Cationic Surfactants Based on Renewable Raw Materials: New Emulsifiers for Elaboration of Nanoparticles of Dispersed Oil

Plamen Kirilov, Hakima Azira, Loïc Lemiègre, Thierry Benvegnu, Fabrice Goursaud, Daniel Plusquellec
Ecole Nationale Supérieure de Chimie de Rennes, CNRS UMR 6226, Campus Beaulieu Avenue Général Leclerc CS 50837, F-35708 Rennes, France
plamen.kirilov@ensc-rennes.fr

The development of surfactants based on natural renewable resources is a concept that is gaining recognition in cosmetic and detergent industries. This new class of biodegradable and biocompatible surfactants is a response to the increasing consumer demand for products that are both greener and more efficient. In order to achieve these objectives, it is necessary to use renewable low-cost materials that are available in large quantities and to design molecular structures that show improved performance, favourable ecotoxicological properties and reduced environmental impact.[1]

Several families of surfactants were prepared using environmentally friendly processes (without solvent or pollutants) and envisaging industrial scaling up. Their production permits to valorise various products and by-products of the sugar and oleochemical industries or derived from marine resources. Sugars [2] or betaine [3] were used as polar heads, and natural Tropical or European oils as raw materials for the lipophilic part of the surfactants. Cationic surfactants from glycine betaine (esters and amides carrying stearic and oleic alkyl chains) or non-ionic surfactants from different sugars were obtained by green solvent-free processes: the reaction takes place in the reagent in excess which is then recycled. For example, esterification reactions of glycine betaine were carried out with recyclable saturated or unsaturated fatty alcohols of various lengths (lauric, stearic or oleic alcohols) at 130°C, in the presence of biodegradable methane sulfonic acid and under reduced pressure to provide glycine betaine ester-type surfactants (Figure 1).

The physicochemical properties of the synthesized surfactants were evaluated: they exhibit attractive surface-tension, and remarkable foaming, surfactant and emulsifying capability. For example concerning emulsifying properties, we followed the O/W emulsion ageing by photodensitometry vs. pH medium in order to compare the capacity of glycine betaine stearic and oleic esters and amides to stabilize oil droplets (Figure 2). These investigations showed the importance of the surfactant type on the stability of obtained emulsions and could define the kind of surfactant applications. A highly biodegradable emulsifying formulation called Emulgreen® is currently under industrial development.

To conclude, a wide range of original surfactants derived from renewable resources were developed with potential applications, notably, in detergency and cosmetic industry. The production of these entirely natural molecules may substitute the petrochemical products classically used.

References:

[1] T. Benvegnu, D. Plusquellec, L. Lemiègre, in Monomers, Polymers and Composites from Renewable Resources 2008, M. N. Belgacem, A. Gandini, Eds. Elsevier Limited: Amsterdam.
[2] M. Roussel, T. Benvegnu, V. Lognoné, H. Le Deit, I. Soutrel, I. Laurent, D. Plusquellec, Eur. J. Org. Chem., **20** (2005) 3085 – WO2003104248.
[3] F. Goursaud, M. Berchel, J. Guilbot, N. Legros, L. Lemiègre, J. Marcilloux, D. Plusquellec, T. Benvegnu, Green Chem., **10** (2008) 310 - WO2005121291.

Figures:

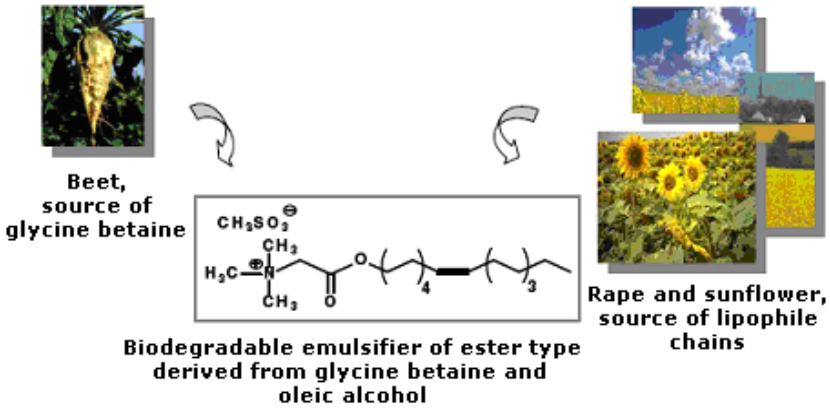
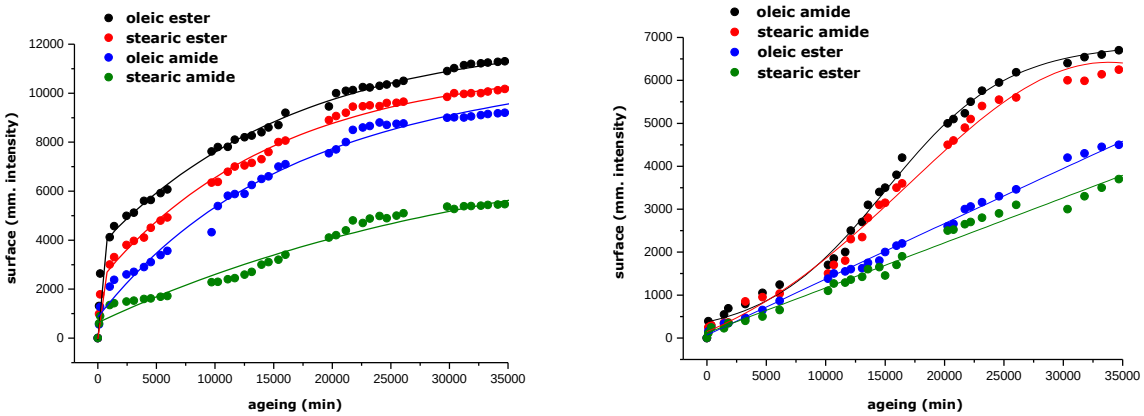


Figure 1. Ester type of biodegradable emulsifier obtained from renewable raw materials.



2a **2b**

Figure 2. Surface variation of the serum peak area (formed during the creaming process) vs. time for emulsions stabilized by glycine betaine esters and amides at neutral pH (**2a**) and at acid (**2b**) pH.