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Review article

CUBOSOME: A NOVEL APPROACH FOR NANOTECHNOLOGY

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ABSTRACT: Cubosome dispersions are thermodinamically stable, bioadhesive and biocompatible.Because of their properties, cubosome are versatile systems, administrable by different ways such as orally, percutaneously and parenterally. The discovery of cubosomes is a unique story and spans the fields of food science, differential geometry, biological membranes, and digestive processes. Despite the early realization of their potential, the manufacture of cubosomes on a large scale embodied difficulty because of their complex phase behaviour and viscous properties. Contributions to cubosome research have come from the fields of biology, material science, medicine, and mathematics and much is known about their formation and properties. At the center of much of the discovery and innovation is the technique of cryo-transmission electron microscopy. Another cubosome advantage is related to the simple production procedure and the chemico-physical stability. With respect to liposome, cubosome possesses a larger ratio between the bilayer area and the particle volume and a larger breaking resistance. Cubosome structure by means of electron microscopy, "light scattering", x-ray and "NMR", nevertheless few researchers have been studying the potential of cubosome as "delivery systems".

Keywords: Cubosomes, Cubic Phase, Nanoparticles, Cubic phase

INTRODUCTION

Bicontinuous cubic liquid crystalline materials are an active ingredients because their give the unique structure ends itself well to controlled release applications. Amphiphilic molecules form bicontinuous water and oil channels, where "bicontinuous" refers to two distinct (continuous, but non-intersecting) hydrophilic regions separated by the bilayer. Cubosomes are discrete, sub-micron, nanostructured particles of bicontinuous cubic liquid crystalline phase. Cubosomes possess the same microstructure as the parent cubic phase but have much larger specific surface area and their dispersions have much lower viscosity than the bulk cubic phase. The ability of cubic phases to exist as discrete dispersed colloidal particles, or cubosomes is perhaps the most intriguing[1]. Whereas most concentrated surfactants that form cubic liquid crystals lose these phases to micelle formation at high dilutions, a few surfactants have optimal water insolubility. Their cubic phases exist in equilibrium with excess water and can be dispersed to form cubosomes. Cubosomes are typically produced by high-energy dispersion of bulk cubic phase, followed by colloidal stabilization using polymeric surfactants. After formation of the cubosomes, the dispersion is formulated into a product and then applied to a substrate of interest, usually bodily tissue[2].

Cubic liquid crystals are transparent and isotropic phases that are physically stable in excess water representing a unique system for the production of pharmaceutical dosage forms. One application of cubic phase liquid crystals is the controlled release of selected water- and oil-solublemolecules. The emulsification of cubic lipid phases in water results in the production of cubosomes that can be defined asnanoparticulate disperse systems characterized by high biocompatibility and bioadhesivity. The last several decades have brought about a great understanding of the properties of cubic phases and a realization of their relevance in areas such as medicine, biology, and chemistry.

An intriguing property of the cubic phases formed by certain classes of amphiphiles is their ability to be dispersed into particles, termed cubosomes. Cubosomes are liquid crystalline nanostructured particles with the same unique properties of the bulk cubic phase, although cubosome dispersions have much lower viscosity[3].

Cubic Phase Liquid Crystals

It is usually assumed that the loading and release properties from cubic phase liquid crystals are solely governed by the solubilized active. Loading properties are governed by the partition of actives between existing phases. The partitioning is driven by thermodynamic constraints that force the chemical potential of the active in each phase to be identical at equilibrium. The concept of functionalization is to control the loading and release properties of the active by changing the properties of the cubic phase. Functionalization is achieved by incorporating amphiphilic molecules into the liquid crystal; the hydrophobic portion of the amphiphile inserts into the bilayers of the cubic phase and the hydrophilic portions extend into the water channels. By customizing the specific properties of the hydrophilic portions, it is possible to control their interactions with the actives. As an example, a positively-charged hydrophilic portion is expected to increase the loading of a negatively-charged active[4].
The amphiphilic actives such as chlorpheniramine maleate, diltiazem-HCl and propranolol-HCl bind differently to the monoglyceride, leading to further partition differences. At longer times, however, the release rates of actives such as chlorpheniramine maleate and pseudoephedrine hydrochloride follow a different rule primarily because they interact with the liquid crystal[5]. The release rates also slow as the concentration in each phase approaches its equilibrium partition value.

Clinical Evaluation of Skin Conditioning by Cubic Phase

The appication of cubic phase liquid crystals, such as in the monoolein-water system, is their use as controlled release systems for delivery of selected water- and oil-soluble materials. Such applications require an understanding of the interface between the bicontinuous cubic materials and the biological epithelia which they contact; e.g., the gut, oral mucosa, and the skin. In the case of skin, the ultimate biological interface is constituted by a thin (~20 micron thick) cross linked biopolymer called the stratum corneum[6].
Proponents of drug delivery across human skin point to the stratum corneum as the chief obstacle and impediment to successful passage of a molecule or drug into the living epidermis and/or the bloodstream. Numerous strategies have been developed, therefore, to disrupt the architecture of the stratum corneum using high energy ultrasound, laser ablation, electrophoresis, and chemical penetration enhancers in order to create momentary micropores or channels for drug passage[7].
The results of two clinical studies involving acute (minutes to hours) and chronic (several weeks) exposure of human stratum corneum to monoolein-water cubic phases. Both studies are conducted on normal adult human female volunteers with consent and institutional review board approval[8 9].

CUBOSOME APPLICATIONS

The rapid expansion of the life-sciences industry is expected to drive previously “exotic” delivery vehicles and ingredients into broader marketplaces, such as personal care and consumer products. A common application for such new materials is as drug delivery vehicles. The first patent describing cubosome usage specifies numerous medical and controlled release applications, although controlled release is usually possible only for bulk cubic phases[10].

Consequently, self-assembled surfactant phases have been extensively examined for compatibility with numerous medical active ingredients and their applications.
The work discusses enhancement of the properties of the native cubic phase using charged surfactants and polymers that strongly associate with solubilized active ingredients. Finally, the effects of the bicontinuous cubic phase on human skin are studied and the results compared to existing consumer skin treatments[11].
Controlled release of solubilized actives is the most popular application pursued by cubosome researchers, and excellent reviews exist of attempted delivery applications as well as pharmaceutical actives that have been solubilized in bulk cubic phase and cubosomes. Cubic phase is attractive for controlled release because of its small pore size (ca. 5–10 nm); its ability to solubilize hydrophobic, hydrophilic, and amphiphilic molecules; and its biodegradability by simple enzyme action[12 13].

CONCLUSIONS

Bicontinuous cubic liquid crystalline phases, either in bulk or cubosome form, offer unique properties of particular interest to the personal care industry. Cubic phase materials can be formed by simple combination of biologically compatible lipids and water and are thus well-suited for use in treatments of skin, hair, and other body tissue. The ability to form cubosomes either in use, during formulation, or during manufacture offers greatly enhanced flexibility for product development efforts. Formulation of personal care products containing cubosomes often requires additional surface-active ingredients. Some observations of skin irritation by bulk cubic phase point to the need for further study of alternative formulations that avoid residual oleic acid and use much lower viscosity cubosome dispersions.

REFERENCES

1. B.Siekmann, H.Bunjes et al (2002). Preparation and structural investigations of colloidal dispersions prepared from cubic monoglyceride-water phases. Int. J. Pharm: 244: 33- 43.
2. Norlén, Al-Amoudi (2004). Stratum Corneum Keratin Structure, Function, and Formation: The Cubic Rod- Packing and Membrane Templating Model. J Inv Derm 123: 715-718.
3. E.Esposito, R.Cortesi et al (2005). Cubosome Dispersions As Delivery Systems For Percutaneous Administration Of Indomethacin. Pharm. Res. 12: 2163-73.
4. Afriat I. and Biatry B. (2001). Use of Cubic Gel Particles as Agents against Pollutants, Especially in a Cosmetic Composition. Eur. Pat. Appl. (L'Oreal, Fr.).1: 1-8.
5. Agache P. Mary S. et al (2001). Assessment of the Water Content of the Stratum Corneum Using a Sorption-Desorption Test. Dermatology. 202: 308-13.
6. Anderson D.M. and Wennerström H. (1990). Self-Diffusion in Bicontinuous Cubic Phases, L3 Phases, and Microemulsions. J Phys Chem. 94**:** 8683-94.
7. Andersson, S. Jacob M. et al (1995). Structure of the Cubosome - a Closed Lipid Bilayer Aggregate. Zeitschrift fur Kristallographie. 210. 315-8.
8. Angelov B. Ollivon M. et al (1999). X-Ray Diffraction Study of the Effect of the Detergent Octyl Glucoside on the Structure of Lamellar and Nonlamellar Lipid/Water Phases of Use for Membrane Protein Reconstitution. Langmuir. 15**:** 8225-34.
9. Boyd B.J. (2003). Characterisation of drug release from cubosomes using the pressure ultrafiltration method. Int J Pharmaceutics. 260: 239–47.
10. Andersson S. Larsson K. (2000). Biomathematics: structure and dynamics in molecular biology. Curr collo surf. 5: 64-69.
11. Jacob M. Andersson S. (1998). The nature of mathematics and the mathematics of nature. Amsterdam' Elsevier. 1: 1-10
12. Boyd B.J. (2003). Characterisation of drug release from cubosomes using the pressure ultrafiltration method. Int J Pharmaceutics. 260: 239–47.
13. Luzzati, V.; Husson, F.(1962). The structure of the liquid-crystalline phases of lipid–water systems. J Cell Biol. 12: 207–219.