosmetic product containing nanomaterials is placed on the market[63] Many cosmeceuticals alter the physiological processes within the skin, however makers avoid holding clinical trials and create the precise claims to avoid subjecting their products to high priced and extended approval process by FDA. New and strange challenges are being faced by the cosmetic trade[64]

II. CONCLUSION

Cosmeceuticals are now an integral part of aesthetic medicine and the growth of the cosmeceuticals are increasing day by day . The unique category of the product gives patient access to cosmetics containing beneficially active ingredients that can be use to enhance the skin appearance. Nanotechnology based cosmecueticals should be designed and sold in a way that fully respect the health of consumers and the environment

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Nidhi Kushwaha " Use of Nanotechnology in Cosmeceuticals: A Review". *International Journal of Pharmaceutical Science Invention(IJPSI),* vol. 09(01), 2020, pp.43-51.