Antimicrobial properties of novel ionic liquids derived from imidazolium cation with phenolic functional groups

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Abstract

Bacterial infections are nowadays among the major threats to public health worldwide. Thus, there is an urgent and increased need for new antimicrobial agents. As a result, the exploration of the antimicrobial properties of different substances including ionic liquids (ILs) has recently attracted great attention. The present work is aimed at evaluating how the addition of halogens and hydrophobic substituents on alkylimidazolium units of ILs as well as the increase in their chain lengths affects the antimicrobial properties of such ILs. After their synthesis, the antibacterial activities of these compounds against Pseudomona aeruginosa, Escherichia coli, and Staphylococcus aureus are determined by measuring their minimal inhibitory concentrations (MICs). Key features in ILs-membrane interactions are also studied using long-term all-atom molecular dynamics simulations (MDs). The results show that these ILs have good antibacterial activity against S. aureus, E. coli, and P. aeruginosa, with MIC values range from <7.81 to 62.50 μM. The antimicrobial property of tert-butyl N-methylphenolimidazolium salts (denoted as 8b and 8c) is particularly better with MIC values of < 7.81 μM. The antibacterial efficacy is also found to depend on the alkyl chain length and substituents on the phenolic ring. Finally, MDs done for ILs in a phosphatidylcholine (POPC) bilayer show key features in the mechanism of IL-induced membrane disruption, where the ILs are inserted as clusters into one side of the bilayer until saturation is reached. This insertion increases “leaflet strain” up to critical threshold, likely triggering the morphological disruption of the membranes in the microbes. © 2021 Elsevier Inc.

Author keywords

Alkylimidazolium ionic liquids; Antimicrobial agents; Drug design; Nosocomial infection; Phenols