From optimized synthesis to controlled degradation – alkyl esters of glycine betaine as low-cost and environmentally friendly alternatives of conventional disinfectants

([1] *Faculty of Chemical Technology, Poznan University of Technology, Berdychowo 4, 60-965, Poznań, Poland*) ○ Tomasz Rzemieniecki,[1] Damian K. Kaczmarek,[1] Witold Stachowiak,[1] Adriana Olejniczak,[1] Michał Niemczak[1]

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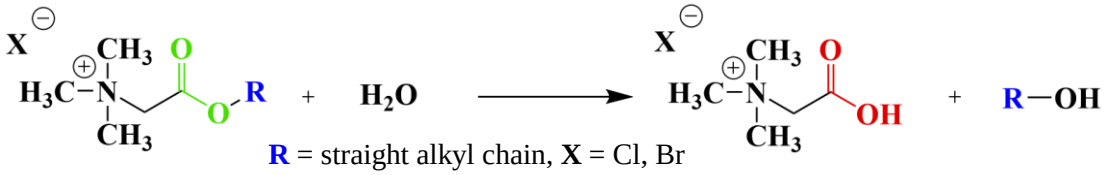
Quaternary ammonium salts (QASs) are widely recognized for their effectiveness in controlling a broad spectrum of pathogenic microorganisms, making them a critical class of disinfectants. However, the high ecotoxicity of commonly used QASs, such as benzalkonium chloride, coupled with their extensive use, necessitates the exploration of more environmentally friendly alternatives. Through the development and optimization of a novel one-step method for the *O*-alkylation of glycine betaine, a common waste of the sugar industry, a new class of glycine betaine-based QASs was efficiently synthesized. These compounds exhibit favorable surface activity and are readily hydrolyzable to low-toxicity by-products (glycine betaine and linear alcohols), due to the presence of an ester bond in their structure.[1]



R = straight alkyl chain, **X** = Cl, Br

Since glycine betaine-based QASs readily degrade in aqueous environments without the involvement of microorganisms (unlike most currently used QASs), formulating a chemically stable aqueous disinfectant poses a significant challenge. However, it was discovered that selecting a sufficiently high concentration of the active ingredient (>15%) and maintaining a low pH effectively stabilizes esterified glycine betaine solutions for up to three months, irrespectively of the alkyl substituent length in the QAS structure. These findings, combined with the optimized synthesis method and the favorable physicochemical properties of glycine betaine ester derivatives, highlight their potential as eco-friendly and effective alternatives to conventional QASs.

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