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Lipid Nanoparticles in Cosmetic Formulations

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Lipid nanoparticles hold a key function to improve the effectiveness of cosmetics. The main problem with cosmetics is the common range of biological variation of normal skin types (Souto & Muller, 2008). With the goal of increasing the physiochemical stability of the skin system and of incorporating active ingredients (actives) in cosmetic products, solid lipid nanoparticles as well as nanostructured lipid carriers have been developed (Inoue, 2006). Because of their physical stability and compatibility with other ingredients, lipid nanoparticles can be added to existing formulations without major complications. They have been developed to have an affinity with the overall skin structure, removing imbalances or other disturbances that could occur when products are applied (Souto & Mueller, 2008). Due to their increased safety, lipid nanoparticles have a promising part in dermatological applications. This paper examines the key aspects of the incorporation of nanotechnology into a major cultural and commercial enterprise, the cosmetic industry.

Background

Nanotechnology has been used in cosmetics since 1961 (Katz, 2007). Liposome technology began with a 15-3500 nm level for moisture creams as a first attempt to capitalize on the properties of nanoparticles (Katz, 2007). These formulations improved solubility and altered physical properties by providing for hydrophilic vesicles, with little or no carrier biotoxicity (Souto & Mueller, 2008). Currently, nanodispersions of this type used in cosmetics are found mainly in the form of lipophilic vesicles ranging in size from 1 – 100 nm (Katz, 2007). Nanotechnology use has increased especially in sun care and the anti-aging segment, where it claims to enhance both cosmetic quality and efficiency. An increasing number of companies such as L'Oreal, Estée Lauder and Clarins are manufacturing products containing nano particles (Charbonneau, 2001). Other personal care industries and some independent research institutes are using nanotechnology to create new preparations for wider skin care applications (Morgan, et al.). Presently, the active ingredients in cosmetics range from prolactin and subtilsin, which are highly compatible with the epidermis, to toxic actives such as escin, prarabins, lead, and even oxybenzone (Arditti, 2004). Nanotechnology is helping to develop safer products and to avoid the use of toxins.

Penetration functionality of lipid nanoparticles

The main point in lipid nanoparticles as a part of cosmetics is the release of active ingredients during their penetration into skin layers (Berger, 2007), as shown in Figure 1. Control of the rate of penetration is enhanced by the dispersion function of nanolipids created by super-

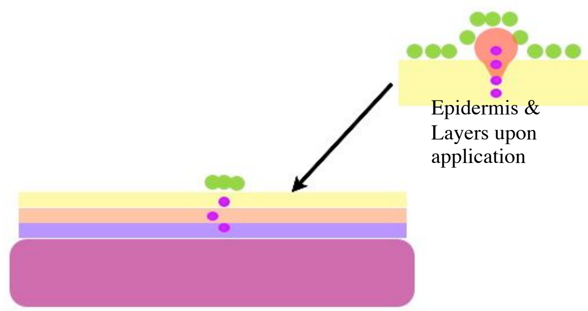

Figure 1. Nano liposome fuses its lipid bilayer matrix with that of the skin, releasing actives. Where actives are released depends on the level of penetration of the programmed lipid nanoparticles. Liposome dissolves after fusion.

saturated systems (Souto & Mueller, 2008). The decrease in size and resulting increase in saturation solubility leads to an increase of diffusion pressure by active ingredients when moving into the skin (Offord et al., 2002). During shelf life, actives remain entrapped in the lipid matrix because particles are polymorphic and preserve the original lipid form of the ingredients (Inoue, 2006). As the saturated product is applied to the skin, there is an increase in thermo-activity causing the lipid matrix to transform from an unstable polymorph into a ordered polymorph (Souto & Mueller, 2008). This process stimulates the release of actives into the system, creating the supersaturated effect (Inoue, 2006).

Nanolipids allow active ingredients that would not normally penetrate the skin to be delivered to it (Souto & Mueller, 2008). For example, vitamin C is an antioxidant that helps fight age-related skin damage, works best below the top layer of skin. In bulk form, vitamin C is not very stable and has low skin penetration (Offord et al., 2002). Nanoparticles can help control active ingredients intended to have a predominantly local effect and prevent absorption into the blood by transdermal delivery (Offord et al., 2002). In contrast, the majority of topically applied cosmetic actives has only superficial effects and is not intended for deep skin penetration or absorption (Souto & Mueller, 2008). Nanoparticles can help control penetration of ingredients intended to have a predominantly local effect, as well as preventing absorption into the blood by transdermal delivery (Berger, 2007). Modulation of release as well as support of active penetration into certain layers of the skin can be thus achieved using these supersaturated systems (Souto & Mueller, 2008).

Hydration properties of lipid nanoparticles in cosmetic formulations

Lipid nanoparticles form a monolayer film when applied with a cosmetic formulation proportional with their small size (Katz, 2007). As they are hydrophobic compounds, the monolayered thick film has an occlusive effect on the skin capable of retarding the loss of moisture, which is caused by evaporation (Souto & Mueller, 2008). Although experimentation studies cannot fully mimic the natural conditions of moisture loss in the epidermis, it is found that the lower the size of the particles, the greater the barrier for evaporation prevention (Iobst, 2006). The film layer is formed upon application of lipid particles onto the skin thus preventing immediate surface evaporation (Souto & Mueller, 2008).

A nanoparticle layer has very small space for air channels, especially compared to a layer of the usual micro-particles, which have been typically used in cosmetics. Thus, the hydrodynamic evaporation of water will decrease in the skin with the use of lipid nanoparticles, keeping it firm and hydrated (Iobst, 2006). The effectiveness of the layer increases as particle size decreases. Particle size can produce different effects for a variety of skin types, including the highly desirable hydration of excessively dry skin (Souto & Mueller, 2008). Due to this hydration effect, increase in skin elasticity can occur.

Lipid nanoparticles can also be produced with an optimum pH for topical applications within their lipid matrix. The pH can be optimized to develop a buffer type formulation and avoid strong acidic or alkaline ingredients commonly used in cosmetics (Souto & Mueller, 2008).

Modifying toxicity

Lipid nanoparticles have a wide range of properties (Berger, 2007) and can be safely used in dermatological and cosmetic preparations to enable distinct features (Senzel, 1977). Because of their compatible biochemical nature, they effectively respect the skin physiology (Souto & Mueller, 2008). The results obtained with dermal application are encouraging and this could be a main application of nanolipids (Souto & Mueller, 2008). Consequently, nanoparticles can replace parabins in cosmetics that with frequent use have been linked to cause skin irritation, rosacea and breast cancer (Arditti, 2004).

Nanoparticles hold promise for formulating sunscreen products with lower and medium sun protection factors (Katz, 2007). Titanium dioxide and zinc oxide nanoparticles are widely used in sunscreens for their UV absorbency ability (transforming UV light into heat) but there are concerns that these compounds might be toxic (Brunner et al., 2006). Current research indicates that titanium dioxide nanoparticles create radicals in the photocatalytic reaction which might be carcinogenic and zinc oxide particles where found to slow down human cell growth in vitro (Brunner et al., 2006).

Conclusion

Lipid nanoparticles are very complex systems with clear advantages and some disadvantages. Using lipid nanoparticles in cosmetics enhances hydration due to the size of the particles, making the skin soft and supple. A flexible film of lipid particles is formed at the surface of the skin instead of a hard film created by solid, toxic parabins. Lipid nanoparticles are safer, but attention is needed towards the side effects of their removal from the skin. Further work needs to be done to understand the structure and dynamics of these particles.

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