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Research Article

Review Paper On: Nanostructured Lipid Carriers [NLCs] In Cosmeceutcals

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ABSTRACT

Nanostructured lipid carriers [NLCs] are novel drug delivery system that have gained huge significance in cosmeceuticals industry due to their qualities such as high drug loading capacity, improved stability and increased skin penetration. NLCs has been found to be comparatively more efficient and effective than first generation nanoparticles i.e. SLNs overcoming its drawbacks .These NLCs are solid lipid matrix mixed with a liquid lipid, resulting in a distinct structure allowing better drug entrapment and release characteristics . They have been employed as carriers in cosmeceuticals to improve transport and its performance on the targeted site. NLCs are advanced approach in Targeted Drug Delivery System, having characteristics like better penetration into skin, improved absorption and rapid onset of action including elimination of first pass metabolism. This review article will provide an overview of types of NLCs, its method of preparation, cosmeceuticals benefits on NLC, its current use in cosmetics, interaction with skin and factors affecting permeation of NLC through skin etc. Furthermore, its mechanism of action is also discussed.

INTRODUCTION

Recently, the term "Cosmeceuticals "was coined to describe a product category that fills the gap between cosmetic and pharmaceutical products. Today, the term is applied to the professional skincare world, defining cosmetic products that have an impact on the biology of the skin. So, officially the term is defined as cosmetic products consisting of active ingredients and provided with the medical benefits. Various technologies were designed in order to create novel, safe, effective, and elegant cosmeceuticals, among which the cosmetic nanotechnology has been emerging significantly. These innovative nanotechnology products include nanoemulsion, liposomes, niosomes, and lipid nanoparticles. [1] Lipid nanoparticles include Solid Lipid Nanoparticles [SLN] and Nanostructured Lipid Carriers [NLCs].

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Solid lipid nanoparticles are first generation of lipid nanoparticles that are stable colloidal carriers made of lipids solid at both room and body temperatures . They are formed of a solid lipid core stabilized by a surfactant and containing the drug dissolved or dispersed. [2] Nanostructured lipid carriers (NLCs) are novel pharmaceutical formulations which are composed of physiological and biocompatible lipids, surfactants and co-surfactants. Nanostructured lipid carriers (NLCs) spring up as second generation of lipid nanoparticle to overcome the shortcomings of first generation i.e. SLNs. [3] SLN contains perfect polymer lattice limiting the drug loading capacity while NLCs has an imperfect matrix structure providing sufficient space for drug loading hence one can say that "the perfectness" of the NLC system is its "imperfectness" in its crystalline structure. [4].

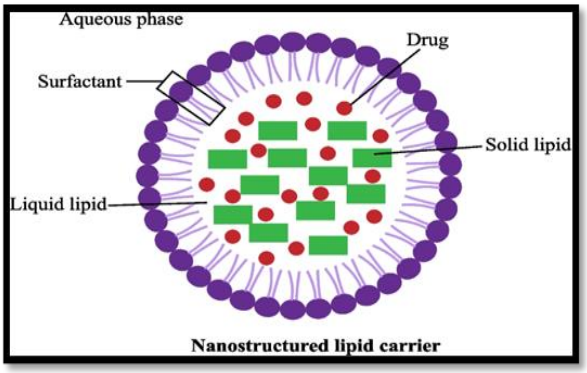

Figure 1: Basic Structure of Nanostructured Lipid Carriers

1.1 Type of NLCs

There are three types of NLCs:

- **Imperfect type NLC** (imperfectly structured solid matrix) lipid content is low which results in deformation in solid lipid crystalline structure. Different fatty acid triglycerides can be used to modify the imperfection and structure of nanoparticles.
- **Amorphous type NLC** (structure less solid matrix) formed by blending solid and liquid lipid in a certain way to avoid crystallization of the core.
- **Multiple types NLC** (multiple type oil in fat in water O/F/W). They contain a high quantity of oil which results in a nano oil-based compartment within the particle resulting in a tiny packet of drug solubilized in liquid lipid. [5] This article reviews the methods of preparation of NLCs, its interaction with skin, mechanism of action, its cosmetic benefits not only these consideration but the recent advances of NLC along with its advantages in cosmeceuticals application.

1.2Methods For Preparation Of NLCs:

There are various methods reported for preparation of NLCs. Following shows the methods of preparation of NLCs.

1.2.1 High pressure homogenization:

Most extensively used method .In this method, lipids are pushed through narrow pore under high pressure. The high shear stress on the lipid disrupts the lipid to sub micron range with lipid ranging from 5-10%. This method performed either by hot (at elevated temperature) or cold (below room temperature) high pressure homogenization.[6]

1.2.2 Ultra sonication:

This process works on the principle of cavitation but is one of the least studied techniques. Firstly, lipids are melted and drug is added, this then added to surfactant solution followed by emulsification using high speed stirrer. Obtained pre- emulsion is ultra-sonicated with probe ultra sonication. Then cooled to get the lipid particles. This method saves

both time and energy but suffer several shortcomings like contamination by metal, low solubility, clumping on storage etc.[6]

1.2.3 Micro emulsion:

In this method, liquid lipids are added to molten solid lipid. The resultant is mixed with an aqueous phase to form microemulsion. This microemulsion is cooled rapidly with cool water forming NLC dispersion system. This is a simple technique of preparation of NLC but requires a high amount of surfactant and co surfactants.[6]

1.2.4 Solvent injection method [ethanol injection method]:

This method follows the principle of phase reaction. Ethanol injection method not only avoids the use of toxic solvents but also obtains lipid structure with smaller size, better dispersion, good storage properties and easy handling along with reproducibility.[7]

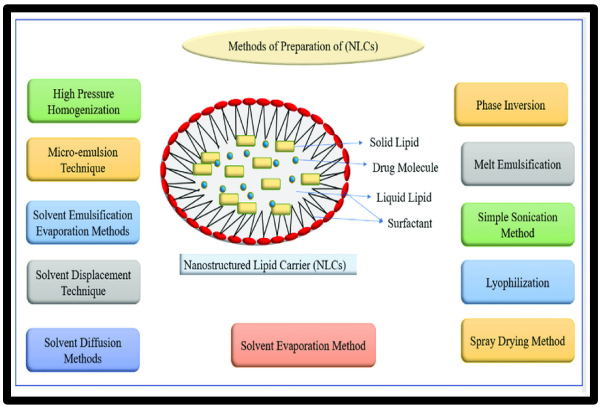

Figure 2: Methods of NLC Preparation

1.3 Mechanism of Action of NLCs:

Because of the similarity in nature of the core of the produced nanoparticles with epidermal lipids, NLC have improved the penetration of drugs after topical application. The improved penetration is caused by the occlusive effect of NLC as it forms a film on the skin. This occlusive effect reduces the water loss through trans epidermal route, improves the hydration of the skin, and increases the drug penetration. This is due to the fact that these particles are small in size and have good adhesive properties. Besides that, the NLC ingredients, which includes lipids and surfactants, can play a role as permeation enhancer through interaction with disordering of Stratum Corneum lipids, which in turn permits the molecules to penetrate down to the deeper layer of the epidermis.[8] Down the epidermis drug through passive diffusion reaches the dermis layer and through the capillaries present in this layer the drug reaches the systemic circulation with optimize and targeted drug delivery and provides the minimum toxic effect and enhanced therapeutic action.

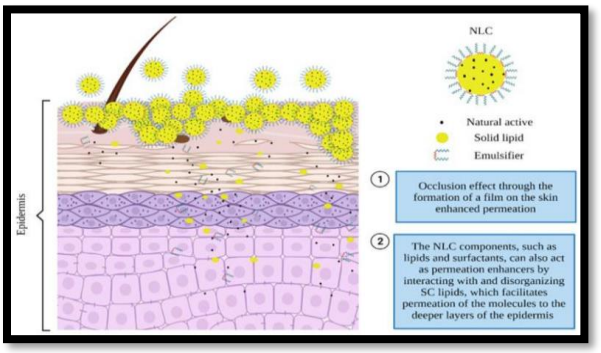

Figure 3: Mechanism of Action of Nanostructured Lipid Carriers

1.4 Factors Affecting Skin Permeation Of NLCs:

1.4.1 Skin physiological condition and administration site:

Age, skin type and sex hormones influence the permeability of skin due to slightly different chemical composition in the stratum corneum structure. Percutaneous absorption of drugs is governed by the integrity and regional variations of the skin, the dimensions and density of the aqueous and hydrophobic pores and the path of lipid fluids.[9] Also the thickness variation of the stratum corneum in the regions of the body, such as the face and the palms of hands and feet. This can be overcome by hydration of stratum corneum for barrier reduction.

1.4.2 Physicochemical characteristics of penetrating molecules:

70% research on the absorption of the drugs through skin reveals that the solubility of the drug in the carrier system plays a fundamental role in the amount of drug permeating the skin. Since permeation is thermodynamically driven event, saturated formulations ensure maximum transcutaneous penetration. Moreover diffusion coefficient is one of the important parameter for permeation. [9]

1.4.3. Physicochemical properties of the formulation:

This includes the parameters such as the affinity of the vehicle for drug molecules (it can influence the release of the drug from the carrier), composition of drug delivery system (composition of drug delivery system may affect not only the rate of drug release but also the permeability of the Stratum corneum by means of hydration),and enhancement of transdermal permeation(use of permeation enhancer can cause physicochemical or physiological changes in stratum corneum and increase the penetration of drugs through the skin).

1.4.4 Physicochemical properties of nanoparticles:

Several parameters governs the entry of nanoparticles through skin, namely i) size of the particles ii) penetration pathway and iii) diffusion coefficient between the formulation and skin. Altogether dimensions shape, and surface properties along with charges and polarity are responsible for the formulation of the NLCs.[9]

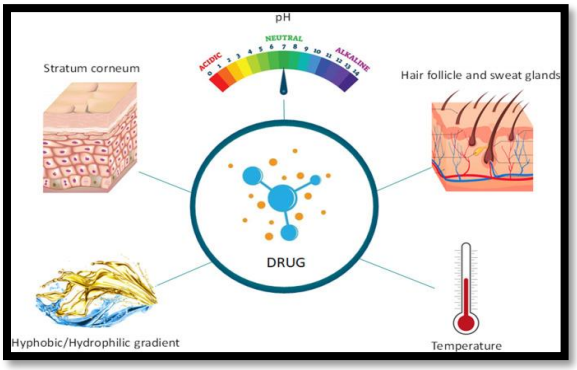

Figure 4: Factors affecting permeation

1.5 Cosmeceutical Benefits Of NLCs:

- Enhancement of chemical stability of actives.
- Film formation on skin and control occlusion.
- In vivo skin hydration.
- Enhance skin bioavailability of actives and skin targeting.[10]

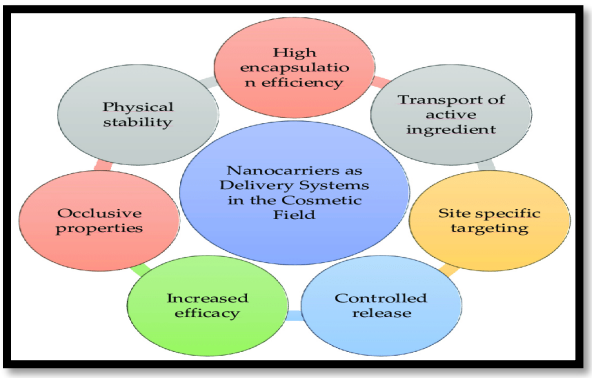

Figure 5: Benefits of NLC in cosmeceuticals

1.6 Uses Of Nlcs In Cosmeceuticals:

Nanotechnology, characterized by the manipulation and control of materials at dimensions typically between 1 and 100 nm is one of the promising frontiers in technological advancements. Unique properties of nanaoparticles have been harnessed in various industries mainly in cosmeceuticals. [11]

The advancements of research and development in the herbal cosmeceuticals is demonstrated by nanotechnology, which boost product efficiency and efficacy by delivering innovative solutions. The applications of nanotechnology are growing in the field of cosmeceuticals to address numerous shortcomings of convectional herbal product. [12]

Figure 6: NLCs based skin care products

2. Marketed Preparations Of Nlc Based Cosmeceuticals:

Examples of cosmetic products currently on the market containing lipid nanoparticles.

Table no.1 Marketed Preparations of NLC based Cosmeceuticals.

Sr. no	Product name	Active ingredients	Manufacturer
1.	Nano lipid Repair CLR	Black currant seed oil and Manuka **oil**	Chemisches laboratorium Dr.Kurt Ritcher, CLR- Berlin, Germany
2.	Intensive serum Nano Repair Q10	Coenzyme Q10, polypeptide, mafane extract	Dr. Rimpler, GmbII, Wedemark, Germany
3.	Extra moist softener	Coenzyme Q10, 3 and 6 unsaturated fatty acid	Amorepacific Corp.Seoul, South Korea

4.	NLC deep effect repair cream	Q10, TiO_2, highly active oligosaccharides	Beate Johnen, GmbII, Aschheim, Germany

Figure 7: Marketed preparation of NLC based cosmeceuticals

CONCLUSION:

In conclusion, Nano lipid carriers have shown great potential in the field of cosmetics due to their ability to improve the stability, bioavailability, and efficacy of active ingredients. These carriers are able to efficiently penetrate the skin barrier and deliver the active ingredients to the target site, resulting in enhanced performance of cosmetic products. The use of Nano lipid carriers can help to address various skin concerns such as aging, hyper pigmentation, and dehydration, making them a valuable tool for formulators and cosmetic companies.

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