Comparison of the antimicrobial efficacy of commercial surfactants with the respective pure components

Idalina Machado, Carla Ramos, Manuel Simões, Maria João Vieira, Maria Olívia Pereira*

IBB – Institute for Biotechnology and Bioengineering, Centre of Biological Engineering, University of Minho, Campus de Gualtar, 4710–057 Braga, Portugal

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Surfactants constitute the most important group of detergent products. Generally, these are water-soluble surface-active agents comprised of a hydrophobic portion, usually a long alkyl chain, attached to hydrophilic or water solubility enhancing functional groups (McDonnell and Russell, 1999) . They are generally characterized by properties such as the critical micelle concentration (CMC), the hydrophile-lipophile balance (HLB), chemical structure and charge, as well as by source (chemical or biological) (Pereira, 2007; Van Hamme *et al.*, 2006).

In real world, microorganisms are often found associated in complex communities (usually comprising more than one microbial species) and exposed to stress factors that can lead to the development of bacterial resistance (Versalovic and Relman, 2006) and thus to the failure of the traditional sanitation procedures.

The development of surfactants with antimicrobials properties aims to reply to a bigger consumption and effectiveness. Nowadays, there is a huge diversity of new products that give rise to new concerns. We assist to an increasing efficiency of the detergent products mainly due to the inclusion of aggressive chemical products to guarantee the inhibition of microorganism growth (Gilbert and Mcbain, 2003;McDonnell and Russell, 1999;Simoes *et al.*, 2006). In this scenario, environment questions emerge aiming to safeguard the Nature and thus the conditions where we live and enlightening to the negative impact that the residues of those products detergents can have in the Environment.

With this study it was aimed to investigate the antibacterial effectiveness of commercial surfactant formulations (Dettol and Cutasept), used in the domestic cleanliness and disinfection of surfaces and equipment, as well as, in food industries and medical area. It was also aimed to compare their sanitation performances with the respective pure surfactants products: cetyl trimethylammonium bromide - CTAB and benzalkonium chloride - BAC (cationic surfactants) and dodecylbenzene sulfonic acid - DBSA (anionic surfactant) using Gram positive (*Staphylococcus aureus*) and Gram negative (*Escherichia coli* and *Pseudomonas aeruginosa*) bacteria from collection. In order to mimic conditions similar to actual situations, simple and mixed growth (achieved through the development of the bacteria, respectively, separately or in mixture) were implemented, as well as, *P.aeruginosa* strains previously adapted to BAC and CTAB.

The susceptibility of the several bacterial strains to the antimicrobial action of all the surfactants was characterized through the determination of the Minimum Inhibitory Concentration (MIC) defined as the minimum concentration where no suspended microbial growth was detected. To obtain the MIC of each product, single and mixed bacteria growth curves were developed in microtiter plates, during 48 h, in the presence of increasing concentrations of each one of the surfactant products.

The analysis of all results gathered with this work allowed to realize that, for equal concentration of the same product, the growth of Gram positive bacteria was more easily inhibited than the growth of the Gram negative bacteria. In the set of the surfactants tested, the commercial formulations Dettol and Cutasept showed to be the most efficient, since they inhibited single and mixed bacterial growth even when diluted

* Corresponding author. Tel + 351-253604402 E-mail: mopereira@deb.uminho.pt

4-fold or even 8-fold, in the case of Dettol. These results seem to point out that the concentrations of the commercial products are very elevated and higher than the really needed. It is important to take this fact in account since residues resulting from the use of those products can have tremendous negative impact in Environment and be responsible for bacterial resistance development. The MIC of the products when applied to the bacteria in mixed growth are comparatively higher than the ones determined with simple growth. This evidence indicates that the bacteria establish favourable microbial relations when developed together. In mixed growth, *P.aeruginosa* appeared to dominate over the others since the trend of the mixed growth curves was similar to the one obtained with that bacteria solely. The experiments carried out with the adapted bacteria revealed that the products concentration required to inhibit the single or mixed growth of the adapted *P.aeruginosa* was higher than the one needed in the experiments with the non-adapted bacteria. These results seem to be a sign of development of bacterial resistance to the products tested. Moreover, some cross-resistance seems also to occur since *P.aeruginosa* adapted to CTAB become less susceptible to the action of BAC. The increase of the MIC to values close to the CMC, in the case of the pure active agents, represents an additional concern as the use of those doses can be responsible for generating toxicities problems.
With the present study it was possible to conclude that: i) the commercial products appear to be more aggressive than the pure components even when used diluted; ii) bacteria developed in mixed cultures are less sensitive to the chemical products tested; iii) the previously contact of *P.aeruginosa* with sub-MIC concentrations of BAC and CTAB give rise to bacterial resistance.
The data collected with this study highlighted for the rational and conscious use of chemical commercial products to control bacterial growth in actual environments.

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