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"A Review On Nanotechnology In Cosmetics And Cosmeceuticals"

Ms. Akanksha Pravin Sarode[1], Ms. Snehal S. Rajora[2], Mr. Rutik D. Lahamge[3]

S.M.B.T. College of Pharmacy, Nandi Hills, Dhamangaon, Tal. Igatpuri Dist. Nashik

Abstract:

The cosmetics sector has ventured extensively into the field of nanotechnology in an attempt to enhance the effectiveness of its products. The extensive use of nanomaterial in cosmetics can have a two sides health related benefits, cosmeceuticals use and some detrimental effects. The primary purpose of this review is to look at the benefits and drawbacks of using nanomaterials in cosmetics. Along with various kinds of cosmetic goods based on nanotechnology, it also provides examples of nanomaterials that are commonly utilized in the cosmetics industry. The benefits of nanomaterials in cosmetic industry are huge. As well as the study regarding toxic effect on health also equally matter. This review gives brief idea about nanomaterial advantages, disadvantages and their beneficial role in nanocosmoceuticals. Keywords: Nanomaterial, Nanoparticles, Cosmeceuticals, Nanotechnology

Introduction

The use of nanotechnology to the cosmetic and cosmeceutical industry to boost product efficac iousness is the basis of this review study.

In a number of scientific fields, nanotechnology has been regarded as a groundbreaking scienti fic discovery of the modern era Materials with at least one nanoscale dimension and notably unique physicochemical characteristics are referred to as nanomaterials [1]. The field of cosmetics and cosmeceuticals has intensively investigated nanotechnology, which is widely recognized as a significant technological advancement. Being one of the fastest-growing sectors of the economy, it calls for more nanotechnology exploration, research, and applications. Anti- aging products have made extensive use of nano cosmeceuticals [2]. With promises to promote growth, protect structure, and improve hydration, these compositions are successfully marketed as skincare, hair care, and nail care products. It is said that this increases their general efficacy as cosmetics. Nanomaterials are attracting attention in this area, as they offer greater advantages over traditionally used cosmetic products [3]. Further, the amalgamation of nanomaterials has greatly. Comparing these products to conventional cosmeceuticals, there are a number of benefits. Their advantageous surface-to-volume ratio and compact size enable them to function as useful supplements to cosmeceuticals. Nanoparticles also improve the look, coverage, and adherence of cosmeceuticals on the skin without changing their original characteristics when added to cosmetic formulations [4].

Although it has been a concept for a while to use nanomaterials, including silver and gold nanoparticles, in cosmetics, the variety of uses has expanded greatly in the last few years. Cosmetics are defined by the Food and Drug Administration (FDA) of the United States as goods that are applied to the human body with the intention of improving appearance, beautifying, or cleansing it without altering its structure or functions [5]. European Union Cosmetics Directive (EUCD) defines cosmetics as "any substance or preparation intended to be placed in contact with the various external parts of the human body (epidermis, hair system, nails, lips and external genital organs) or with the teeth and the mucous membrane of the oral cavity with a view exclusively or mainly of cleaning them, perfuming them, changing their appearance and/or correcting body odours and/or protecting them or keeping them in good condition"[6]. In this industry, nanomaterials are becoming more and more popular because they offer more benefits than conventional cosmetics. Moreover, there is a lot of promise for the combination of nanomaterials. Both the pharmaceutical and cosmetics industries have grown significantly globally as a result of the use of nanomaterials. According to estimates, the global market for nanomaterials was valued at 8.5 billion in 2019. It is projected to increase at a compound annual growth rate of up to 13.1% between 2020 and 2027[7].

Nanotechnology and Nanoparticles

Nanoparticles are divided into the two categories

1.Nanospheres 2.Nanocapsules

According to, definitions, nanospheres are homogenous matrix systems in which a solid sphere allows a dispersed or dissolved active component to be absorbed on the surface or trapped inside the polymeric matrix structure [8].

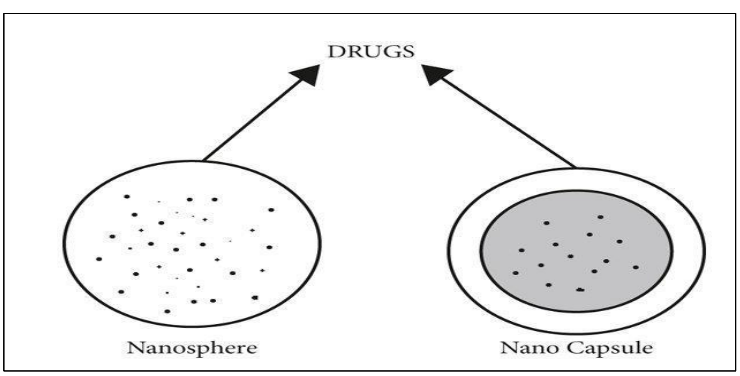


Fig. Nanosphere and Nano capsule

Nano Capsule

These are used in cosmetics for keeping important active ingredients that are either constrained to an aqueous or greasy condition. In cosmetics, nano capsules are used to safeguard substances, reduce chemical odors, and resolve issues with compatibility among formulation elements. Nanoprecipitation, a method using poly-l-lactic acid, may produce stable forms of 115 nm-diameter nano capsules. Polymeric nano capsule suspensions can be used as an ingredient in semi-solid formulations or applied directly to the skin as a finished product [9].

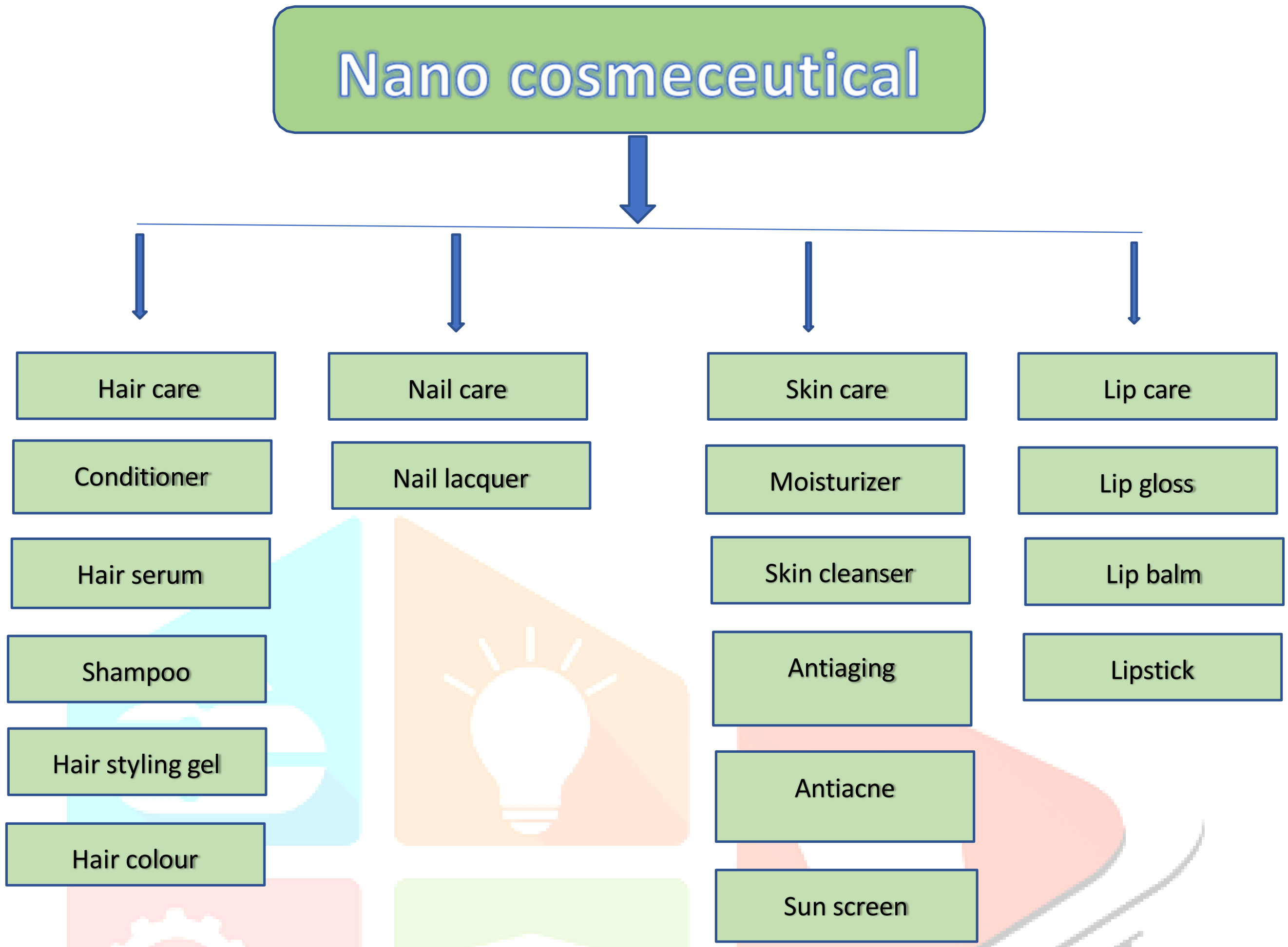
These nano capsules are biodegradable and biocompatible, which means they naturally break down and are appropriate for the use in living things. They are also stable in water. It is viable to encapsulate hydrophilic and hydrophobic substances in these nano capsules. The way that chemicals are encapsulated in biocompatible nano capsules has the ability to greatly impact deodorant production in the future [10].

Nanosphere

Nanospheres are tiny spherical particles with a shell-enclosed core structure. A spherical polymeric matrix, usually with a size range of 10 to 200 nano meters, covers the nanospheres. The drug is enclosed, dissolved, linked, or trapped in a polymer matrix in nanospheres. It helps in preventing chemicals or enzymes from damaging the drug. These include both crystalline and amorphous characteristics. Nanospheres are tiny particles found in skin-moisturizing, wrinkle- reduction, and acne-fighting creams and lotions [11].

There are two types of nanospheres: biodegradable (which dissolves spontaneously over time) and non-biodegradable (which does not). Nanospheres made up of albumin, natural, modified starch, or gelatin are examples of biodegradable materials. inversely, PLA nanospheres are an example of non-biodegradable nanospheres. Further, methods like hydrothermal methods, reduction mechanisms, and catalytically assisted chemical vapor deposition (CCVD) can be used to generate nanospheres. The cosmetics industry is utilizing a growing number of nanospheres, particularly in skincare products like moisturizing, anti-acne, and anti-wrinkle creams [12]. The cosmetics sector has ventured extensively into the field of nanotechnology in an attempt to enhance the effectiveness of its products.

Type of nano cosmeceuticals



1.Inorganic Nanomaterial

Major class of Nanocosmeceuticals

Using nanotechnology to create microscopic particles to enhance the performance and efficacy of active components in a variety of goods, including sunscreens, moisturizers, anti-aging creams, and scents, the cosmetics sector is benefiting from this breakthrough. By increasing these components' bioavailability, this invention improves the goods' ability to deliver the desired advantages more effectively and efficiently [13].

Lip Balm

When occlusive substances like petroleum jelly and waxes keep lips comfortable and stop moisture loss, flavoring, colorants, sunscreems, and a varity of medications provide additional, targeted benefits [14]. Lip gloss and lipstick can be infused with different types of nanoparticles to prevent moisture loss through the skin and soften or soothe the lips. Lipsticks containing silica nanoparticles improve the uniform application of pigments [15]. For red or blue coloration, gold nanoparticles are used; for a yellowish tone, silver nanoparticles are used; and for orange coloration, gold-silver nanocomposites are utilized. They stop the pigments from leaking into the lips' tiny wrinkles or spreading after application [16].

Sunscreems

When exposed to direct sunlight, people frequently use sunscreen to guard their skin from the harmful rays of ultraviolet (UV) radiation [17]. These ingredients originally developed as additives for sun protection products, but they are now often included to regular cosmetics to increase their capacity to shield against UV exposure-related long-term damage and to provide sufficient protection. The good mineral-based elements zinc oxide (ZnO) and titanium dioxide ($TiO2$) prevent the skin from sun damage. In order to create a product that is apparent, less greasy, and has a gentler aroma, it has to penetrate into the skin's deeper layers. This is the case in which nanoparticles come into play. Improved sunscreens are just one of the many creative uses of nanotechnology [18].

Shampoo

Nanotechnology is frequently used in various hair care products such shampoos, conditioners, hair color, serums, sprays, and styling items. Hair is a crucial health indicator, consisting of a shaft and a root enclosed by a follicle with a bulb at its end [19]. The cortex, which determines strength, elasticity, texture, and appearance, is covered by the cuticle. The cuticle is made of keratin and serves as a protective barrier. Nanoparticles are utilized to treat a variety of hair- related issues, promote hair growth, stop hair loss, and enhance overall hair quality. While the hair is not a necessary organ, it can tell many things about an individual's health and greatly influence their appearance [20].

To treat a variety of hair problems, polymeric nanoparticles have been used to deliver specific drugs to hair follicles. Due to its ability to restore hair, pluronic lecithin organogel (PLO) loaded with roxithromycin (ROX) has been used as an effective treatment for hair loss. Shampoos now contain nanomaterials that enhance the amount of time the ingredients are in contact with the scalp and hair follicles. As a result, moisture is sealed inside the cuticles and water loss via the hair follicles is prevented by the protective film that is formed by the active components. As a result, the hydration, gloss, and smoothness of hair are enhanced [21].

Moisturizer

People believe skin moisturizers to be among the most essential skincare basic necessities, and there is a growing need for them to enhance the synthesis of moisturizing products [22]. Many considerations need to be made when using moisturizers, such as age, race, and even the local climate. Sustaining the ideal moisture balance on the skin is essential for regular skin shedding cycles. The mechanical characteristics of the skin, such as its softness, elasticity, plasticity, and flexibility, are greatly influenced by its water content. A synergistic effect of combining glycerol with occlusives is to alleviate skin dryness. The majority of cosmetic emulsion formulations are lotions (oil-in-water emulsions) or creams (water-in-oil emulsions). As a result, the majority of moisturizers that contain nanoparticles as a primary ingredient are often made using nano emulsions [23].

Nail care

Nanotechnology-based nail cosmeceuticals have a number of benefits over conventional ones [24]. A study has shown that nail polishes using nanoparticles can improve the toughness, scratch resistance, and impact resistance of mammalian nails. Put more simply, applying nail paints containing nanoparticles can strengthen, improve mark resistance, and increase the durability of your nails. One significant development in cosmeceuticals is the use of antifungal nanoparticles to nail polish, such as metal oxide and silver nanoparticles. This invention attempts to address and cure toenail fungus infections. Nanotechnology-based nail polishes have more toughness, quicker drying times, more durability, less chipping, and easier application due to their increased flexibility [25].

Nanoparticle used in cosmetics

Different nano-delivery techniques are used to encapsulate essential substances in cosmetic formulations. Nanoparticles work as delivery vehicles by allowing the active components to stick to their surface. In order to maximize the benefits of size- and shape-dependent features and improve the efficacy of cosmetic products, cosmetics can use nanoparticles with a variety of forms and chemical compositions [26]. Metal and metal oxide nanoparticles of different kinds are used in the formulation of these cosmetics. According to a further study, two different grades of zinc oxide nanoparticles are combined in cosmetic compositions. Because of their stability, biocompatibility, and lack of cytotoxicity, gold nanoparticles are extremely advantageous in cosmetic compositions [27]. The cytotoxicity of gold nanoparticles is now the subject of much discussion due to the multitude of factors that might affect it, such as size, shape, concentrations and coatings of the particles, cell lines utilized in toxicity experiments, production process, incubation duration, and surface functionalization. The antifungal and antibacterial characteristics of gold nanoparticles are beneficial in addition to these. Numerous cosmetic items, such as face packs, anti-aging creams, anti-inflammatory creams and lotions, and disinfectants for skin wounds, have used gold nanoparticles. Gold nanoparticles have a number of advantages when added to cosmetic products, including increased blood flow, anti-aging characteristics, antibacterial and anti-inflammatory actions, better skin elasticity and firmness, and skin metabolic stimulation [28]. Punica granatum juice, an important component of cosmetic treatments, can be used to environmentally friendly produce gold nanoparticles. Cosmetic product nanoparticles can play a number of functions, including those of active substances, transporters, and consistency-improving elements, all of which increase the efficacy of the final product. Silver nanoparticles are often used as preservatives in cosmetic formulations because of their broad antibacterial capabilities [29]. Because silver nanoparticle-containing creams have antibacterial properties, they can be used as wound and skin disinfectants [30]. Because they are inexpensive to produce and have hydrophilic surfaces, silica nanoparticles are frequently used in cosmetics. The efficacy, uniformity, and shelf life of cosmetic products are all improved by these nanoparticles. They also help these goods' absorbency to be improved. Silica nanoparticles are very useful in a variety of colored cosmetics, such lipsticks. Silica nanoparticles are also used in other cosmetics for the face, nails, hair, and skin to improve the products' efficacy [31].

Liposomes

Bangham first explored liposomes in a 1963 publication. Mezei and Gulasekharam, however, failed to demonstrate that liposomes are an effective way of delivering drugs via the skin until the early 1980s [32]. Liposomes are tiny, spherical structures with an aqueous core in the center encased in two phospholipid layers. Hydrophilic active chemicals are retained within the core, while hydrophobic active substances can be transferred over this outer layer. Because liposomes have so many useful features, they are frequently seen in cosmeceutical products. They are non- toxic, biocompatible meaning the body can tolerate them well biodegradable meaning they decompose naturally over time. Additionally, they are readily able to encapsulate chemical agents because they are flexible vesicles. The liposomes can act as an obstacle between the substance and its surroundings, protecting it. Both hydrophobic (water-repelling) and hydrophilic (water-attracting) chemicals can be delivered with them effectively. Nanoliposomes are also utilized in cosmetics to enhance skin hydration, elasticity, and smoothness. These tiny particles deliver and distribute nutrients effectively, while also imparting pleasant fragrances to body wash, lipsticks, and antiperspirants. By virtue of their diminutive size, nanoliposomes significantly improve skin hydration, resulting in a more elastic and smoother complexion [33].

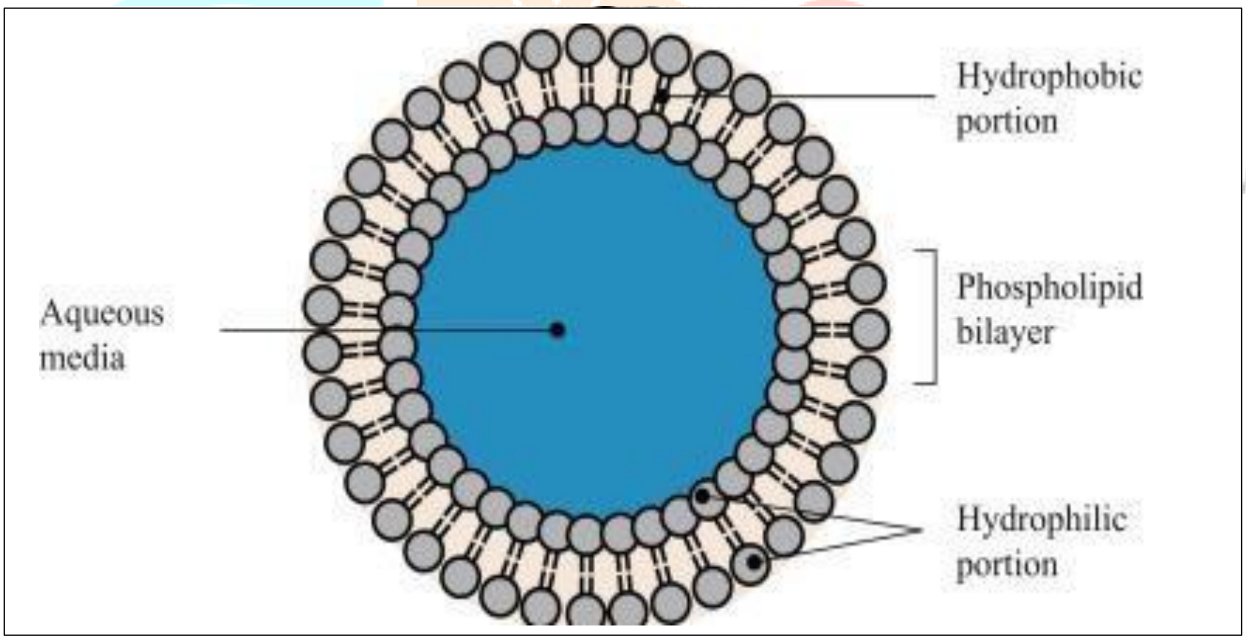


Fig. Liposome

Dendrimers

Dendrimers are tiny structures that have multiple branches; they resemble little molecular trees. They have a central core from which many branches arise, with specific chemical groups situated at the ends of these branches. These outer chemical groups are essential because they control the bonding between the dendrimer and other molecules that it binds to or carries, such as medicines or imaging agents [34]. Due to their remarkable diversity, dendrimers can be used with active pharmaceutical ingredients (APIs) that are both water-loving (hydrophilic) or water- repellent (hydrophobic). These APIs can be attached to the surface of the dendrimer or plac. Their size typically falls within the range of 2 to 20 nanometres. ed in its central core Dendrimers' size and surface charge have a significant impact on how well they can pass through the skin. Dendrimers have made significant progress the field of nanotechnology-based cosmeceuticals [35].

Silver Nano particles

Since silver nanoparticles (AgNPs) have a broad spectrum of antibacterial and antifungal action, they are widely used in numerous consumer products. Silver nanoparticles can be made using a variety of synthetic and natural processes [36]. Plants, fungi, and bacteria are used for producing silver nanoparticles since they not generate any substances that are toxic in the process. Antibiotic-resistant strains of bacteria as well as Gram-positive and Gram-negative bacteria can be effectively fought by silver nanoparticles. They also show effect against a fungus and viruses. Strong antibacterial activity against Klebsiella pneumoniae (K. pneumoniae) and Staphylococcus aureus (S. aureus) is shown by silver nanoparticles smaller than 30 nm. In particular, 5 to 20 nm-sized silver nanoparticles have strong antimicrobial activity against S. aureus [37]. Silver nanoparticles, referred to as AgNPs, are commonly found in a wide range of cosmetic products, such as deodorants, toothpaste, creams, soaps, and lotions [38].

Gold Nano partials

Due to their antibacterial and anti-oxidant properties, gold nanoparticles (AuNPs) have been extensively studied as a desirable material in the cosmetics sector. The typical size range of gold nanoparticles is 5–400 nano meters [39]. These nanoparticles' properties allow them to fight bacteria and fungi. They have been shown to exhibit proteasome inhibitory activity, improve skin elasticity and firmness, and delay the aging process. These gold nanoparticles themselves offer several beauty care benefits, including reducing inflammation, acting as an antiseptic, and combating aging effects [40]. They also help maintain and improve skin elasticity and firmness, accelerate blood circulation, and rejuvenate skin metabolism. Gold nanoparticles are also used to find biomarkers in the detection of infectious diseases, cancers, and heart diseases. They are also widely used in lateral flow immunoassays; the home pregnancy test is a typical instance in household. They are therefore integrated into deodorants, lotions, and creams that fight ageing [41].

Noisome

They go by as non-ionic surfactant vesicles also. They are composed of up of cholesterol and non-ionic surfactants, typically belongs to the alkyl or dialkyl polyglycerol ether class that includes Spans, Tweens, and Brij [42]. They serve for the delivery of materials that dissolve poorly in water as well as those that are soluble in fat or water. This offers a substitute to liposomes, addressing issues such as their poor long-term stability and oxidation risk. Niosomes, on the other hand, have a capability to gather and undergo fusion, leakage, and destruction of the loaded active pharmaceutical ingredient (API). This reduces their shelf life and reduces their capacity to load substances [43].

Nano emulsion

Nano emulsions are extremely tiny droplets, with sizes ranging from a few nanometers to 200 nanometers, that are dispersed in either oil or water [44]. These could be droplets of water dispersed in oil or droplets of oil dispersed in water. The four main parts of a nanoemulsion are an aqueous phase, a surfactant, a cosurfactant, and an oily phase. To make an appropriate nanoemulsion, these components are mixed in exact ratios that are determined using a pseudoternary phase diagram. Active pharmaceutical ingredients (APIs) and nutraceuticals are widely administered to the deeper layers of the skin via nano emulsions [45]. Their structure, which has a lipophilic (loving fat) center, makes it particularly well suited for delivering substances that also dissolve in fats. This makes it feasible for the substances to be effectively administered to the desired layers of skin. As water and oil combine to form nanoemulsions, tiny globules with a narrow size range typically between 10 and 100 nanometres are produced. Nanoemulsions provides enhanced stability and effectiveness due to the effective movement of active products made accessible by their small size of particles. The maximum amount of oil that surfactants can the nano emulsion against physical instability processes such as sedimentation, flocculation, and coalescence, it is essential that this selection be made in order to reduce the tension between the oil and water phases. This ultimately gets longer the product's shelf life [46].

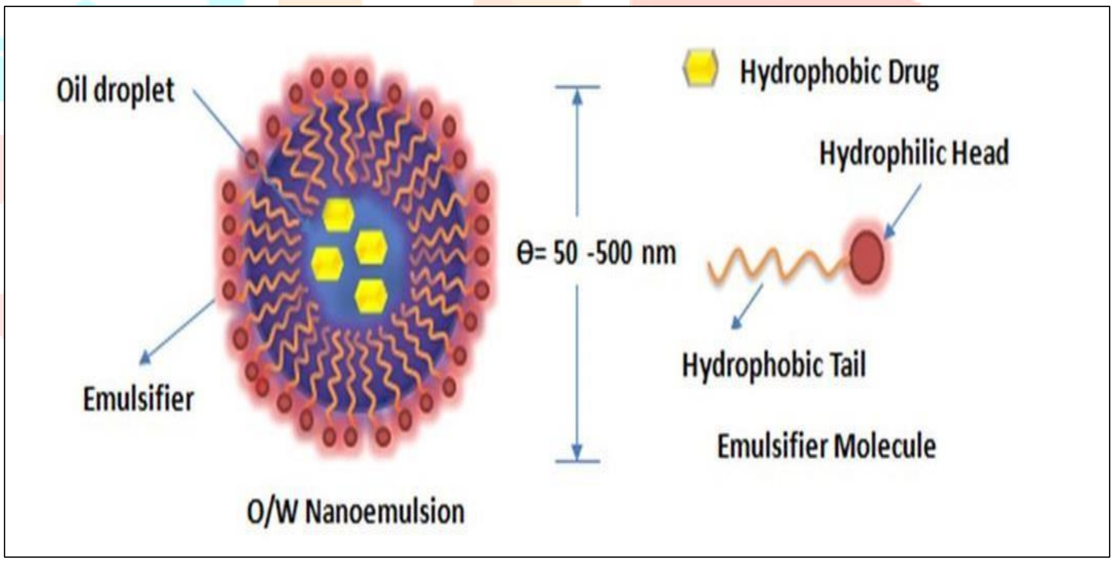


Diagram. O/W Nano emulsion

Fig. O/W Nano emulsion

Prose of nanomaterial in cosmeceuticals

Cosmetic that uses nanotechnology for a number of benefits are known to as "nanocosmeceuticals". Here's a more basic summary of their benefits:

1. Enhanced efficacy: When compared to conventional cosmetics, nanotechnology-based solutions

have a higher level of efficacy since it facilitates the skin's better absorption of active components.

2. Targeted delivery: By using nanoparticles, skin conditions like wrinkles, pigmentation, or acne can be specifically treated by delivering substances to the right parts of the skin.

3. Prolonged shelf life: Due to their greater stability, which keeps their active components working for longer and reduces the chance of deteriorating, nanocosmeceuticals usually have longer-shelflives.

4. Reduced harmful effects: By providing components with more, when compared to usual cosmetics, nanocosmeceuticals provide better overall outcomes, correct targeting, better feel, longer endurance, and a lower chance of side effects [47].

Cones of nanomaterial in cosmeceuticals

High oxygen species synthesis from nanoparticles can cause oxidative stress, inflammation, and damage to proteins, DNA, and cell membranes. There are dangers associated with some nanomaterials, including carbon-based fullerenes, titanium dioxide, and copper. In particular, silver nanoparticles might be harmful to human tissues and cells [48]. "These microscopic compounds possess a tendency to cause various reactions and create a risk to health. This increases their probability of penetrating the skin and affecting body cells. "Nano cosmeceuticals don't need clinical trials for approval, which raises worries about potential toxicity after using them"[49].

Future aspect

"Nanocosmeceuticals are increasing in popularity within everywhere. Nanotechnology-infused skincare have shown significant promise in the treatment of a range of skin disorders." "The cosmetic industry extensively utilizes nanomaterials for various purposes, including UV filters and preservatives.""Nanocosmeceuticals ought to be produced in a manner that enhances the health of consumers." "People are becoming more aware of environmental concerns and the potential risks associated with the side effects of nanoparticle systems." To create uniform rules and regulations for the utilization of nanosystems in cosmetics, researchers and regulatory agencies around the world must work together worldwide. The collaboration will help in making in the existing gaps in relevant data. The toxicity as well as potential impacts of the various nanomaterials used in the industry on the environment and human health should be thoroughly investigated [50].

The extraordinary characteristics of nanoparticles that have led to significant development in the field of nanotechnology, shown by the increasing number of publications in this area. But it's essential to take toxicity studies of nanoparticle into account." To create a more effective regulatory framework for ensuring safety, efficacy, and marketing standards, internationally harmonized standards should be established order. In ultimately, this assists the cosmetics industry grow and safeguards customers from possible hazards [51].

Summary

Controlled manufacturing of nanoparticles that enables a wide range of applications in many areas and for many different purposes, considering nanotechnology a versatile field. Over the last ten decades, nanotechnology has become widely used and shown promises in various fields of cosmetics, dermatology, and use in medicine. Scientists are currently using leading-edge delivery methods and new technology they have created to produce cosmeceuticals. New nanocarriers that are currently being used in cosmeceuticals include liposomes, niosomes, solid lipid nanoparticles (SLNs), nanoemulsion, nanosomes, nanostructured lipid carriers, and gold nanoparticles. Many benefits, such site-specificity, improved stability, prolonged action, biocompatibility, controlled and targeted administration of drugs, and improved drug-loading capacity, can be achieved with these the moment delivery systems. A number of nanoparticle forms have been utilized in cosmetic formulations. The precise manufacturing of nanomaterials and their broad spectrum of applications in various industries and for various goals can be accomplished in the versatile the realm of nanotechnology.

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