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INTRODUCTION OF NANOTECHNOLOGY IN COSMETICS

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ABSTRACT

This review has overviewed the nanoparticles and its uses in cosmetic formulation, their challenges, opportunity and application. Nanoparticle based cosmetic have been used widely from recent few years in products like sunscreen, moisturizer, antiaging products, skin cleanser, shampoo, hair oil, hair gel, nail care, oral care etc. However there is major problems in nanoparticles containing products like toxicity and environment risk. Nano cosmeceuticals also doesn't have regulation in it. Nanoparticles provide a high entrapment power for active ingredients and show high efficacy. Mainly nanoparticles are provide better performance in cosmeceutical field. Every year new research has been done in this area like to treat skin diseases with nanoparticles. And there future aspects of creating or formulating cosmetics with recycling natural by products and re-inventing traditional ingredients. In this article we are going to focus on the different aspect nanoparticles in area of cosmetic preparation. We conclude from this study that in future cosmetic industry have to draw some attention toward sustainability in cosmetics industry.

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INTRODUCTION

Cosmetics can be defined a/c to D&C Act 1940 and rules 1945 'substance that are intended or rubbed, sprinkled and sprayed or applied on skin for beautifying, cleansing, promoting attractiveness or altering appearance'. [1] Nano means 'dwarf' nanoparticles are defined as particles which loaded with drug in small vesicles to penetrate skin deeply and show better action than conventional materials. [2] Nanoparticles are in range of 1 to 100nm in diameter. These are subset of nanomaterials which are defined as single particle below 100nm or they may be larger agglomerates. [1] Nanoparticles come under nanotechnology which is an engineering technology of functional system at nanoscale. According to NNI (National Nanotechnology Initiative) –

Nanotechnology means research and technology development at atomic, molecular or macromolecular levels in nanoscale, range of 1 to 100nm. [3] A physicist Richard Feynman (1959) innovated a concept of nanoscience and nanotechnology. A Japanese scientist Norio Taniguchi (1974) first used the term nanotechnology. The first product saw the daylight in (1991), at Shiseido in Japan and then L'Oréal adopted them as essential in 1999. [4] There are nanoparticles of titanium oxide in this foundation, which are full of iron for photochromic effect. In 1998 U.S. company introduced first anti-wrinkle cream using nanoparticles. Nanoparticles of TiO₂ and ZnO are transparent in formulations spread on the skin surface and used as UV filters in sunscreen. [4] This transparency provides the cosmetic acceptability not achievable with larger-particle formulations. L'Oréal has used polymer nanocapsules to deliver active ingredients, e.g. retinol or Vitamin A (1998). In 2005 Olay brand was introduced with nano emulsion technology. Use of nanoparticles in cosmetic lead the cosmetic industry in a positive direction which makes our personal care products more efficient and helpful.

Importance of nanocosmeceuticals

- ❖ Nano cosmeceuticals aims product intended for application to the skin, face and body to penetrate into deeper layers. [5]
- ❖ They show better performance in compared to conventional ones.
- ❖ In small vesicles we load high dose of active ingredients which can show better action.
- ❖ Nowadays nano cosmeceuticals are used majorly to deliver cosmeceutical products efficacy.
- ❖ Nano cosmeceuticals provide a steep growth in cosmetic market.
- ❖ They protect active ingredients from chemical or enzymatic degradation.
- ❖ They also control release of chemicals in skin to protect it from any skin irritation.
- ❖ They also prolong the residence of cosmetic active ingredients and drugs in the stratum corneum.
- ❖ These nanoparticles show site specific targeting and have physical stability.
- ❖ They provide high entrapment efficiency and increased efficacy.

Nanocosmeceuticals: challenges, opportunity, application

Challenges:-

- ★ Main challenge in nano cosmeceuticals there is possible risk in applying nanoparticles. [5]
- ★ And other possible problem is that the ingredients can be show incompatibility.
- ★ They may cause nanotoxicity to both human and environment. Its causes are as follows -
 - Smaller size of particles
 - Shape of nanoparticles
 - Surface area of nanoparticles
 - Penetration of nanoparticles via skin
 - Cellular toxicity of ZnO & TiO₂ nanoparticles
 - Route and extent of exposure
 - Occupational risk of nanoparticles
 - Inhalation
 - Ingestion
 - Environmental risk
- ★ There is no regulation for clinical safety of nanoparticles.
- ★ For nanoparticles no clinical trials has been done.

Opportunity:-

- ★ Through nanoparticles we can protect our skin from sunburn and pigmentation.
- ★ Phyto-based nanocosmeceuticals will play a greater role in future for enhanced protective, benefits and health benefits. [6]
- ★ These nanoproducts contribute higher efficacy skin-based nanotherapy. [7]

Application:-

- ★ Major applications of nanocosmeceuticals are preparation of more effective and more potent cosmetics. [6]
- ★ Because of decreased size of active drug, they can penetrate easily and can show better action. [7]

Nanoparticles Used For Cosmetics

- ♥ Nanoparticles used as UV filters
- ♥ Liposomes
- ♥ Nanocapsule
- ♥ Solid lipid nanoparticles
- ♥ Nanocrystals
- ♥ Dendrimers
- ♥ Cubosomes
- ♥ Niosomes

Nanoparticles used as UV filters –

Nanoparticle is ultrafine particle usually defined as a particle of matter whose size in between 1 to 100nm in diameter. Nanoparticle varies in a great variety of shape such as nanospheres, nanochains, nanorods etc. In recent time nanoparticle is the main area of research and development. Mostly nanoparticles are used in sunscreen for better result. [8]

The smaller size of these minerals increased cosmetic acceptability and much less visible after application.

Nanoparticles of zinc oxide and titanium dioxide was used in sunscreen for protection against UV rays. These particles reflects rays and absorb UV photons. ZnO has a flat absorption curve towards UVA and UVB spectrum and TiO₂ shifts dominantly towards UV B spectrum, when both ZnO and TiO₂ are used in combination they show better protection from UV spectrum. These inorganic particles can be coated with silica mostly because it prevent photocatalytic event. [8]

Herbal Ingredients as UV Filter –

- Raspberry seed oil.
- Shea butter.
- Wheat germ oil.
- Sunflower oil.
- Carrot oil.

Preparation Of Nanoparticles (Naringenin with ZnO and TiO₂) –

The polymeric nanoparticles of naringenin were prepared by single emulsion and solvent evaporation technique. [9].

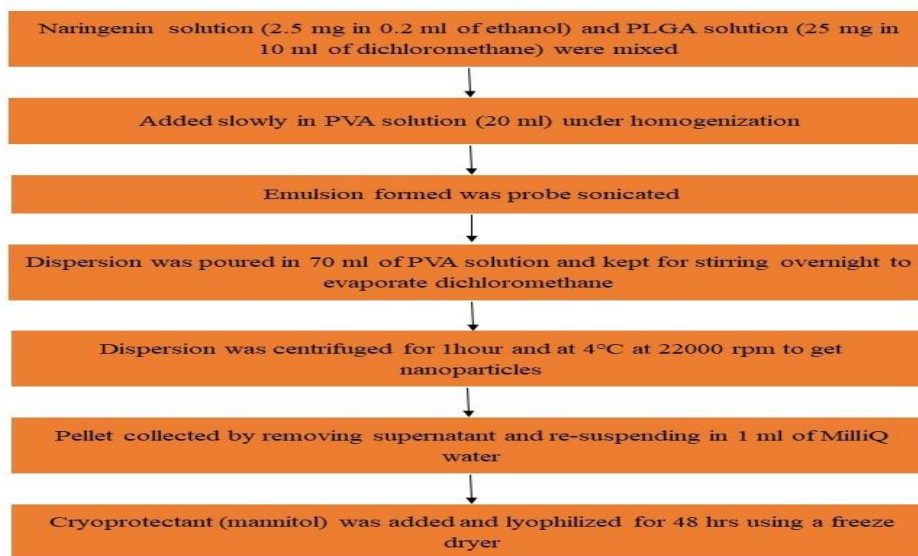


Figure 1 - Flow chart of preparation method of Naringenin loaded nanoparticles.

Characterization of Nanoparticles in Sunscreen –

Particle Size Measurement –

Dynamic light scattering technique was used to measure the average size of naringenin NPs and its distribution using NanoZS (Malvern Instruments, Malvern, UK).

Zeta Potential –

A combination of laser Doppler velocimetry and phase analysis light scattering was used.

Drug Entrapment Efficiency –

Sample was dispersed in 0.2ml of pellet in methanol. After that it was probe sonicated for 15 min and water-bath sonicated for 15 min. Samples was filtered into 0.2 μ m syringe filter and amount was determined using UV spectrophotometer at 288 nm.[9].

$$\text{Entrapment efficiency (\%)} = \frac{\text{Amount of encapsulated drug}}{\text{Total amount of drug}} \times 100$$

Example Of Some Marketed Products –

- ★ Neutrogena sunscreen SPF50+
- ★ Coola SPF30 sunscreen
- ★ Mamaearth sunscreen
- ★ Epicuren sunscreen SPF27
- ★ The Inkey Sunscreen

Application Of Nanoparticles –

- Deeper penetration.
- Controlled release.
- Make chemically stable.
- Site specific targeting.
- Retarded release.
- Better efficacy.
- Improve drug solubility.
- Skin hydration and film formation.
- Enhanced skin bioavailability.

Challenges in Sunscreen Containing Nanoparticles -

- ♣ Inhalation of nanoparticles leads to lung damage.
- ♣ Environmental safety and toxicity.
- ♣ In some studies it was found that use of nanoparticles leads to potentially cytotoxic and carcinogenic.
- ♣ Because of its deeper penetration properties it can reaches to blood stream and its prolong use result in toxicity.
- ♣ In some studies it was also noticed that regular use of nanoparticles based sunscreen increased concentration of zinc in blood and urine.

Liposomes

Liposomes are reservoir system and they are small vesicles of spherical shape that are composed of lipidic bilayer of phospholipid and cholesterol. It can be one or more membrane. Liposomes are drug loaded with wide range of drugs, proteins, nucleoprotein or plasmids to penetrate skin deeply and give better results. Liposomes were discovered about 40 year ago by A.D.Bangham, a British hematologist (1961 and published (1964)).

The term liposome proposed by Weissmann(1961).The term liposome comes form two greek word “lipos” means fat and “soma” means body. It has become versatile tool in biology, biochemistry and medicine. [10]

Structure of Liposomes –

Phospholipids are amphipathic molecule that means having both affinity for aqueous and polar moieties, it have both hydrophilic head and hydrophobic tail. This portion of tail contains two fatty acid chains of 10-24 carbon atoms and 0-6 double bond in each chains. The head consist phosphoric acid bound to a water soluble molecule. [10]

Mechanism of Action –

A liposome consist aqueous solution inside hydrophobic membrane. These lipid bilayers fused with other bilayers of cell to release liposomal content.[11]

Steps –

1. Adsorption.
2. Endocytosis.
3. Fusion.
4. Lipid exchange.

Classification -

- ✚ Transferosomes
- ✚ Marinosomes
- ✚ Ultrasomes
- ✚ Phytosomes
- ✚ Ethosomes
- ✚ AOCS liposome
- ✚ Yeast-based liposome

How to Prepare Liposomes –

Liposomes are formed when phospholipid molecules mainly phosphatidylcholine derived from egg or soya lecithin, putted excess water and form, spontaneously and lipid aggregates through the interaction of the lipophilic portions of the phospholipid.[11]

Various Methods for Preparation of Liposomes –

- ❖ Physical dispersion methods
 - ★ Hand shaking MLVs
 - ★ Non shaking LUVs
 - ★ Freeze drying
 - ★ Pro-liposomes
- ❖ Reduction of size
 - ★ Micro emulsification method
 - ★ Membrane extrusion method
 - ★ Ultrasonication method
 - ★ French Pressure cell method
- ❖ To increase size
 - ★ Dried reconstituted vesicle
 - ★ Freeze thawing
 - ★ Induction of vasiculation by pH change
- ❖ Solvent dispersion method
 - ★ Ethanol injection
 - ★ Ether injection
 - ★ Water organic phase
 - Double emulsion method
 - Reverse phase evaporation
 - Stable pluri lamellar vesicles method
- ❖ Detergent solubilization

Mostly Used Preparation Method of Liposome –
Ultrasonication

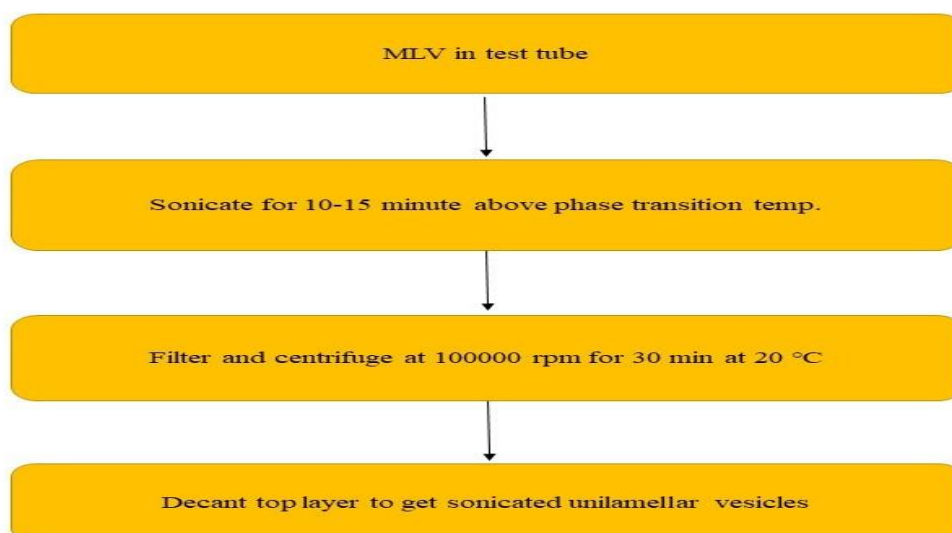


Figure 2 – Flow chart for preparation of liposomes.

Liposome based cosmeceutical formulations are –

- Anti-acne
- Anti-aging
- Hyperpigmentation
- Melasma

Herbal ingredients used in liposomal cosmeceuticals –

- Quercetin
- Arbutin resveratrol
- Curcumin
- Apigenin
- Proanthocyanidin
- Ricinoleic acid
- Vitamin C
- Red grape seed and stalk extracts

Advantage –

- ♥ Increase in therapeutic index and efficacy.
- ♥ Increase in stability by encapsulation.
- ♥ Non-toxic, flexible, biocompatible, completely biodegradable, and non-immunogenic for systemic, and non-systemic administrations.
- ♥ Reduction of toxicity by encapsulation.[12]

Disadvantage –

- ♥ Low solubility
- ♥ Short half-life
- ♥ Sometimes phospholipid undergoes oxidation and hydrolysis reaction
- ♥ Leakage and fusion of encapsulated drug/molecules
- ♥ Production is high

Application –

- ♥ Great potential in topical application
- ♥ Stability and sterilization
- ♥ Encapsulation efficiency
- ♥ Active targeting

Marketed Liposome Cosmeceutical Formulation – [12]

- ✚ Capture – First anti-aging liposomal cream – Christain Dior in 1987 – (Claim – reduce sign of wrinkles).
- ✚ Sesderma Acglicolic Liposomal Serum
- ✚ Sesderma Azelac Liposomal Serum
- ✚ Sesderma Liposomal Serum Photoaging

Nanocapsule

Nanocapsules can be characterized as nanovesicles. It is vesicular or “resevior” system in which oil/water is incorporated or filled in cavity surrounded by polymeric membrane.[13]

Structure -

It has nano-vesicular system formed in a core-shell arrangement. . These are nanoscale shell made from non-toxic polymer. It consist inner liquid core encapsulated by polymeric membrane. Polymer used can be biodegradable polyester.

History of Nanocapsule As Cosmetics -

Active substances incorporated can be solid and liquid.

(Bizerra and Silva, (2016); Daudt et al.,(2013); Devissaguet and Fessi, (1991)). If active substances exhibit lipophilic characteristics it may solubilised in core or may be absorbed in polymeric matrix depending on its solubility. The substance which are liposoluble dissolved in core while amphiphilic have greater affinity in polymeric matrix. (Danckwerts and Fassihi, (1991); Dash and Cudworth, (1998); Kimura and Ogura, (2001)). Nanocapsule are differ from microcapsule in particle size.

Nanocapsule are now commonly used in cosmeceutical industry for better result.

Nanocapsule applied in cosmetic and dermocosmetic formulations to act as reservoir for prolonged release of active substance, protect from oxidative process and reduce unpleasant odour.[14]

Vitamin A nanocapsule of anti-aging was formulated by Kaur and Agrawal (2007). Because these nanocapsule show prolonged action.

In year 2009 a study was proposed by two scientist Wu and Guy, they reported that in sunscreen formulation nanocapsule of octyl-methoxy cinnamate and benzophenone-3, because they form a film and slowly release ingredients, promote extended protection.

A scientist Wu et. al. (2013) developed a nanocapsule of γ -polyglutamic acid/quitosans containing jasmine essence, and reported sustained release of essence at room temperature. From this study it was found that nanoencapsulation of fragrance used to prolong pleasant odour of cosmetic products Wu et. al. (2013).

Preparation of Nanocapsule –

- Interfacial polymerization
 - Oil containing nanocapsule
 - Nanocapsule containing aqueous core
- Obtained from performed polymer

Oil Containing Nanocapsule Method –

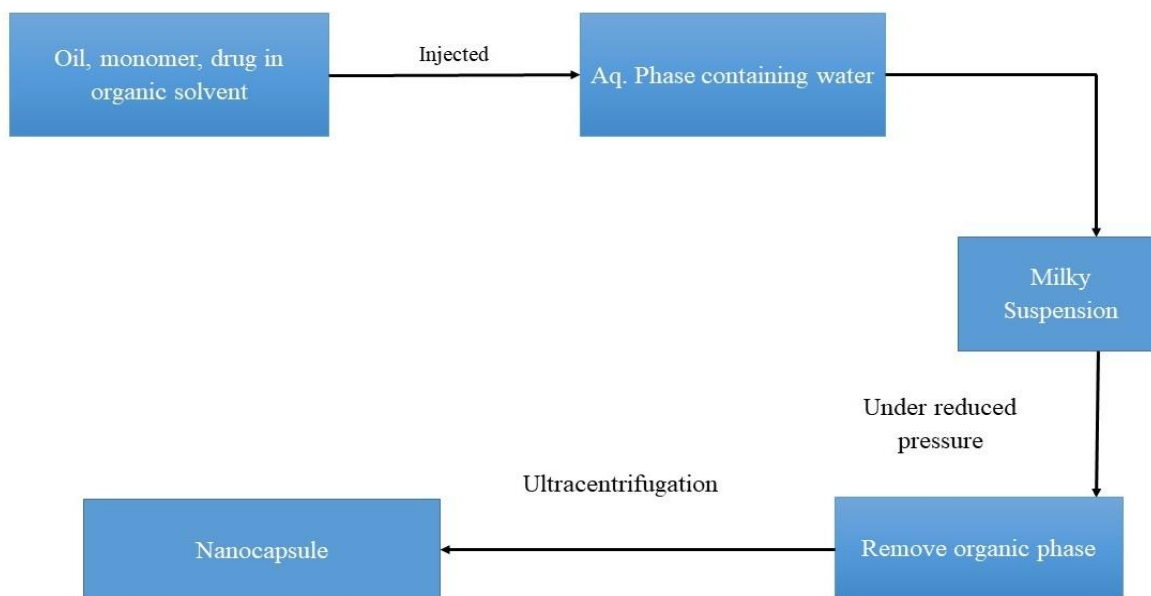


Figure 3 – Flow chart for preparation of nanocapsule.

Advantages – [13]

- Higher dose loading with smaller dose volumes
- Longer site specific dose retention
- More rapid absorption
- Increased bioavailability
- Higher safety and efficacy

Challenges – [13]

- Very costly formulation
- Productivity is more difficult
- Reduced ability to adjust dose
- Highly sophisticated technology
- Stability of dosage form is big issue
- Recycling is very expensive

Marketed Formulation –

- ❖ Primordiale Intense by L'Oréal
- ❖ Hydra Zen Serum by L'Oréal

Solid Lipid Nanoparticles

Solid lipid nanoparticles are new pharmaceutical and cosmeceutical delivery system. These are typical spherical and size range from 10 to 1000 nm. These are colloidal particles of submicron range.[15]

This is designed to overcome the disadvantage of liquid state of oil droplets. Solid lipid nanoparticles were discovered by Gasco and Muller (1991).

Structure Of SLN –

They possess solid lipid core matrix which can solubilize lipophilic molecules.

History of SLNs as cosmetics –

For delivery of chemically labile active substances like retinol, SLNPs play major role. (Wu and Guy - 2009). Another one is incorporation of sunscreen in lipid matrix, delaying penetration of active ingredients in skin by keeping it in stratum corneum. (Daudt et. al.(2013), Wu and Guy (2009)).[16]

Methods Of Production –

- High pressure homogenization
 - Hot homogenization
 - Cold homogenization
- Ultrasonication
- Solvent emulsification / evaporation
- Micro emulsion
- Using Supercritical fluid
- By Spray drying

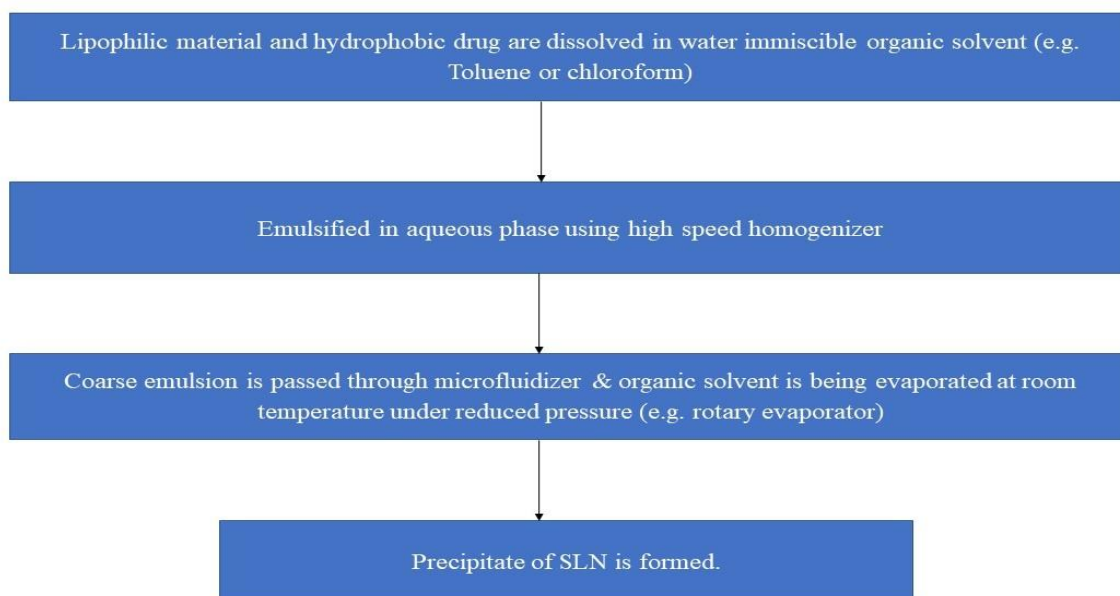
Solvent Emulsification/Evaporation

Figure 4 – Flow chart for preparation of SLN.

Advantages –

- Excellent biocompatibility.
- Improve stability of formulation.
- High enhanced drug content.
- Easy to scale up and sterilize.
- Enhanced bioavailability of active ingredients.
- Chemical protection of labile incorporated compounds.

Challenges –

- Poor drug loading capacity.
- Drug expulsion after polymeric transition during storage.
- Relatively high water content of dispersions.
- Load capacity of load hydrophilic drugs due to partitioning effect.

Marketed Products –

- ❖ NanoRepair Q10 by Cutanova.
- ❖ Super vital extra moist cream by IOPE.

Nanocrystals

A nanocrystal is a material particle having dimension smaller than 100 nm. It is based on quantum dots and composed atoms of single or poly crystalline arrangement. [17]

Preparation Methods –

- Bottom up
 - Precipitation
 - Cryo-vacuum
- Top down
 - Wet milling
 - High pressure homogenization

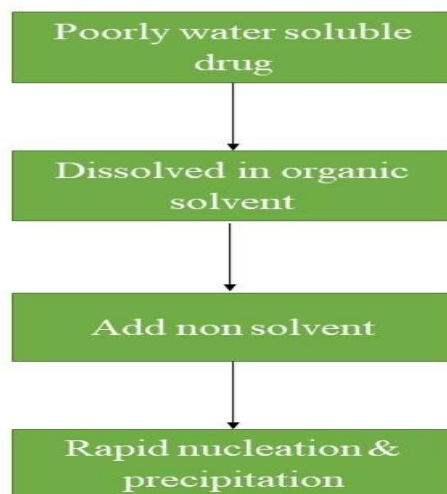
Bottom Up Technique –

Figure 5 – Flow chart for preparation of Nanocrystals.

Advantages –

- Enhanced bioavailability
- Enhanced solubility
- Improved dose proportionality

Disadvantages –

- Long production time
- Physiochemical related stability problems
- Uniform and high dose cannot achieved.[18]

Marketed products –

- ❖ Nivea crème

Dendrimers

It is a synthetic polymer of repetitively branched molecule. The word dendrimer comes from greek word “dendron” means tree like structure. [19]

Structure of Dendrimers –

It can be defined as synthetic 3D, hyper branched, globular macromolecule which provides high degree of surface functionality. It has three parts – initiator, interior layer and exterior layer.[20]

History –

Chemistry of dendrimers introduced by Vogtle and co-workers (1978).

Dendrimers are also called hyper branched molecules discovered by Donald Tomalia and co-workers (1980). Cascade molecules was the first family of dendrimers synthesized by Vogtle (1985).[21].

Preparation Methods –

- Divergent Method
- Convergent Method
- Hypercore and branched monomer method
- Double exponential and mixed growth

Divergent Method –

1. Activation of functional surface groups
2. Addition of branching monomer units

Disadvantages –

- It can cause trailing generations.
- It is difficult to purify the product.
- Relative size differences between perfect and imperfect dendrimers are very small.

Cubosomes

The square and rounded particles of cubosomes have visible internal cubic lattice. These are formed by aqueous lipid and surfactant system which is self-assembled nanostructured particles. These are thermodynamically stable; they have structure like “honeycombed”.

Advantages –

1. High drug payloads
2. Simple method of preparation
3. Biodegradability of lipids
4. Capability of encapsulating hydrophilic, hydrophobic and amphiphilic substances.
5. Controlled release of bioactive agents.
6. Have relative insolubility of cubic phase forming lipid in water leads to stable in any dilution level.

Disadvantages –

Because of high viscosity sometimes large scale production is difficult.

Preparation Methods –**Two methods of manufacturing-**

1. Top down technique
 2. Bottom down technique
- ❖ Liquid cubosomes precursors (The Hydrotop Dilution Process)
 - ❖ Powder cubosomes precursors

Top Down Technique

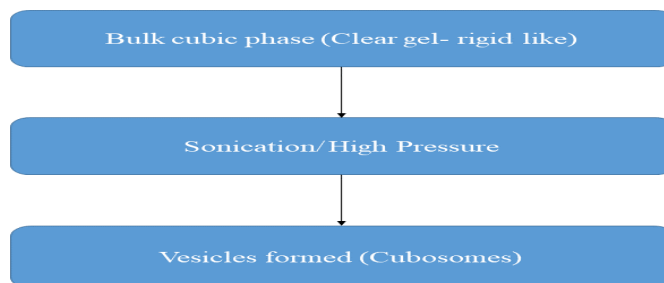


Figure 6- Flow chart for preparation of cubosomes.

NOTE – Currently used in oil-in-water emulsion stabilizers and pollutant absorbents in cosmetic by L'Oréal.

Niosomes

By incorporation of cholesterol as excipient in non-ionic surfactant leads to the formation of niosomes. It has more penetrating capability than other emulsions. It can entrap both hydrophilic and lipophilic drugs, in both aqueous layer and vesicular membrane of lipid material. [22]

Structure –

Niosomes are microscopic in size and also have lamellar structure. The non-ionic surfactant part of niosomes have alkyl or dialkyl polyglycerol ether class containing cholesterol in aqueous media. [23]

Classification -

- Small unilamellar vesicles
- Large unilamellar vesicles
- Multi-lamellar vesicles

General Characteristics –

- Biocompatible
- Biodegradable
- Non toxic
- Non immunogenic
- Non carcinogenic
- High resistance to hydrolytic degradation

Advantages –

- Targeted drug delivery
- Even small dose can give desired effect
- Side effects decreases
- Therapeutic efficacy can be improved easily.[24]

Disadvantages –

- Exhibit fusion, aggregation, leaching and hydrolysis of drugs
- Requires more time
- Highly specialized equipment
- Inefficient drug loading

Method of preparation –

- Ether injection (LUV)
- Hand shaking method (MLV)
- Reverse phase evaporation (LUV)
- Sonication (SUV)
- Micro fluidization method (SUV)

Common Stages of Preparation

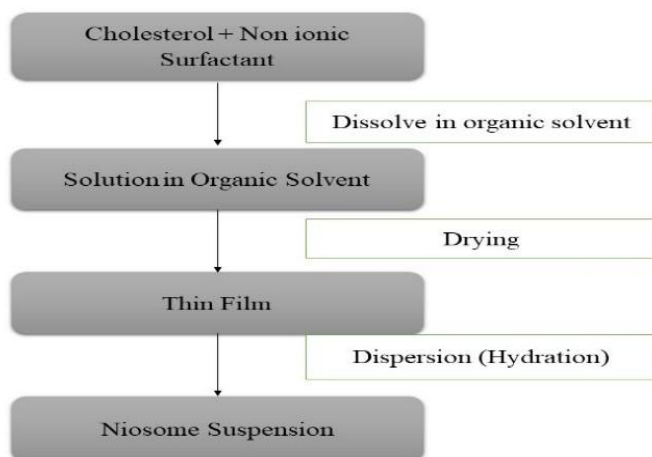


Figure 7 – Flow chart of preparation of niosomes.

History in Cosmetics –

Since 1970s niosomes are used in the area of cosmetics. They are mostly stable with less irritating and good penetrating power. Niosomes play major role as a carrier for anti-aging topical products.[25]

Research Done In This Area -

Liposome –

Liposomes are widely used in cosmeceuticals, because it has less side effects and also protect the drug from metabolic degradation. [12]

Some of antioxidants like CoQ10, carotenoids and lycopene and active ingredients like Vitamin A, E and K have been incorporated in liposomes.

Formulations in which liposomes used –

Liposome are being developed mainly for delivery of fragrance, botanicals and vitamins like antiperspirants, body sprays, deodorant and lipsticks.

Also used in delivery of antiaging creams, moisturizing cream, sunscreen, beauty creams and hair loss treatment.

Some marketed products –

Table 1.1. – Marketed products of liposomes.

S.No.	Product Name	Marketed by
1	Capture Totale	Dior
2	Azelac RU Liposomal Depigmenting Serum	Sesderma
3	NOW Solutions MSM Healthy Skin Liposome Lotion	NOW Foods
4	Cosme Decorte Liposome Moisture Serum	Decorte
5	Glucosamine, MSM & Arnica Liposome Lotion	NOW Foods

Niosomes –

These are defined as vesicles having a bilayer structure made up of hydrated non-ionic surfactant. [24]

Niosome was developed by L'Oréal in year 1970 by development of synthetic liposomes. It was patented in year 1987 and launched by name Lancôme.

Some formulations of niosome are anti-wrinkle cream, moisturizing cream, skin whitening cream, hair repairing shampoo, foundation and conditioner.

Some marketed products –**Table 1.2. – Marketed products of Niosomes.**

S.No.	Product Name	Marketed By
1	Niosome+ Perfected Age Treatment	Lancôme
2	Mayu Niosome Base Cream	Laon cosmetics
3	Anti-Age Response Cream	Simply Man Match
4	Identik Masque Floral Repair	Identik
5	Eusu Niosome Makam Pom Whitening Facial Cream	Eusu

Solid Lipid Nanoparticles –

SLN was developed in early 1990s and these are very popular in area of cosmeceuticals, because it is composed of biodegradable and physiological lipids that exhibit low toxicity.

Mainly SLNs are used in delivery of perfume, body moisturizer and anti-wrinkle cream[26].

Some Marketed Products –**Table 1.3. – Marketed products of SLN.**

S.No.	Product Name	Marketed By
1	Allure body cream	Chanel
2	Allure Parfume bottle	Perfume
3	Soosion Facial Lifting Cream SLN Technology	Soosion

Nanoemulsions –

It is a kinetically and thermodynamically stable dispersion of liquid with both oil and water phase in combination with surfactant.[27]

Some of Nano emulsions in cosmeceuticals are deodorant, sunscreen, shampoo, lotion, nail enamel, conditioner and hair serum.[28]

Some marketed products are –**Table 1.4. – Marketed products of Nano-emulsion.**

S.No.	Product Name	Marketed By
1	Korres Red Vine Hair Sun Protection	Korres
2	Vital Nanoemulsion A-VC	Marie Louise
3	Coco Mademoiselle Fresh Moisture Mist	Chanel
4	Phyto-Endorphin Hand Cream	Rhonda Allison
5	Vitacos Vita-Herb Nona-Vital Skin Toner	Vitacos cosmetics

Nanogold –

These gold nanoparticles are inert in nature, highly stable, biocompatible and non-cytotoxic. The colour of nanogold ranges from red to purple, to blue and to black due to aggregation. [29]

Nanogold are used in these cosmeceuticals like cream, lotion, face pack, deodorants, anti-aging creams.

Some marketed products are –**Table 1.5. – Marketed products of Nanogold.**

S.No.	Product Name	Marketed By
1	Chantecaille Nano Gold Energizing Cream	Chantecaille
2	Ameizii Nano Gold Foil Liquid	Ameizii
3	Orogold 24K Nano Ultra Silk Serum	Orogold
4	O3+ 24K Gold Gel Cream	O3+
5	LR Nano Gold Day & Silk Day Cream	LR Zeitgard

Nanocapsule –

Nanocapsules are submicroscopic particles that are made of a polymeric capsule surrounding an aqueous or oily core. Nanocapsule can be used to decrease toxicity of UV filter octyl methoxycinnamate, proved in a study on pig skin in comparison with conventional emulsion.[30].

Some Marketed Products –**Table 1.6. – Marketed products of Nanocapsule.**

S.No.	Marketed Products	Manufacturer
1	Double dose in a box, laser relief, laser tight	Dr. Brandtt
2	Hydra flash bronzer	Lancome
3	Super aqua skin cream range	Enpranil

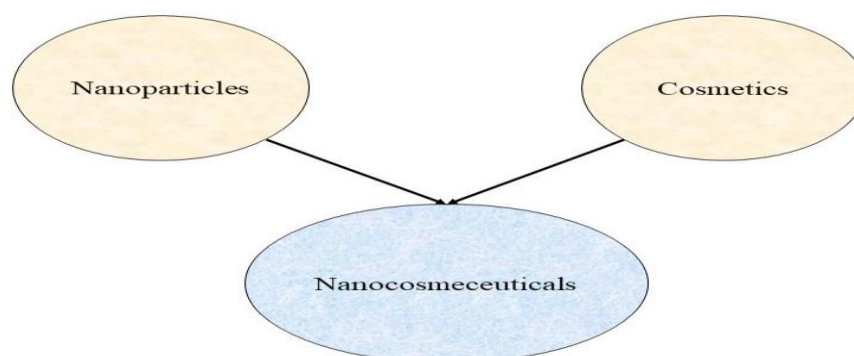
Nanocrystals –

They form a cluster containing hundreds to thousands of atoms. Size of these cluster is in between 10 and 400 nm and they exhibit both physical and chemical properties between bulk solids and molecules. They allow safe and effective passage through skin. [30].

Some Marketed Products –**Table 1.7. – Marketed products of Nanocrystals.**

S.No.	Marketed Products	Manufacturer
1	Revitalift double lifting	L'Oreal
2	Revitalift intense lift treatment mask	L'Oreal

Formulation of Nanoparticles –Nanocosmeceuticals – These are cosmetic formulations which contains nanocarriers or nanoparticles.

**Figure 8 – Diagrammatical representation of Nano cosmeceuticals.****Different formulations prepared by nanotech –**

- i. Sunscreen
- ii. Antiaging Cream
- iii. Cleanser
- iv. Moisturizer

Sunscreen –

This can be also called as sunblock or suntan lotion, by application of it protects from sunburn by absorbing or reflecting sun's UV rays. (31)

Introduction – Sunburn occurs due to action of UV rays on skin and long term exposure leads to carcinoma and melanoma. There three types of UV rays –

- i) UVA
- ii) UVB
- iii) UVC

UVA rays can cause skin ageing, dryness, dermatological photosensitivity and skin cancer. UVB rays can leads to DNA damage by formation of pyrimidine dimer, and cause apoptosis. UVC rays cannot penetrate through atmospheric layer. (31)

There are three types of sunburn –

- i) First degree sunburn
- ii) Second degree sunburn
- iii) Third degree sunburn

First degree sunburn can lead to redning of skin and mild pain. Second degree sunburn leads to blistering of skin and severe pain. Third degree sunburn is rare. (30)

SPF (Sun Protection Factor) –

It can be defined as how much UV radiation required to produce sunburn on protected skin relative to amount of solar energy required to produce sunburn on unprotected skin.(32)

SPF = minimum erythematous dose with sunscreen / minimum erythematous dose without sunscreen.

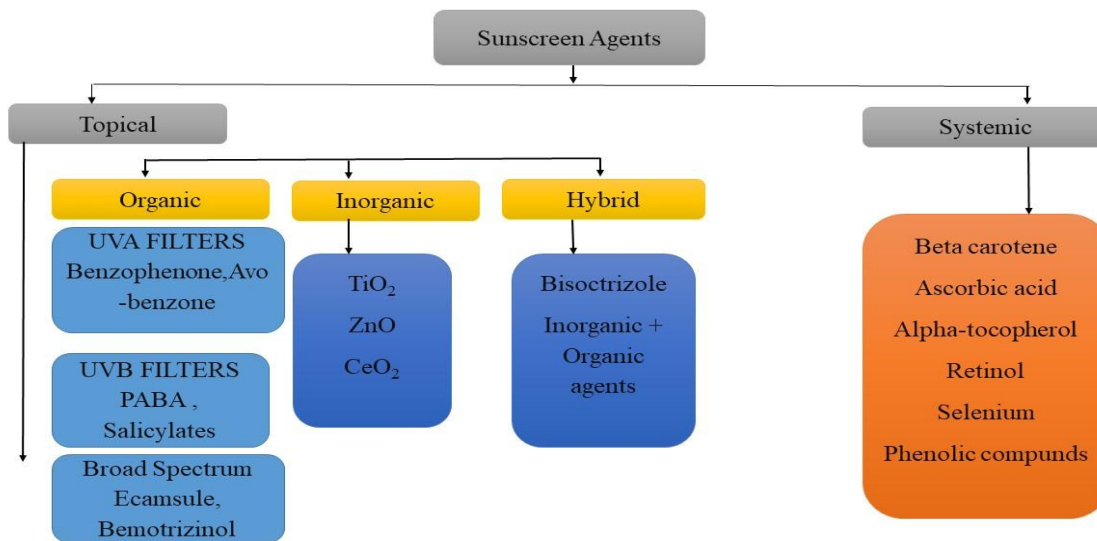


Figure 9 – Classification of sunscreen agents.

Marketed Nanocosmeceutical sunscreen preparations –

Table 1.8. – Marketed products of sunscreen containing nanoparticles.

1	Aspect Sun Envirostat SPF 50	The Clinic
2	Ultra Matte Dry Touch Sunscreen	Re’equil
3	Dermalogica Sun Protection SPF 50	Dermalogica
4	Timeless Sun Defense Serum	Timeless Organics
5	EltaMD UV Clear Facial Sunscreen	EltaMD
6	Pure Zinc Matte Sunscreen Gel	The DermaCo.

Anti-Aging Cream - These are types of cosmeceutical skincare products which claims to look younger by reducing, masking or preventing signs of aging.

7 Signs of aging are – sagging, wrinkles, photoaging, erythema, dyspigmentation, yellowing and abnormal growth.

Types of skin aging –

- i) Intrinsic Aging – It is a type of aging which occurs due to decrease in synthesis of collagen and elastin.
- ii) Extrinsic Aging – It is caused by photoaging and smoking.(32).

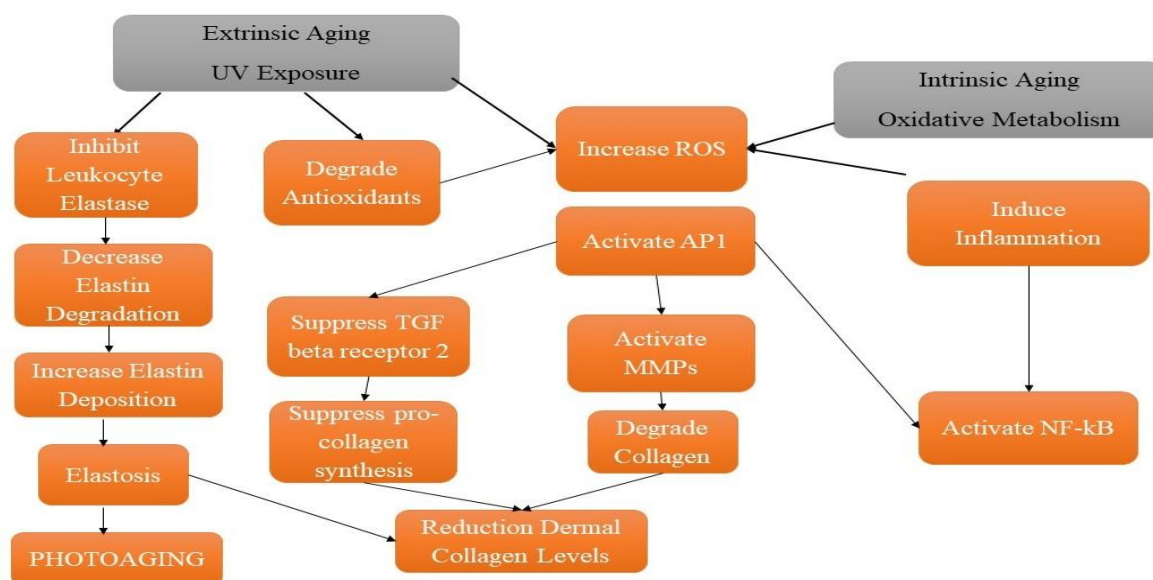


Figure 10 – Classification of skin aging and its mechanism.

Marketed Nanocosmeceuticals of antiaging preparations –

Table 1.9. – Marketed products of anti-aging preparations containing nanoparticles.

S.no.	Formulation Name	Brand
1	Age Prevention	Mitchell USA
2	Cream Veso Face Cream	LR Wonder
3	Lifting and Revitalising Cream	Sublime Life
4	Age Defying Face Cream	Tjori
5	Age Defender Cream	Kiehl's India
6	Idc Deep Wrinkle	Glenmark

- Moisturizer – It is a type of cosmetic preparation contains emollient used for protecting, moisturizing and lubricating the skin which function was governed by sebum produced from healthy skin.

Marketed Nanocosmeceuticlas Moisturizer Preparation –

Table 1.10. – Marketed products of moisturizer containing nanoparticles.

S.no.	Formulation Name	Brand
1	The Moisturizer	The Clinic
2	Bright Star	Liberty Belle Rx
3	Oil Free Moisturizer	Neutrogena
4	Oil Free Mattifying Moisturizer	Re'equil
5	White Truffle Organic Face Cream	Savor Beauty
6	Repairative Moisturizer	Gee Beauty US

Cleanser –

It is a type of formulation for skin care which is used to cleanse or remove dirt or other substances.

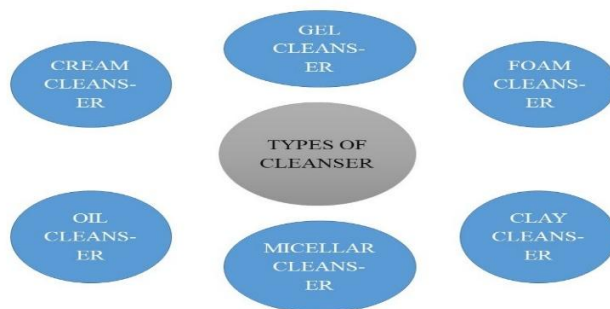


Figure 11 – Types of cleanser.

Marketed Nanocosmeceutical Cleanser Preparation –

Table 1.11. – Marketed products of cleanser containing nanoparticles.

S.no.	Formulation Name	Type of Cleanser	Brand
1	Curcumin Loaded Face Wash	Gel Cleanser	Evver
2	AHA-BHA Foaming Cleanser	Foam Cleanser	The Derma Co
3	Clear Face Cleanser	Gel Cleanser	Sebamed
4	Rice Water Bright Cleansing Foam	Foam Cleanser	The Face Shop
5	Nourishing Oil Cleanser	Oil Cleanser	Tata Harper

Composition –

Table 1.12. – Composition of Cleanser.

S.no.	Ingredients
1	Emulsifier
2	Emollient
3	Preservative
4	Humectant
5	Conditioning Agent
6	Active Ingredients
7	Vehicle

Evaluation Parameter –



Figure 12 – Evaluation Parameters.

CONCLUSION & FUTURE PERSPECTIVE –

Nowadays many nanotechnologies are involved in cosmetic industry with no. of benefits and advantages. These nanotechnology based cosmetics leads cosmetic market to raise their value and get a hike in price as well which raises the value of cosmetic industry to higher. NPs in cosmetics plays a major role i.e. increase drug permeation, UV filtering and increases active ingredient delivery in comparison to conventional one. As innovation in cosmetics increases rapidly the chances of other hazard also increases like toxicity of nanomaterials which results into brutal effect on environment, human and animals. Because of this reason cosmetic industry now become more focused towards the herbal ingredients in place synthetic ones. As we know the main focus of cosmetic industry is now towards herbal ingredients, whose excessive use can cause scarcity of these resources. So, from now cosmetic industry have to support the concept of sustainability for preventing resources from scarcity. Sustainability is the future of cosmetic industry in many manners like it can prevent by the resources from extinction and also it can be step toward green environment.

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ABBREVIATIONS -

UV	Ultraviolet
NPs	Nanoparticles
D&C	Drug and Cosmetic
TiO₂	Titanium Dioxide
ZnO	Zinc Oxide
DNA	Deoxyribonucleic Acid

Competing Interests –

The author declare no conflict of interests.

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