**Phase Behavior of Bio-based Ionic Liquid Crystal Mixtures based on Choline and Fatty Acids**

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**Highlights**

* Remarkable wide ILC temperature domain of systems containing bio-based ILs
* Mixing ILs and fatty acids improved their physical and thermal properties
* The investigated mixtures form solid solutions
* Mixtures presented high MP depression and high decrease in ILC temperature domain

**1. Introduction**

Bio-based ionic liquids (ILs) are promising compounds and their synthesis by using compounds obtained from natural sources has been considered as an alternative way to overcome the toxicity aspect and expand their applications in food and cosmetic industries [1]. This is the case of ILs based on fatty acids and choline. Fatty acids are considered GRAS substances and food additives with functional properties (e.g. omega fatty acids) [2], which makes them interesting precursors to produce low toxic and possible edible ILs. Choline cation belongs to the B-complex vitamins, that can be found in several foods and is considered as essential and nontoxic nutrient.

Mixing ILs have been considered an alternative way to improve their thermal and physical properties, but studies on such approaches using ILs obtained from natural compounds are still scarce [3]. The phase behavior of mixtures containing such ILs are far from be fully evaluated, especially those systems with liquid crystalline mesophases. In this context, new possibilities toward the design of bioproducts by using compounds of interest for food and cosmetic industries, such as lipidic based products, have been encouraged.

The aim of this work was to characterize the Solid-Liquid-crystal-Liquid thermodynamic Equilibrium (SSLcLE) of two binary mixtures of bio-based ILs and fatty acids.

**2. Methods**

The two systems comprises ILs with their fatty acid precursor: cholinium stearate + stearic acid ([Ch][C18OO] + C18OOH) and cholinium oleate + oleic acid ([Ch][C18:1OO] + C18:1OOH). The melting temperatures were determined using a DSC8500 calorimeter (PerkinElmer, USA) in a cooling-heating cycle at 1 K min-1. The liquid crystalline mesophases (LCMs) were evaluated using a polarized optical thermomicroscope (Leica, Germany) in a 0.1 K min-1 heating run.

**3. Results and discussion**

Phase equilibrium data indicated two phase transition regions S-LC and one LC-L, presenting three solid phases with solid solutions SS, one mesophase LC and one isotropic liquid phase L. This behavior is commonly observed for ILs. Furthermore, the investigated mixtures form solid solutions. This work also revealed a remarkable wide ILC temperature domain of ILs derived from choline and fatty acid. The system [Ch][C18OO] + C18OOH presented lower decrease on their ILC temperature domain and lower depression of the melting points (MPs). This could be related to higher anion-cation interactions and layered structures, as well as mesophases-forming ability due to their long alkyl chain length and linearity. Otherwise, systems containing molecules with unsaturation in their structures presented a higher decrease on ILC temperature domain and a higher MP depression.



**Figure 1.** Phase equilibrium of the binary mixtures of ILs and fatty acids: cholinium stearate + stearic acid ([Ch][C18OO] + C18OOH) (A) and cholinium oleate + oleic acid ([Ch][C18:1OO] + C18:1OOH) (B).

**4. Conclusions**

The results reported in this work show a decrease on the ILC temperature domain and melting temperature by mixing bio-based ILs and fatty acids. The tunability on the thermal and physical properties of the mixtures are related to the concentration and presence of unsaturation in the molecular structure of their components. The melting profile exhibited the formation of very well define liquid crystalline mesophases in a wide temperature range. These results open perspectives on the applications of ILs for the design of lipid-based structuration agents or industrial applications in processes at high temperatures.

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**References**

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