Rheological behavior of liquid-crystalline emulsion of topic application with econazole nitrate

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Abstract
A methodology to obtain the liquid-crystalline emulsions with an active incorporated in their structure was developed. Emulsions present secondary droplets, which are aggregates of droplets surrounded by a laminar lyotropic structure. This is formed by a surfactant (triethanolamine stearate), a fatty acid (stearic acid) and water. The formation of the secondary droplets due to the presence of lyotropic liquid crystals in the emulsion causes a decrease in viscosity. The addition of an active incorporated in the liquid crystals modified the rheology of the system but obtained emulsions results to be stable.

Keywords: Lyotropic liquid crystals, emulsions, secondary droplets, econazole nitrate.

1. Introduction

The lyotropic liquid crystals proved to be suitable systems for the controlled release of active ingredients and as a consequence, the liquid-crystalline emulsions exhibit similar behavior [1]. Emulsions with liquid crystals present, according to Susuki, Takei and Yamazaki [2], more stability attributed to the increase of the mechanical strength of the oil-water interface and the setting of the emulsion droplets to the liquid-crystalline structure. This multilayer that surrounds the drops of the emulsions reduces the van der Waals interaction between the oil drops and acts as a barrier against coalescence.

We studied the rheological behavior of emulsions with liquid-crystalline interfaces (standard system) [3,4] and emulsions with liquid crystal interfaces with the addition of an active principle incorporated in the crystal structures.

2. Materials and methods

2.1. Composition of the emulsion systems:

We worked with two systems of emulsions with liquid crystals:

2.1.1. Emulsions with liquid-crystalline characteristics without active principle (standard system).

Oily phase:
Stearic acid: 15,00%
Mineral oil: 20,00%
Propylparaben: 0,03%
2.1.2. **Emulsions with liquid-crystalline characteristics with econazole nitrate at 0.1%**.

**Oily phase:**
- Stearic acid: 15.00%
- Mineral oil: 20.00%
- Propylparaben: 0.03%

**Aqueous phase:**
- Triethanolamine: 4.14%
- Water: 60.76%
- Methylparaben: 0.07%
- Econazole, nitrate: 0.1%

A propeller stirrer electronic digital Eurostar four blades was used.

2.2. **Sample preparation:**

The oily phase of the tested emulsions contained stearic acid, mineral oil and propylparaben, while the aqueous phase was formulated with triethanolamine, water and methylparaben. Two emulsions prepared by a method of forming liquid crystals were tested; the first is the reference sample (1) and was added to the second sample econazol nitrate (2). For the formation of emulsions with liquid crystals’ characteristic adding stearic acid, mineral oil and propylparaben, in warm (about 70°C) and with shaking, to a mixture consisting of triethanolamine and part of the water (which was at the same temperature as the oil phase). After homogenizing mechanically, the previous mixture was diluted with the remaining water that contained the methylparaben. To obtain the systems with liquid crystalline characteristics was progressively increased stirrer speed from 50 rpm to a final speed of 500 rpm.

In the sample that includes an active principle, econazole nitrate, it was added to a part of the aqueous phase formed by a mixture of triethanolamine and methylparaben, that in presenting an alkaline pH we get the econazole nitrate is hydrolyzed and when mixing the aqueous phase with the oil phase the econazole is solubilized in the oil phase and in the liquid crystalline structure.

![Interphase of a liquid crystalline structure](image)

*Fig. 1: Interphase of a liquid crystalline structure.*

(Fase oleosa=Oily phase, Agua=Water, Fase acuosa=Aqueous phase)
2.3. Examinations done on the emulsions:

2.3.1 Microscope observation:

A polarizing microscope brand Carl Zeiss model Axiolab was used, equipped with digital camera Olympus SP 35, to find out the formation of liquid-crystalline structures.

2.3.2. Rheological behavior:

The rheological profile was carried out with a viscometer brand Brookfield, model DVII+ Viscometer, the rotor N° 28 was used and work was done at 28 °C.

2.3.3. pH:

System 1: 7.5  
System 2: 7.5

3. Results

The emulsions (1) and (2) presented liquid-crystal structures and secondary drops which were very similar in both emulsions (without active principle and with econazole).
Fig. 4. System 1. Viscosity curve.

Fig. 5. System 1. Flow curve.

Fig. 6. System 2. Viscosity curve.
The rheological essays showed that these systems are plastic bodies with thixotropy, although the values for the sample with econazole are lower than those of the sample without active principle.

4. Discussion

The methodology proposed allows the obtainment of liquid-crystalline emulsions with the active incorporated in the crystal structures.

The addition of an active such as econazole decreases the rheological values. However, such values are high enough to present creaming, sedimentation and phase separation.

Furthermore, the system proved to have thixotropy and the secondary droplets increased the physical stability of the biphasic system.

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