Toxicity mechanisms of mixtures of anionic and non-ionic surfactants

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1. Introduction

In recent years, several toxicological studies concerning pollutants have focused on the joint toxicological assessment of co-pollutants, revealing that multiple interactions between toxics can appear and need to be described. In the case of surfactants, while individual studies of them can provide valuable information, they may not reflect real-world exposure to multiple surfactants at once. Synergistic or antagonistic effects can appear on the combined toxicity of surfactants, meaning that the combined effects are greater or lower than the sum of the individual effects.

In this work we study the joint toxicity effects of anionic and non-ionic surfactants to bacteria microcrustaceans *Daphnia magna*. The type of action (concentration addition or response addition), and the possible antagonistic or synergistic toxic effects related are described.

2. Materials and Methods

Surfactants: anionic surfactant ether carboxylic derivatives (EC-$R_{12\text{-}14}E_3$, EC-$R_{12\text{-}14}E_{10}$ and EC-R_8E_8) and amine-oxide-based non-ionic surfactants AO-R_{14}, AO-R_{12} and AO-$_{Cocoamido}$ (supplied by Kao Corporation S.A., Tokyo, Japan). Individual and binary mixtures (1:1) of the surfactants were tested.

Toxicity tests: Toxicity was tested using microcrustaceans *D. magna* and according to the guideline UNE-EN ISO 6341.

3. Results

Toxicity test of binary mixtures (1:1) reveals that concentration addition can be expected for mixtures of the most toxic surfactants from the same family (EC-EC-$R_{12\text{-}14}E_{10}$ + EC-$R_{12\text{-}14}E_3$ and AO-R_{14} + AO-R_{12}), whereas response addition can be expected for the mixture EC-EC-R_8E_8 + EC-$R_{12\text{-}14}E_3$. Antagonism effects, this is mixture is less toxic than the expected, were identified for mixtures including AO-$_{Cocoamido}$, but a synergism effect was identified for the mixture of EC-EC-$R_{12\text{-}14}E_3$ + AO-R_{14}.

4. Conclusions

- Antagonisms effects were identified for some mixtures of ether carboxylic derivatives and amine-oxide-based surfactants.
- Mixtures showing antagonism effects are preferred for the selection of surfactants in the formulation of more eco-friendly products.