Role of Nanoemulsions in Cosmetics

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Abstract Nanoemulsions are colloidal dispersion systems comprised of emulsifying agents and two immiscible liquids and today there is a growing demand for using them in food, pharmaceuticals and cosmetics. Over the last decade, nanotechnology has emerged as the most compelling sector in the cosmetics industry. Among numerous methods, nanoemulsions emerged as a delivery method with enormous potential and tremendous appeal in the cosmetics industry. A great deal of research has been done on nanocosmetics and nano cosmeceuticals for the lips, teeth, nails, hair and skin, and it has been discovered that adding nanoparticles to products increases their effectiveness and customer satisfaction. The skin care business places a high value on nanoemulsions because of their favourable biophysical characteristics (especially their hydrating power) and sensory features (merging textures and rapid penetration). Thus, in present chapter, an attempt has been made to provide in depth information about the use of these nanoemulsions in cosmetic industry.

Keywords Nanoemulsions · Nanocomposite · Pharmaceuticals · Cosmetics · Applications

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1 Introduction

The term nanoemulsion is comprised of the two terms nano and emulsion. The term "emulsion" is a liquid created by the dispersion of either oil in water or water in oil when the presence of a surfactant is present whereas the term "nano" refers to a small size ranging from 1–100 nm. Emulsions are compositions that are both kinetically and thermodynamically stable. An emulsion's composition and structure vary depending on its content, and such emulsions are employed in cosmetic items based on their distinct features. Emulsions can be manly divided into four categories: water in oil, oil in water, oil in water in oil, and water in oil in water. The size of nanoemulsion particles ranges from 10 to 200 nm. The compositions known as nanoemulsions are less viscous, kinetically stable, have a larger surface area at the interface, and have a higher solubilization capacity. They have an appearance that is translucent or transparent. The dispersed phase of nanoemulsions is made up of microscopic particles or extremely small droplets that have very low water or oil interfacial tensions. The core of nanoemulsions is made up of lipophilic parts whereas phospholipids make up the outside layer. Since the lipophilic part makes up the core of nanoemulsions, they are appropriate for the transport of lipophilic substances. Sedimentation, creaming, coalescence, flocculation and are the main issues that are solved with the use of nanoemulsions [3, 10, 21, 41, 56].

Co-solvents that are water soluble and surfactants, oils, lipids, and water are all components of nanoemulsion systems. Free fatty acids, vegetable or mineral oils, tri-, di-, or mono-acylglycerols and other triglycerides may be used in the oil phase of nanoemulsion formulations [22]. Drug Typically, solubility is taken into account when choosing an oil. The development of nanoemulsions typically begins with oil phases with high drug loading [5, 52]. Frequent emulsifiers employed in nanoemulsion processes for food and medicine shipment include polyoxyethylene (POE) derivatives of sorbitan fatty acid ester (spans), lauroyl macrogol glycerides (GelucireR 44/14), carbohydrates (derived from gum and starch), and lipid [34, 59, 60]. Incredibly a little negative surface tension is necessary to regard nanoemulsion production. Co-solvents or co-surfactants are used in conjunction with a surfactant in order to achieve this. Transcutol-P (diethylene glyco monoethyl ether), ethylene glycol, propylene glycol, ethanol, polyethylene glycol, propylene glycol, glycerin, and Often used in the creation of nanoemulsion systems, propanol is a co-surfactant or co-solvent [33, 43, 60, 66].

Because of the fact that nanoemulsions are an extremely effective medium for the regulated release of functional ingredients, there is a substantial market for their application in numerous cosmetic products. Nanoemulsions are used in numerous cosmetic items, including body lotions, face and hair serums, hair conditioners, perfumes, and many more. The substance having nanoemulsions can be absorbed into the skin quickly and easily. It also moisturizes the skin and delivers active substances on target. Employing nanoemulsions has several important advantages, including higher absorption rate, simplicity of formulation into foams, liquids, creams or sprays, lack of toxicity and irritation, and compatibility for both lipophilic and hydrophilic drug delivery [64, 67]. The silicone oil-in-water nanoemulsions can improve the silicone oil's absorption on the surface of the hair. The nanoemulsion system is useful for making shampoos because they are thermodynamically and self-assembled stable systems that are simple to create, transport and maintain [24]. Additionally, because of its tiny particle size, it can disperse quickly into the hair. Furthermore, it may efficiently combine washing and hair care into a single step, saving both time and effort. Thus, this chapter's goal is to give in-depth information on the application of nanoemulsions in cosmetics.

2 Method of Synthesis

The best way to create nanoemulsions, which have extremely small particle sizes, is with high-pressure machinery. High-pressure homogenization and microfluidization, which are applied on both a laboratory and an industrial scale, are the most often utilized techniques for creating nanoemulsions [46]. These processes are also appropriate for ultrasonication and in-situ emulsification [7, 25]

2.1 High Energy Methods

(a) **High Pressure Homogenization**
Higher pressure homogenization is essential to the production of nanoemulsions. With the help of a strong homogenizer or piston homogenizer, this technique produces nanoemulsions with very tiny dimensions of the particles (up to 5 nm). Moving the concoction of aqueous phase and oily phase via a small input aperture at a strong pressure (500–5000 psi) generates high hydraulic shear and turbulence to occur with the product, which results in the production of exceedingly minute emulsion particles. The resultant particles are composed of an aqueous monomolecular coating of phospholipids surrounding a liquid, lipophilic core. The only downsides of this approach, which has a high level of efficiency, are During processing, there is a large energy expenditure and colloid temperature rise [15, 22].

(b) **Micro Fluidization**
In the mixing procedure known as micro-fluidization, the use of a tool known as a micro-fluidizer is made. The object needs to be driven via the interaction chamber, which is comprised of microscopic channels known as "micro-channels," using a rising positively displacement pump in this device (500 to 20,000 psi). Submicron-sized particles are produced as a result of the material flowing via micro-channels and onto an impingement area. The two solutions, the oily and the aqueous phase, are mixed and made into a coarse emulsified using an inline homogenizer. The unstable nanoemulsion is produced by further processing the coarse emulsion in a micro-fluidizer. The interaction chamber's

micro-fluidizer is used to continually push the rough emulsion through until the target particle size is achieved. To remove big droplets and create a homogenous nanoemulsion, the bulk emulsion is run through a filter that is submerged in nitrogen [51].

(c) **Ultrasonication**

Many academic articles that aim to use ultrasonic sound frequency to reduce droplet size report on the creation of nanoemulsions. An amplitude and frequency sonotrode is used in a different technique at system pressures higher than ambient pressure. It is generally known that when external pressure rises, the cavitation threshold in an ultra—sonic field sharp rise, resulting in a reduction in the formation of bubbles. However, raising the pressure also raises the cavitation bubbles' collapse pressure.

As a result, when cavitation takes place, the bubbles collapse more violently and with greater strength than when the pressure is at atmospheric levels. The main process of energy dissipation in a lower frequencies ultrasonic system is cavitation, hence fluctuations in the power density can be directly correlated with variations in the navigational intensity. To maintain an ideal temperature, the system additionally uses a water jacket [47, 58].

2.2 Low Energy Methods

(a) **Phase inversion emulsifying**

To create fine dispersion, this method leverages chemical energy from stage changes brought on by the emulsification pathway. In this approach, phase change occurs during the emulsification process due to the surfactant's spontaneous curvature. Surfactant spontaneous curvature varies according to changes in variables like temperature and composition. The phase transition is caused by altering the composition of the emulsion while keeping the temperature constant, or vice versa. Phase inversion temperature (PIT) and phase inversion composition (PIC) are the two categories of transitional phase inversion [62].

The PIT procedure inverts the surfactant's spontaneous curvature by changing the temperature. Dehydration of polyoxyethylene (POE) groups of polyethoxylated nonionic surfactants (i.e., polyethoxylated surfactants) results in increased lipophilicity and subsequently causes variations to the surfactant's curvature. Phase inversion consequently occurs, leading to the formation of nanoemulsion [18].

PIC involves adding one of the constituents, like water, to a combination and then adding oil-surfactant or oil to the water-surfactant mixture. In order to create nanoemulsions, POE type nonionic surfactants are frequently used in the PIC process [36].

(b) **Automatic emulsification**
There are three primary steps.

(a) Using surfactants that are both hydrophilic and lipophilic and dissolving them in a water-soluble solvent to produce a homogeneous organic solution.
(b) The liquid layer was combined with the organic layer and stirred magnetically to produce an o/w emulsion.
(c) The component that was water-miscible evaporated when the pressure was lowered [50, 59].

(c) **Membrane emulsification**
Membrane emulsification is a method for creating low energy nanoemulsions. With relatively little surfactant used, this method creates an emulsion with a restricted dimension distribution range. In this method, a dispersed phase is transferred over a membrane to create a continuous phase. Due to the poor flux of the dispersed phase via the membrane, this approach has a problem scaling up, which is one of its biggest drawbacks [19].

3 Challenges of Nanoemulsions in Cosmetics

The development of products that are dependable, stable, efficient, and appealing while still offering customers the best value is an ongoing challenge for the cosmetics sector. Early on in the process of developing new products, considerations for safety, the environment, productivity, and quality must be made. Nanoemulsions have considerable adaptability, allowing users to choose their preferred manufacturing method and a variety of chemicals, including active substances, lipids and surfactants [28]. The impact of method or formulation component variations on end products should be investigated logically [69]. The choice of an acceptable process for a given system depends on factors including reproducibility, simplicity of scaling up, and manufacturing time optimisation. It is also essential to comprehend how surfactant-oil-water (SOW) phases behave whether they are processed, stored, or in touch with skin or hair. The type of oil phase utilised to create O/W nanoemulsions affects the solubilization and effectiveness of lipophilic active components [70]. Additionally, the use of nanoemulsions as a carrier system must ensure the skin's protection by preventing the infiltration of harmful exterior chemicals [12]. Knowing the main destabilising mechanisms well is necessary to guarantee long-term stability in both standard and stressful situations without changing a product's ideal sensory qualities or performance [63]. The usage of nanoemulsions is limited for several applications due to incompatibilities with specific cosmetic chemicals, including as polymers, multivalent salts, pigments, and oxidants, which still need to be resolved. It is recognised that variables like ethanol, water activity and pH, have an impact on how long the colloidal systems of nanoemulsions preserve [20]. But it's also important to have a better understanding of how other factors, including particle size, impacts on the preservation of colloidal solutions [17].

4 Nanoemulsions as a Potential Carrier in Cosmeceuticals

Cosmeceuticals are herbal active ingredients in cosmetic formulations that when applied to the skin provide therapeutic advantages. Cosmeceuticals have the greatest benefit of being free of adverse effects, which is why they are so well-liked and preferred in the market and their claim of boosting beauty has been demonstrated over the past several decades. The use of cosmeceuticals has grown significantly over the years in virtually every aspect of personal care, including the treatment of psoriasis, bloating, and hair loss as well as wrinkles and hyperpigmentation [6, 13].

Numerous innovative techniques have been developed for their simplicity in compatibility with cosmeceuticals, including liposomes, nanoemulsions, gold nanoparticles, niosomes and solid lipid nanostructured materials. Nanoemulsions have been widely employed as a carrier for the regulated administration of cosmeceuticals such as sunscreens, shampoos, lotions, nail polishes, hair serums and conditioners. Nanoemulsions provide therapeutically active drugs with rapid skin penetration and active transdermal delivery. The thermal stability and moisturising effects of an *Opuntia ficus-indica* (L.) Mill extract-formulated nanoemulsions-based moisturising compounds were assessed by Ribeiro et al. [57]. Results showed improved stratum corneum water content and stability for up to 60 days. Using the nano emulsification technology, [23] developed gold nanoparticles that were loaded with lipoic acid, Calendula officinalis extract, and Nigella sativa oil and they investigated their potential in vitro cell culture studies for cell-based and cell-free antioxidant properties and wound healing. The produced formulation, compared to the standard *Nigella sativa* emulsion, showed improved wound healing and antioxidant property, based on the results. This research created new opportunities for the development of herbal medications that are more enriched and effective using other bioactive ingredients. In their formulation of peppermint oil-loaded nanoemulsions, [38] used medium-chain triglycerides that had been stabilised with food-grade biopolymers and further converted to starch. The proposed formulation was tested for its antimicrobial activities against *Staphylococcus aureus* and *Listeria monocytogenes* Scott A, two Gram-positive bacterial strains, using the MIC and time-kill dynamic methods. As compared to bulk peppermint oil, the results showed that nanoemulsions formulation effectively suppressed both strains over the long term. Tatiya et al. [65] synthesized a nanoemulsions gel for transdermal administration that contains *G. glabra* extract, and they tested the formulation ex vivo and in vitro (antimicrobial investigation). Results indicated that nanoemulsion formulation significantly increased the amount of *G. glabra* extract that permeated it in comparison to aqueous extract solution, and it also significantly increased the amount of antimicrobial activity. For example, [40] successfully utilized a nanoemulsion as the target delivery technique and successfully encapsulated vitamin E (an oil-soluble vitamin). In fact, water-in-oil nanoemulsions are a more dependable approach in dermatology because a lipid film structure on the skin makes the oil-soluble active ingredients more favourable. Nanosized range and structure nanoemulsions have thus far been connected to mechanisms explaining the improved skin penetration by these substances [9]. Surfactants in the formulation may be able to cross the stratum corneum's diffusional boundary, resulting in great penetration of cosmetic products. The water composition of nanoemulsions performs a crucial functional task. Due to the stratum corneum's hydration effect, percutaneous penetration of cosmetic products is improved when the water content of the formulation is sufficiently higher. Thus, the active ingredient can now be distributed throughout the skin barrier via nanoscale droplets disseminated in the continuous phase of the nanoemulsions that can migrate easily through the stratum corneum [8]. Dirschka et al. [16] studied that the research on the treatment of actinic keratosis with BF-200 ALA gel and MAL cream shows a trend toward increased effectiveness in the following three months and significantly decreased recurrence rates after a year of follow-up. Abd et al. [1] investigated how to increase more caffeine transfollicular using nanoemulsion formulations with oleic acid and eucalyptol as chemical penetration enhancers. In this study, caffeine was used as a hydrophilic model drug that was successfully transported into and through hair follicles. It was also revealed that the optimized pharmaceutical formulations may have selectively targeted follicles and surrounding areas for the specific medications. Kong et al. [35] suggested that HA-GMS (hyaluronan-glycerol-α-monostearate) based nanoemulsion produces an appealing colloidal transdermal carrier suitable for use in skin care and cosmetic preparation. Nevertheless, the use of nanotechnology in cosmeceuticals is not a very novel recent application. In the 1980s, it was initially introduced to the cosmeceutical market in the preparation of liposomes. Numerous other nanoproducts that contain stem cells, peptides, proteomics and epigenetic factors have since been developed and are still being offered to customers [42]. Every year, major cosmetic companies publish a number of patents relating to nanotechnology. This is why, these investment and patents are crucial at this time for this reason (Table 1; Fig. 1).

Retinol is nano emulsified in porous polymer particles with a size range of 50–200 nm to create the retinol polymer nanocapsule. The stabilization of retinol is then accomplished using lecithin and mung bean medium-chain triglyceride extract [30]. A Japanese firm, Ands Corporation, is continuing to use a patent that describes the creation of a 100 nm-sized nanoemulsion made up of phospholipid and lysophospholipid nanoparticles distributed in water. A method for creating a dry collagen face lotion that combines gelatin protein or collagen with the formation of nanoparticle powder with particle sizes between 10 and 40 nm was patented by Iwamoto Shigemi and the cosmetic items and nanoemulsions were compounded [45]. A nanoemulsion containing a skin-care formula and ginseng saponin metabolites for anti-aging that also contains the same was converted into liposomes using a dermotropic emulsifier for improved skin penetration to promote the synthesis of collagen fibroblast proliferation [68]. Based on the rising number of patents, nanotechnology in cosmetics has been increasingly successful. As consumers become more aware of the advantages of nano-based cosmetic products compared to conventional cosmeceutical treatments, it is clear that they prefer nano-based cosmetics (Fig. 2).

Nanoemulsions are a perfect delivery system for use in cosmetics because of their simplicity in formulation, controllable particle size, enhanced stability, and relatively low surfactant levels. nanoemulsions give formulators a bigger platform to create a variety of modified formulations with different effective properties and

Table 1 Summary of various nanoemulsions -based cosmetic formulations

Cosmeceutical products	Nanoemulsion based formulation	Method of preparation	Action	Key references
Squalene and coconut oil mediated nanoemulsions	Nanocream	Shock method via a phase inversion temperature	The developed NE formulation helped to shrink the droplet size from 3000 to 400 nm, resulting in increased solubility and penetrating power	[11]
Rapeseed oil-mediated nanoemulsions	Topical creams	Sonicator (20 kHz, 500 W, 13 mm)	Amplify the skin membrane's ability to absorb topical lipophilic active substances	[31]
Centella asiatica extract mediated nanoemulsions	Lotion	High-pressure homogenization	Possesses stable physical characteristics while being stored and has greater penetration than non-nanoemulsion lotion	[26]
Curcumin mediated nanoemulsions	Nanoemulsion as a carrier	An aqueous microtitration method with high-energy ultrasonication	Improve transdermal medication delivery permeability for inflammation and wound healing	[4]
Norcanthridin mediated nanoemulsions	Nanoemulsion as a carrier	Aqueous phase titration method	Improve the insecticidal efficacy	[71]
Fluvastatin mediated nanoemulsions	Hydrogel	Aqueous phase titration method	Effective through-skin-layer penetration	[32]
Hydrocortisone mediated nanoemulsions	Gel	Emulsification Method	Effective treatment for topical atopic dermatitis	[61]
Glycyrrhiza glabra Extract mediated nanoemulsions	Gel		Significant antibacterial activity and faster penetration rate	[65]
Lemon myrtle and anise myrtle-mediated nanoemulsions	Nanoemulsion as a carrier	Ultrasonication	NE showed good stability and improved antimicrobial properties	[48]

(continued)

Table 1 (continued)

Cosmeceutical products	Nanoemulsion based formulation	Method of preparation	Action	Key references
Nanoemulsions incorporating citral essential oil	Nanoemulsion as a carrier	Ultrasonication	NE can be used in antimicrobial activity in the agrochemicals, cosmetics and pharmaceutical industries	[39]
Vellozia squamata mediated nanoemulsions	Cream	Phase inversion method	Showed god anti-oxidant activity	[53]
Opuntia ficus indica mediated nanoemulsions	Nanoemulsion as a carrier	Emulsification	The developed NE increased water content of stratum corneum showing its moisturizing efficacy and thus used as a commercial moisturizer	[57]

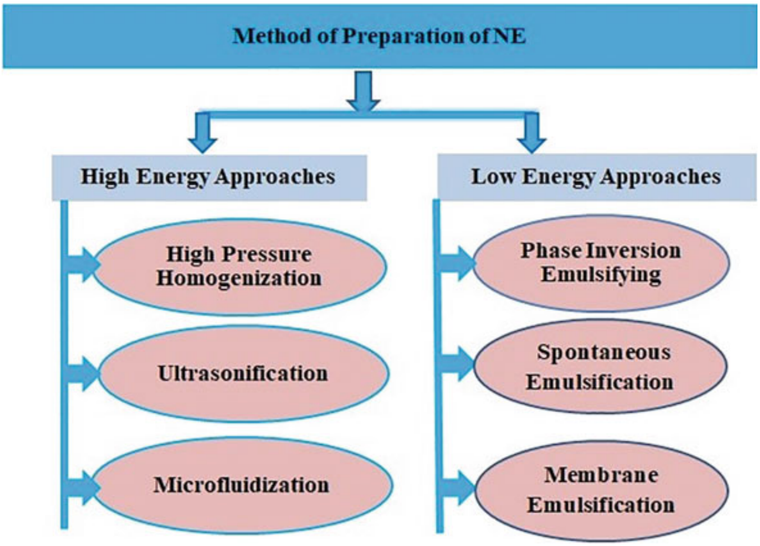

Fig. 1 Method of formation of nanoemulsions

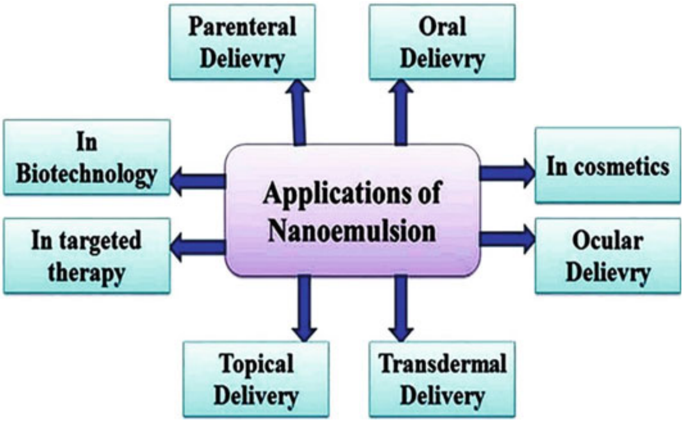

Fig. 2 Application of nanoemulsions (Adopted from [25])

sensory benefits, such as gels, foams, spray, fluids, and creams [14]. A list of several NE-based cosmetic formulations is shown in Table 1. The effectiveness of cosmetic goods is determined by their ability to incorporate functional and active ingredients as well as their grace of appearance. Keeping this in mind, formulators face a significant problem when incorporating amphiphilic, lipophilic and hydrophilic components but nanoemulsions could make it simple to incorporate all three of these. Nanoemulsions have water, oil and interfacial structure that makes it simple to transport numerous media types as well as active ingredients. Droplet size at the nanoscale results in a higher surface-to-volume ratio, which increases active ingredient penetration and permeability into the skin as well as dispersion phase admission on hair [29]. Since a thin lipid film forms easily with nanoemulsions, formulations specifically made for topical treatment can be applied with ease, enabling improved performance and higher bioavailability. There have been several preliminary studies about the potential of nanoemulsions in cosmetics. For example, the Huand team created cationic nanoemulsions for hair, and the results showed a considerable improvement in the appearance of dry hair over time. Nanoemulsions also showed their promise in terms of sterility, because of their nanoscale droplet size at the nanoscale, nanoemulsions can easily be processed via micrometre filters, which are a common and effective method of sterilizing for all businesses [27] (Fig. 3).

4.1 Dermal Application

Recently, nanoemulsions have captured interest as potential solutions for the dispersion of active ingredients in specific skin layers and the controlled release of foundation. It is currently well-established that nanoemulsion can improve the effectiveness of drugs when applied topically and transdermally [54]. Nanoemulsions,

Fig. 3 Applications of nanoemulsions in cosmetics

which are emulsions with narrow distributions and a size range between 20 and 200 nm, has many advantages for the topical and transdermal delivery of cosmeceutical molecules. Controlled droplet size, the capacity to liquefy lipophilic pharmaceuticals successfully, enhanced skin permeation, and prolonged discharge of both lipophilic and hydrophilic drugs are some of these benefits. Additionally, they have outstanding sensory as well as physical qualities including even dispersion on skin and skin nourishment in medications for cosmetics and beauty [2]. When nanoemulsions are applied topically, small particles and solubilized hydrophobic constituents provide a method to greatly speed up the rate of therapeutic dissolution and, as a result, systemic bioavailability via the transcellular pathway. In order to prevent occlusive effects drug discharges from nanoemulsions include partitioning them from oil into a surfactant deposit and subsequently into the aqueous phase [29]. This approach is an intoxicating replacement for improving medicine delivery by restoring and concentrating on the explicit of poorly soluble medicines, increasing skin absorption, lengthening the period the drug remains in the target area, and ultimately leading to less side effects. Because of its tiny droplet size and absence of flocculation and creaming, nanoemulsion is a popular delivery method in the cosmetics industry. This makes it easier for antigen-presenting cells to absorb ongoing cosmetic formulations like creams, lotions, and moisturisers.

4.2 Nanoemulsions as a Novel Vehicle in Skin Care

Due to its ability to solubilize nonpolar dynamic chemicals, nanoemulsions are anticipated to be widely used in medical sciences as drug delivery systems. Nanoemulsions have an innovative application in transdermal medication delivery, where they function as an effective delivery method for bioactive substances that also facilitate administration. The predictable transdermal drug delivery methods for creams, ointments, and lotions, which are widely used to treat local skin infections, are currently changing quickly in the direction of a higher level of development. It is also taken into account as a possible system because of its numerous benefits, which include the absence of organic solvents, thermodynamic stability, improved storage stability, minimal production costs, and high industrial viability. They incorporate the repeatable bioavailability of medications as well as plasma concentration patterns. These methods are currently being employed to provide deeper skin permeation as well as dermal and surface properties. Numerous studies have shown that reducing transepidermal water loss supports the skin's obstructive function [44]. The most significant benefit of utilizing nanoscience in the cosmeceuticals industry is the increased stability of many cosmetic ingredients, such as antioxidants, vitamins or unsaturated fatty acids that are encapsulated within nanoparticles, the increased rate of permeation of all convinced ingredients, such as vitamins and other antioxidants, and the improved aesthetics of the preparations, in addition to improved coordination and approval of UV filters on the stratum corneum [55]. Dispersed nanosized droplets in the continuous phase of the nanoemulsions can successfully penetrate the stratum corneum and spread the active component across the epidermal barrier. O/W nanoemulsions with lipophilic nano-TiO_2 and octyl methoxycinnamate, which contain both physical as well as chemical UV filters, were treated by ultrasonic using conventional ethoxylated alkyl ethers. The effects of structuring the oil phase of nanoemulsions incorporating chemical UV filters were researched by other scientists. Several UV filters were formulated with nanostructured lipid carriers (NLC) and nanoemulsions in the oil phase.

4.3 Nanoemulsions in Hair System Care

Nanoscience has evolved into a very simple tool for creating a solution to this pathology, enabling targeted drug administration with increased local bioavailability, which may reduce the negative effects of the pharmaceuticals. Considering the significance of hair on the value of existence, it is no wonder that people are challenged to change their hair for a number of innovative purposes. Due to their unique and inherent properties, nanoparticles are increasingly being utilized in the creation of superior skin-care medications that particularly target the hair shaft and follicle. The uptake and permeation of topically applied nanostructured materials are considerably facilitated by the hair follicles. According to some evidence, follicular allocation varies depending on the body region, with the forehead supporting a significantly higher density of follicular orifices [49]. They claimed that whereas follicular apertures might give nanoparticle components access to the hair follicle, there may be considerable variations in the percutaneous absorption of appendage-free and abundant parts. Results can reveal a mechanical influence as opposed to a particle size-specific effect when they are compared to earlier findings. Hair growth procedures could be used to push nanoparticles deeper inside hair follicles [37]. Therefore, a variety of aesthetic techniques can be used to specifically target the arrangement surrounding the follicle by varying the particle size. The use of nanomaterials to enhance hair cosmesis (health of hair, smoothness and preserving shine) has been the subject of extensive prior research. Nanostructured materials have been added to shampoos to optimize resident contact time with the hair follicle and scalp, enabling active molecules to coat the cuticles with a protective layer and retain moisture (i.e., averting trans follicular water loss). However, while being fabricated into nanostructure particles, silicone oil may diffuse swiftly into hair fibres despite being manufactured into nanoparticles due to its tiny size. It was noticed that when the size of the nanoemulsion decreases, more nanodroplets were absorbed into the hairs. This is explained by the fact that the interactions between nanoemulsions droplets increase as their droplets size decreases, which raises nanoemulsions viscosity and enhances silicone oil deposition. This improved lubrication, shiny finish, and hair moisture without harming the hair fiber's cuticles, permits absorption into the hydro-lipid emulsion layer [63]. This demonstrates that even when using shampoo frequently, cationic nanoemulsions with droplet size of less than 1–100 nm considerably improve dry hair.

5 Conclusion

In conclusion, it can be concluded that the era of nanoparticles has already begun and that the research around them will continue to advance and be applied to the creation of new testing procedures for a lovely, healthier, and safer future. Over the last decade, nanotechnology has emerged as the most compelling sector in the cosmetics industry.

As new technology and delivery methods continue to advance at a steady rate, researchers are better able to create newer, more adaptable cosmetic goods. Among numerous methods, nanoemulsions emerged as a delivery method with enormous potential and tremendous appeal in the cosmetics industry. This chapter discussed possible nanoemulsion system capabilities in cosmetics and personal care items used for diverse applications with supporting data. nanoemulsions smaller droplet size satisfies all basic criteria including delivery qualities, rheological stability and optical stability, which are necessary for an effective delivery method and which are not satisfied by conventional microemulsions. Because of their greater penetration abilities, nanoemulsions are an ideal option for hair care and skin products, whether they use cosmeceuticals or synthetic cosmetics.

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