Novel Soft Quaternary Phosphonium Compound (Soft QPC) Collection as Antimicrobial Agents

Investigators

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Background and Unmet Need

Historically, quaternary ammonium compounds (QACs) have been the standard antimicrobial agents in the current disinfectant market. However, the environmental persistence qualities of this agent are of notable concern. Long-term environmental exposure to QACs not only results in growth inhibition and lethal complications of aquatic organisms, but also contributes to antimicrobial resistance. This is because these compounds persist in the environment at subinhibitory concentrations, which is demonstrated to drive the development of QAC resistance.

During the COVID-19 pandemic, the use of antimicrobial materials rose to unprecedented levels, and usage remains elevated. QACs are regularly found in aquatic environments downstream of water treatment plants and hospitals. It was reported that 75% of QACs are released into wastewater treatment plants, and the remainder is released directly into the environment.[1]

The creation of novel antimicrobial structures is of crucial importance for human and environmental health. They respond to the urgent need to balance antibacterial potency with environmental considerations to counter the development of bacterial resistance.

Opportunity

QACs hold the highest share of active disinfectant agents on the market, despite their environmental impacts and increased prevalence of antimicrobial resistance. This invention will contribute to that market without the disadvantages of QACs. The current global disinfectant market is forecasted to reach a value of more than $14.9 Bn by 2030 as individual brands seek to expand upon their eco-friendly product offerings.[2]

Villanova University scientist Dr. Kevin Minbiole, in collaboration with Dr. William Wuest of Emory University, has developed a series of novel soft, or decomposable, quaternary phosphonium compounds (soft QPCs) – changing the historical standard of quaternary ammonium compounds (QACs).

These novel soft QPCs provide an environmentally conscious alternative to QACs, as they are specifically designed to be unstable in standard environmental conditions. Hydrolysis experiments indicated immediate precipitation (<5 mins in acidic conditions) or rapid decomposition (under 24h in basic conditions) of the soft QPCs. The inventor reports the soft QPCs to be environmentally benign, as they do not maintain any notable long-term toxicological impact on the environment and living organisms.

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[1] Li, X.; Brownawell, B. J. Quaternary Ammonium Compounds in Urban Estuarine Sediment Environments - A Class of Contaminants in Need of Increased Attention? Environ. Sci. Technol. 2010, 44, 7561-7568. DOI: 10.1021/es1011669

[2] *Global Disinfectants Market, 2020 – 2030*, Transparency Market Research, May 4, 2022.

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These specific properties address the environmental persistence challenges of traditional QACs. Minimal environmental persistence is advantageous to decrease the development of bacterial resistance to anti-microbial agents, as they do not remain in the environment in subinhibitory concentrations.

This invention offers a new class of potent disinfectants. These novel QPCs are highly effective against both Gram-positive and Gram-negative pathogenic bacterial strains with notably low MIC values that are superior to commercially available QACs.

Unique Attributes

- Product stability (long-term stability in water or neutral buffer) to achieve desired disinfectant use
- Environmentally benign with effective broad-spectrum potency against both Gram-positive and Gram-negative bacterial pathogens
- Deactivation under hydrolysis conditions and fast decomposition in environmental conditions
- Simple and high-yielding synthesis

Applications

This invention can be commercialized as a variety of disinfectant products for multiple industries, such as home-cleaning products, industrial / commercial settings, and hospital settings. Potential products made from this compound include, but are not limited to:

- Anti-microbial gels/liquids
- Anti-microbial surface cleaner wipes
- Anti-microbial sprays

Stage of Development

Prototype and Proof of Concept developed.

Intellectual Property

Provisional Patent Filed December 2022.

Licensing and Collaboration Opportunity

Villanova and Emory are seeking a licensee to commercialize the invention. Also, please see companion intellectual property: “Novel Quaternary Phosphonium Compound (QPC) Disinfectants” and “Novel Alkyl Quaternary Phosphonium Compound (Alkyl bisQPC) as Antimicrobial Agents.”

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