Novel Quaternary Phosphonium Compound (QPC) Disinfectants

Primary Investigators

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Background and Unmet Need

Quaternary ammonium compounds (QACs) are a staple disinfectant in household, agricultural, industrial, and clinical settings. Their popularity has continued to persist due to their broad-spectrum activity against various micro-organisms. While the non-specific mechanism of QACs suggested that these compounds would evade resistance development, unfortunately, tolerance of QACs was eventually observed.

Furthermore, sub-inhibitory concentrations of QAC treatments have been found to promote co-resistance to disinfectants and antibiotics.

Thus, there remains a need for novel broad-spectrum disinfectant compounds to address these concerns.

Opportunity

QACs hold the highest share of active disinfectant agents on the market, despite their contribution to increased antimicrobial resistance.

However, design of disinfectants is not limited to ammonium-based compounds. Compounds designed with phosphorus have been found to overcome the challenges of resistance development. Recently, quaternary phosphonium compounds (QPCs) have proven to be an effective alternative to traditional QAC-based products.

Villanova University scientist Dr. Kevin Minbiole and Dr. William Wuest from Emory University have developed novel QPCs that can be used across a variety of fields. By replacing nitrogen with phosphorus, resistance to QACs has been evaded successfully to create a new class of molecules critical for new, unusually potent and fast-acting, environmentally friendly products.

When tested against commercial QACs, comparable hemolytic activity and 8-64-fold increase in activity against Gram-positive and Gram-negative species were observed. A study reporting the recent spread of disinfectant/antibiotic resistance genes through a novel horizontal gene transfer mechanism[1] underscores the need for next-generation disinfectants, such as those developed by Minbiole and Wuest, that overcome mounting resistance.

[1] T. M. Wassenaar, D. W. Ussery, H. Ingmer, Front. Microbiol. 2016, 7, 1528.

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The global disinfectant market is forecasted to reach a value of more than $14.9 Bn by 2030.[2] The present invention will contribute to that market growth as a product to mitigate the transfer of pathogenic bacteria that have developed resistance to QACs.

The investigators have reported that not only can QPCs be used to create effective anti-microbial cleaning products, but they also can also be used to develop methods of preventing diseases, including bacterial, fungal, pest, or viral infections.

Furthermore, novel derivatives of QPCs have been developed by Dr. Minbiole, including atom-economical alkyl QPCs and environmentally benign soft QPCs. A description of these inventions is attached. These additional novel compounds have been proven to be highly effective disinfectants that can be further developed as environmentally friendly alternatives to QAC-based disinfectant products.

Unique Attributes

- Effective against antimicrobial resistant bacteria by replacing nitrogen with phosphorus
- Effective inhibition against otherwise pan-resistant pathogenic bacterial strains
- Broad commercialization potential to develop a variety of products not limited to only disinfectant products
- Baseline for additional novel QPC-based product development

Applications

This invention can be commercialized through a variety of products which include, but are not limited to, anti-microbial disinfectants / cleaning products, pharmacological therapeutics, and anti-fungal and pest products.

Stage of Development

Prototype and Proof of Concept.

Intellectual Property

International Publication: WO 2023/023113 A1

Licensing and Collaboration Opportunity

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

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