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The use of two non-toxic lipophilic oils to generate environmentally friendly anionic reverse micelles without cosurfactant. Comparison with the behavior found for traditional organic non-polar solvents

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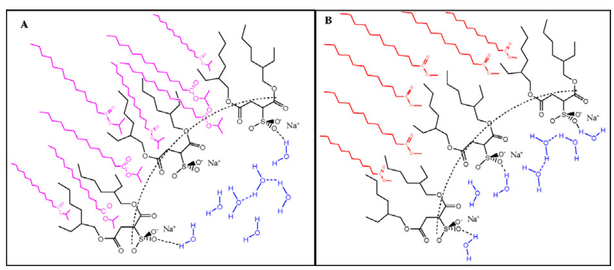
HIGHLIGHTS

- ML and IPM were used as external non-polar solvents to formulate aqueous AOT RMs.
- Size, N_{agg} and amount of water solubilized in both AOT RMs are different.
- Higher viscosity and polarity of IPM than ML promotes more interface penetration.
- Comparable behaviors between ML-*n*-heptane RMs and IPM-benzene RMs are observed.

GRAPHICAL ABSTRACT

Effect of the use of non-toxic lipophilic oils (IPM, A and ML, B) to generate environmentally friendly anionic reverse micelles.



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ABSTRACT

In this work two different non-toxic solvents/sodium 1,4-bis-2-ethylhexylsulfosuccinate (AOT)/water reverse micelles (RMs) have been investigated by dynamic (DLS) and static (SLS) light scattering techniques. Methyl laurate (ML) and isopropyl myristate (IPM) were used as external non-polar solvents to formulate the AOT RMs without cosurfactant. DLS results reveal the formation of IPM and ML AOT RMs containing water as a polar component since the droplet sizes values increase as the W_0 values increase. To the best of our knowledge this is the first report where ML is used to formulate AOT RMs. The droplets size values, the maximum amount of water solubilized and the aggregation numbers (N_{agg}, determined by SLS) of both AOT RMs are dissimilar considering the chemical structure of the external solvents and they can be explained taking into account the different non-polar solvent penetration to the interface. The results suggest that IPM penetrate more the interface than ML in AOT RMs, diminishing the inter-droplets interactions and producing RMs with smaller sizes and N_{agg} than ML/AOT. The higher viscosity and polarity of IPM in comparison with ML promotes the interface penetration. Thus, the penetration of IPM into the interface is higher than ML, making the interface of IPM/AOT RMs more rigid and, in consequence with smaller droplets sizes values. Finally, a peculiar comparable behavior (droplets size, maximum amount of water solubilized and N_{agg}) between *n*-heptane and ML AOT RMs and benzene and IPM AOT RMs was observed. These results present a very promissory field since that the unique properties of the alkanes/AOT/water RMs can be obtained using non-toxic lipophilic oils and, in the same way the opportunity to formulate environmentally friendly AOT RMs.

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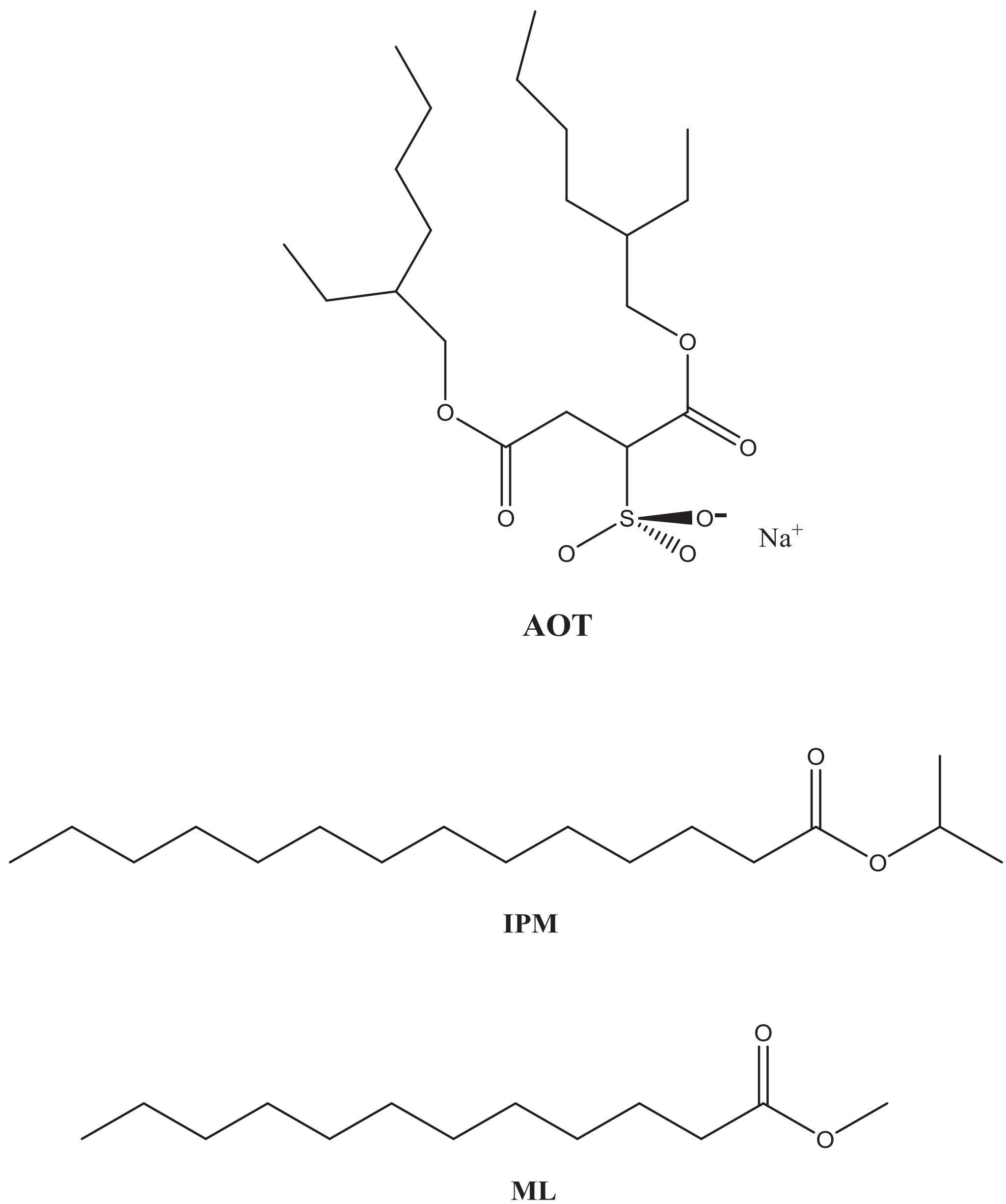
1. Introduction

Reversed micelles (RMs) are spatially ordered macromolecular assembly of surfactants formed in a non-polar solvent, in which the polar head groups of the surfactants point inward and the hydrocarbon chains point toward the non-polar medium [1–3]. RMs have been an interesting subject for decades due to their broad applications in chemical reactions, separation science, material science, and in the pharmaceutical industry, among others [1–4]. These nanoscale aggregates are suitable media for processes that involve hydrophobic and hydrophilic reactants in a variety of chemical and biological reactions [1,2,5,6]. There are a wide range of surfactants that form RMs [1–22] and probably, the most frequently surfactant used is the anionic sodium 1,4-bis-2-ethylhexylsulfosuccinate (AOT, Scheme 1) [4,7–9,15,17,18,20,21,23,24]. AOT has the ability to form RMs in aromatic (benzene, toluene, chlorobenzene, xylene) and aliphatic (*n*-heptane, *n*-hexane, isooctane, decane) solvents without addition of a cosurfactant and, water can be solubilized up to $W_0 = [H_2O]/[\text{Surfactant}] \sim 60$ depending on the external solvent and temperature [1–3].

The potential application of highly biocompatible aqueous RMs to the food, cosmetic, and pharmaceutical industry as solubilization media of hydrophilic, hydrophobic, and amphiphilic functional materials has been of growing interest during the past decade [25–28]. These applications are mainly linked to their unique properties such as thermodynamic stability, optical clarity, and high solubilization capacity [2,29]. However, the most critical problem regarding the use of RMs in the food, cosmetic, and pharmaceutical fields is the toxicity of their partial components. Formulation and characterization of non-toxic RMs formulations based on biological amphiphiles and different oils have been studied for over a decade [28]. These bio-compatible systems are discussed as potential substitutes for chlorinated solvents in dry-cleaning applications and as solvent delivery systems for pharmaceutical applications [28]. Studies in oil like isopropyl myristate (IPM), which possesses different physical properties and structure as compared to the traditional hydrocarbon oils, have been performed before [30–38]. Compared to alkane, IPM is a kind of non-toxic lipophilic oil, which has been widely used in biological resembling systems, and pharmaceutical and drug delivery systems [30,39–43]. On the



Scheme 1. Molecular structure of AOT, IPM and ML.