IFSCC Mexico Conference 2021

NT_642

EXACTAS UBA

CONICET UBA

INQUIMAE

OPTIMIZATION OF EMULSIONS WITH LIQUID-CRYSTALLINE STRUCTURES FOR THE VEHICULIZATION OF ACTIVE INGREDIENTS IN COSMETIC FORMULATIONS

Michel Torino, Mateo[1,2]; Vadra, Nahir[1,2]; Huck Iriart, Cristián[3]; Suarez, Sebastián A.[1,2*]

[1] Departamento de Química Inorgánica, Analítica y Química Física, Facultad de Ciencias Exactas y Naturales, Universidad de Buenos Aires, Buenos Aires, Argentina; [2] INQUIMAE, CONICET, Buenos Aires, Argentina; [3] UNSAM-CONICET, San Martin, Argentina.

*seba@qi.fcen.uba.ar

Introduction:

Cosmetic actives ingredients (CAI) often have an optimal concentration range above which they can be harmful and below which they are worthless.[1] In this context, one of the objectives of drug delivery is to obtain a sustained and controlled release of an active ingredient within an appropriate concentration range and time.[2,3]

It has been proved that the presence of liquid-crystal (LC) phases within the emulsions modify the rheological properties, promoting better stability in the ternary system and promoting the sustained release of active ingredients in the other.[4,5] Moreover, the structures forms by LC can act as hosts for hydrophilic, lipophilic, or amphiphilic guests, locating them on different regions of the supramolecular structure.[6] In this work, we synthesized, characterized, and explore the release of caffeine (as a model for water-soluble active ingredient), aiming to evaluate the effect of structure/composition over the transport of hydrophilic active ingredients.

Materials & Methods:

Formulation: The aqueous phase was composed of NaCl 1,2% w/v (with or without caffeine), the Oily phase was composed of a mixture of linear fatty alcohols C18 (Ceto-Stearyl Alcohol) and Mineral Oil (Paraffinum Liquidum), and the emulsifier was composed of a mixture of C18 alcohol ethoxylated by 20 PEG units (Ceteareth-20).

Lyotropic liquid crystal (LLC)-based emulsions characterization: Final aspect and macro and microscopical characterization of emulsions depend on the analyzed region of the ternary diagram. Liquid Cristal phases were characterized using Polarized Optical Microscopy (POM) and X-Ray Scattering at small and wide angles (SAXS/WAXS), as well as X-Ray Diffraction (PXRD).

Diffusion experiments: Diffusion was studied *in vitro* using a Franz cell. The membranes used were full-thickness section of porcine epidermal tissue, removed with a scalpel from the outer side of the ears.

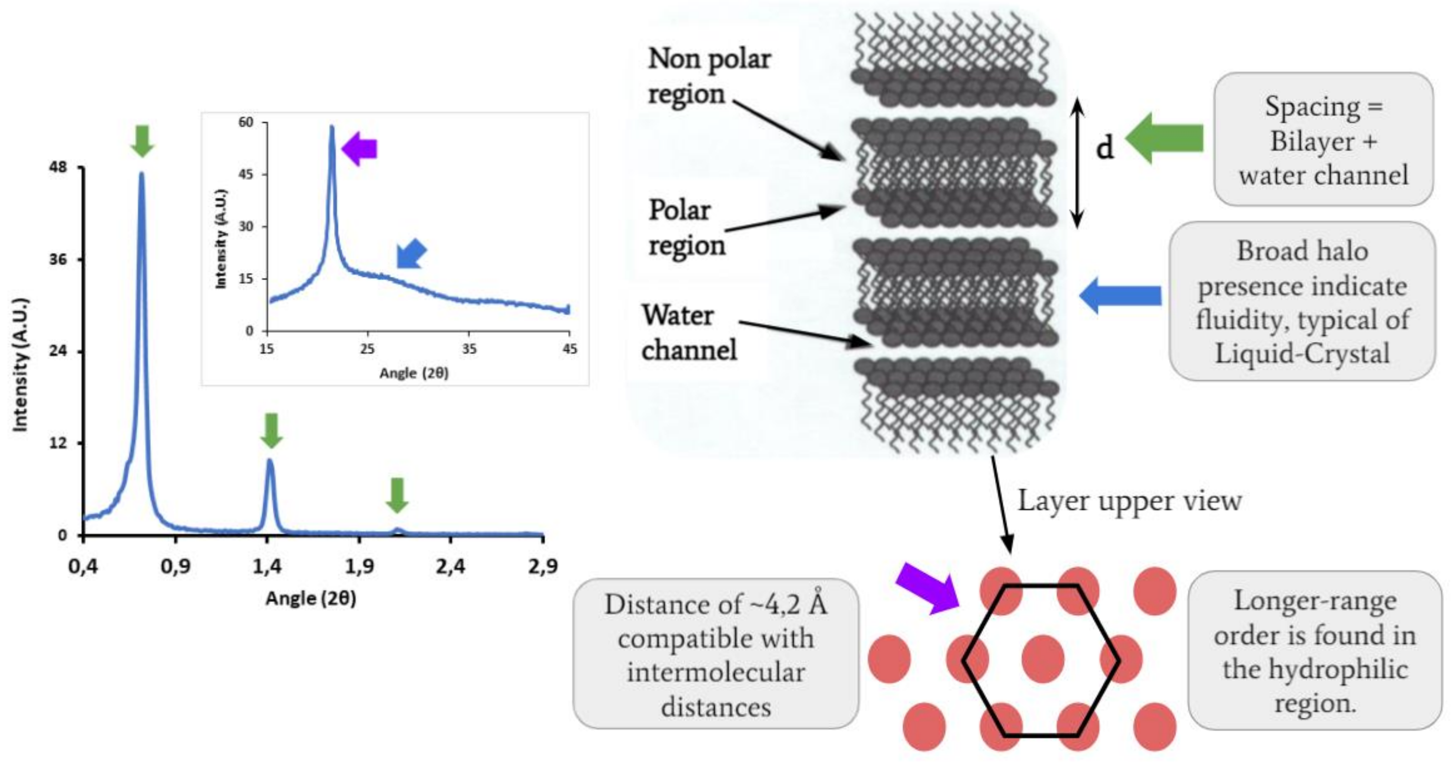
Conclusions:

In the present work, we achieved the synthesis and characterization of a broad region of the ternary system: surfactant – oil – aqueous solution. To carry out these studies was employed a multi technics approach. Liquid crystal phases have been identified and characterized by polarized optical microscopy (POM), small and wide-angle X-ray scattering (SAXS / WAXS), as well as X-ray diffraction (PXRD). We found diverse regions characterized mostly by one liquid crystalline lamellar phase, one region of intermediate phases, and finally, one region of coexistence between two phases. Also, the different showed properties of interaction with biological membranes. This characteristic was studied by the permeation of a water-soluble A.I., such as caffeine.

Results show that water content is directly involved in caffeine's diffusion since it seems to be the case of a guest transported by water channels. Furthermore, it would be possible to control the active ingredient's diffused concentration as a function of the liquid crystal phase synthesized.

Results & Discussion:

In Lyotropic Liquid Crystals, the repetitive angles spacing correlates with the physical spacing between adjacent bilayers, including the water channel present on the sides of the bilayers (Scheme 1). On the other side, the presence of a wide halo at broad angles (4.5 Å) evidences the fluid character of the material due to the mobility of molten aliphatic chains. In the same broad-angle region, a strong signal corresponding to 4.1-4.2 Å can be appreciated. It is characteristic of a hexagonal lattice formed by the polar region that integrates each layer. This last aspect is typical of a Lamellar lattice, in which the hydrocarbon chains are usually completely elongated and with a high degree of rotational disorder.



Scheme 1. Structural Analysis for lamellar LLC phase.

Even though the distances obtained by diffraction were dependent on surfactant concentrations, the interplanar distances obtained in all of them were almost double the length of a single molecule (~90 Å). This denotes the presence of a bilayer. Moreover, the smaller distance can be attributed to a mixed contribution between the interpenetration of the aliphatic chains, as well as, the water amount present in each layer (Scheme 1). Within the region of the laminar phase of the ternary mixture diagram, a decrease in water concentration generates, as expected, a reduction in the distances between bilayers. Because of this, a lower permeation of hydrophilic active ingredients was observed (Figure 1).

In summary, it has been observed a difference of an order of magnitude in the A.I. diffusion values depending on the presence of liquid-crystal structures. This could be attributed to the stabilization produced by LC phases, increasing the mechanical strength of the oil-aqueous interphase and the fixation of the emulsion droplets to the liquid-crystal structure. Situation that avoids the coalescence of the emulsion.

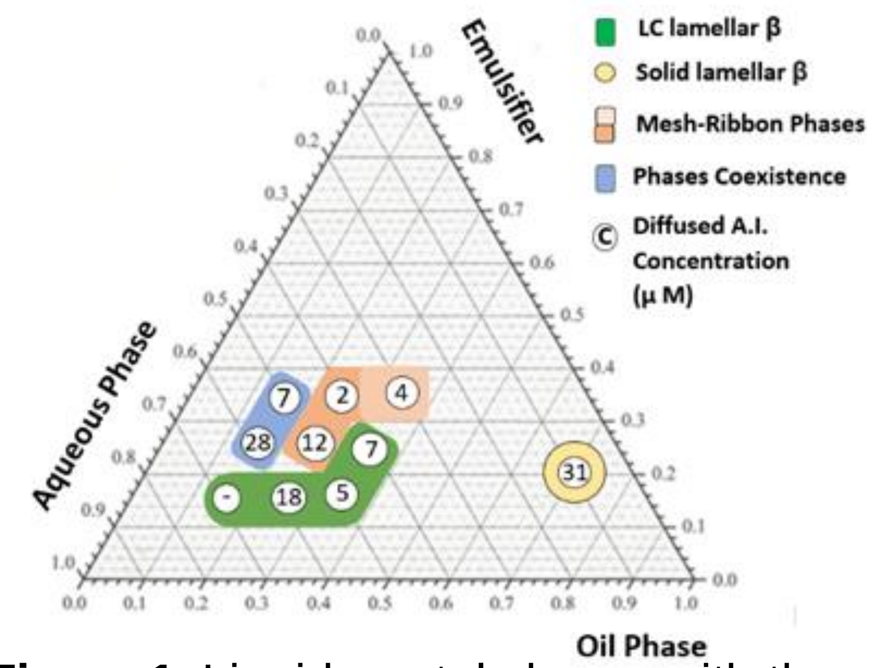


Figure 1. Liquid crystal phases with the corresponding concentration of diffused hydrophilic active ingredient (mM).

Aknowledgments:

The authors would like to thank Eduardo Schvartzman and Federico Svarc for their valuable inputs and commentaries. This work was financially supported by the Argentine Association of Cosmetic Chemicals (AAQC) and School of Science - University of Buenos Aires (FCEN-UBA). The authors thank to fabriQUÍMICA S.A.U. and Silkey s.a. for the raw materials used in this work. SAS and HIC are members of the research staff of CONICET.

References:

[1].Drummond, C. J., & Fong, C. (2000). Surfactant self-assembly objects as novel drug delivery vehicles. Current Opinion in Colloid & Interface Science, 4, 449–456.
[2].Malmsten, M. (2002). Surfactants and Polymers in Drug Delivery. Dekker, Marcel.
[3].Walker, R. B., & Smith, E. W. (1996). The role of percutaneous penetration enhancers. Advanced Drug Delivery Reviews, 18, 295–301.
[4].Kim, D.H., Jahn, A., Cho, S.J., Kim, J. S., Ki, M.H., & Kim, D.D. (2015). Lyotropic liquid crystal systems in drug delivery: a review. Journal of Pharmaceutical Investigation, 45(1), 1–11.
[5].Hiwale, P., Lampis, S., Murgia, S., & Monduzzi, M. (2013). Liquid-Crystal Based Formulations for Topical Drug Delivery. Journal of Dispersion Science and Technology, 3.
[6].Guo, C., Wang, J., Cao, F., Lee, Robert J., & Zhai, G. (2010). Lyotropic liquid crystal systems in drug delivery. Drug Discovery Today, 15, 1033–1040.

Do you want to know our group?