

# Novel antimicrobial quaternary polyethyleneimine compounds for the treatment of infected wounds

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## Introduction

Chronic wounds are a major clinical and economic burden, with high infection rates and increasing antimicrobial resistance (AMR). Quaternary ammonium polyethyleneimines (QPEIs) are broad-spectrum antimicrobial polymers that disrupt bacterial cell walls and membranes via electrostatic interactions, leading to cell lysis. Unlike antibiotics, this physical mechanism reduces the likelihood of resistance while maintaining efficacy against biofilms and drug-resistant pathogens. This study evaluates a specific QPEI formulation (C24) as novel antimicrobial compounds for infection control in wound management.

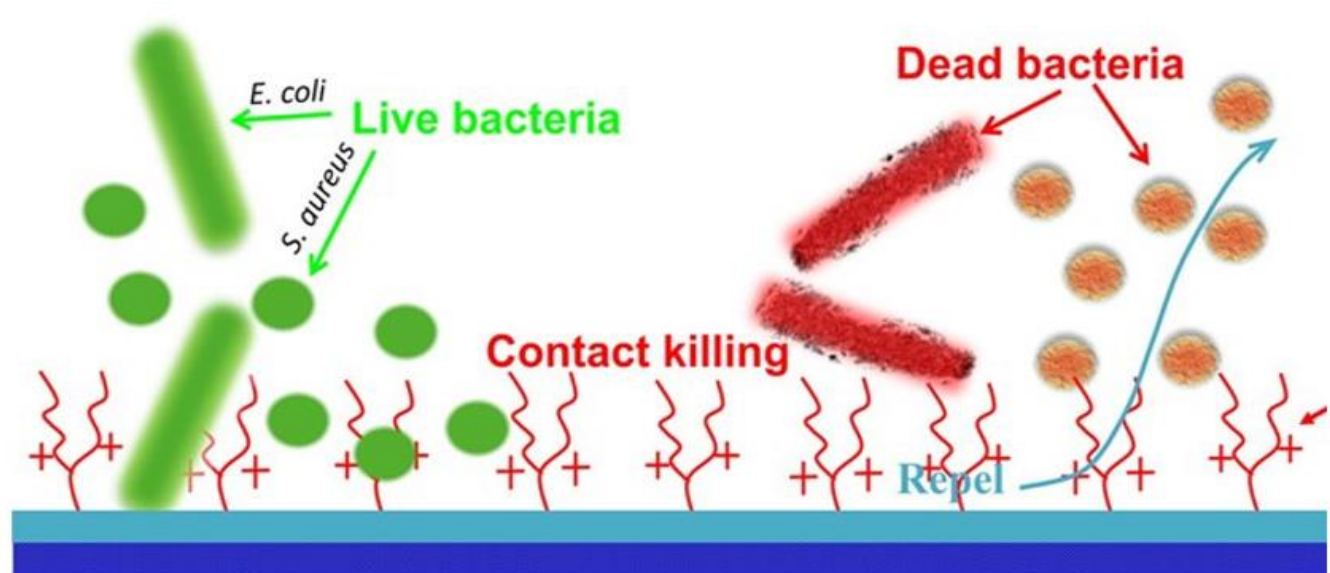


Figure 1. QPEI mechanism of action

## Aim

Determine the potential of dressings with incorporated C24 QPEI to exhibit antimicrobial properties in simulated use condition and on AMR pathogens.

## Methods

- QPEI minimum inhibition concentration (MIC) was tested against clinically-relevant bacterial and fungal strains.
- Bacterial morphology post-QPEI treatment in-vitro was visualized by scanning electron microscopy (SEM).
- Gelling fibers dressings incorporating C24 QPEI were tested to measure the antimicrobial activity in simulated use condition.

## Results

### C24 QPEI performance

#### C24 QPEIs exhibit antibacterial activity

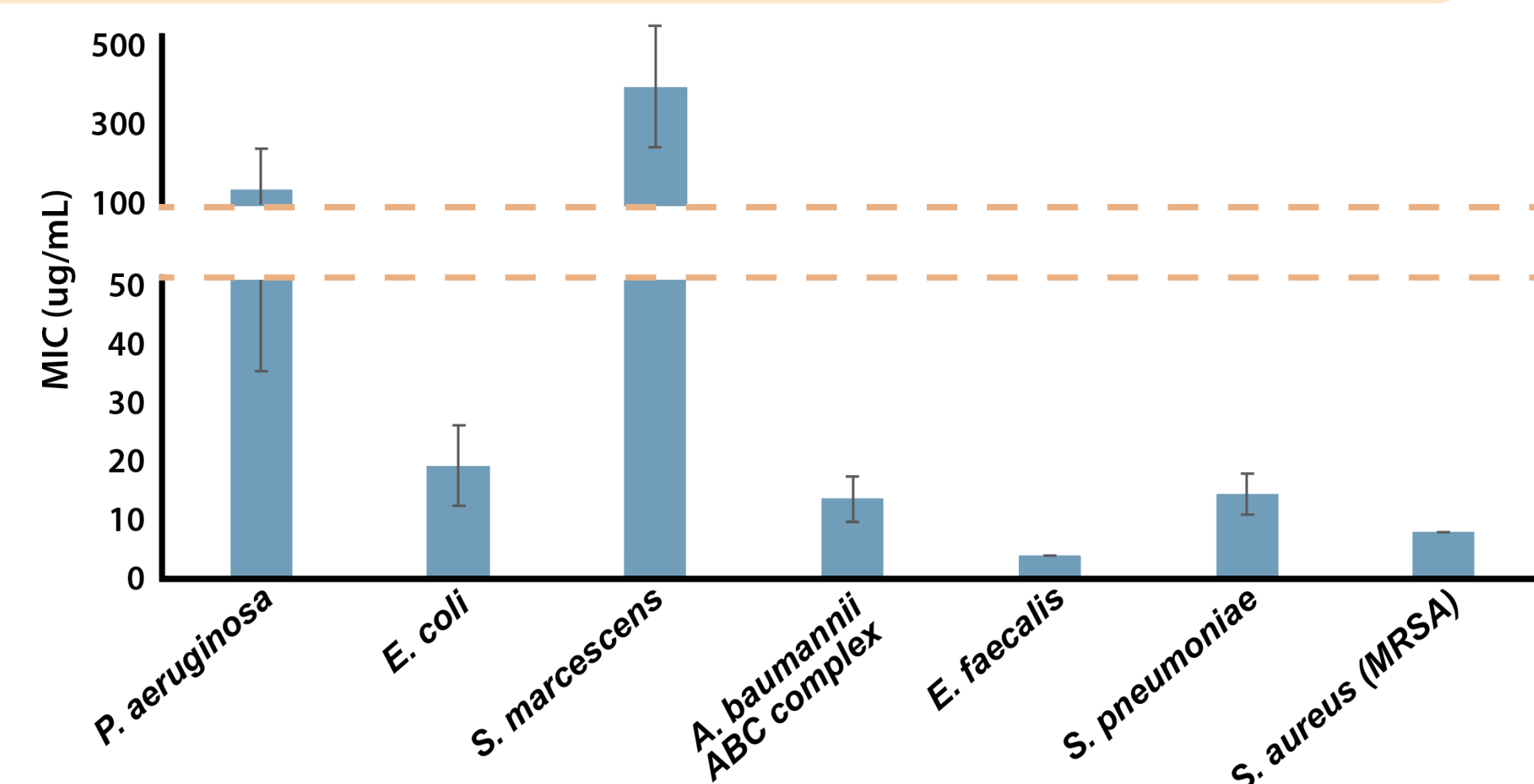


Figure 2. MIC of C24 QPEI in solution on different bacterial strains. QPEI displays activity against both Gram-positive and Gram-negative bacteria

#### C24 QPEIs demonstrate anti-fungal activity

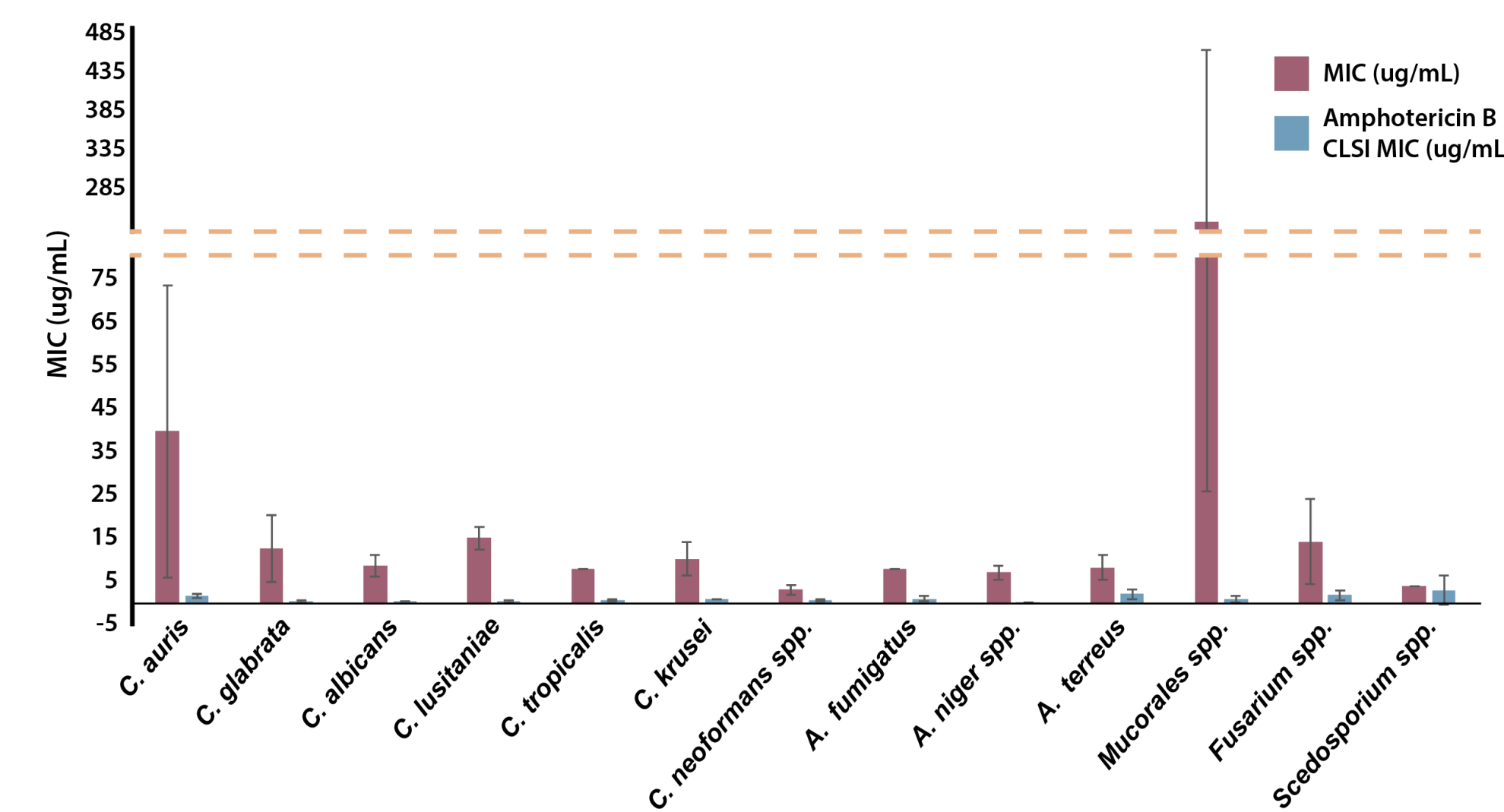


Figure 3. MIC of C24 QPEI in solution on different fungal strains. C24 QPEI displays activity against both Gram-positive and Gram-negative bacteria

#### Antibacterial effect of C24 QPEI

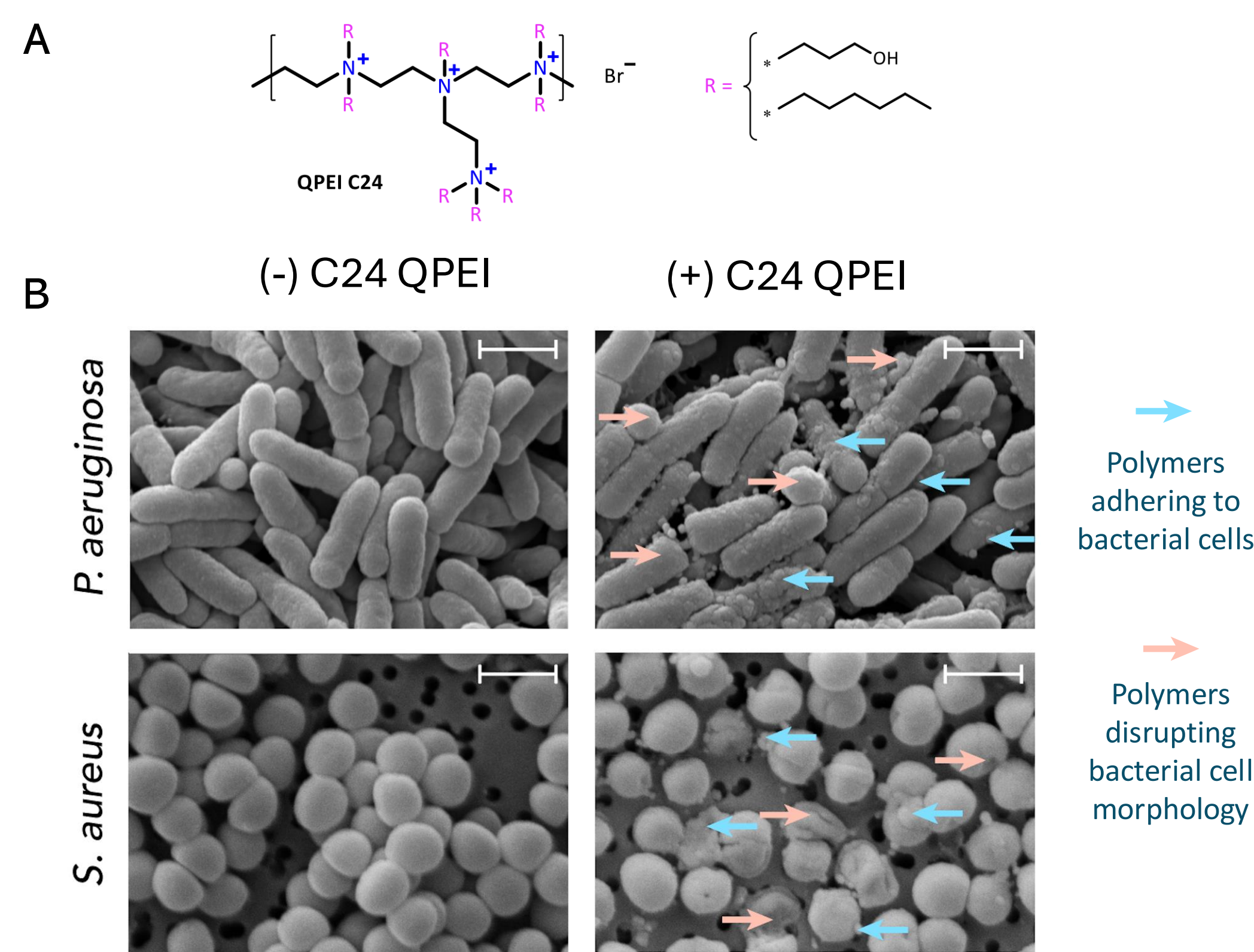


Figure 4. C24 QPEI molecular structure (A) and SEM visualization of the C24 QPEI capacity to disrupt bacterial cell walls (B)

#### Incorporation of C24 QPEI into wound dressings

##### C24 QPEI incorporation into gelling fibers

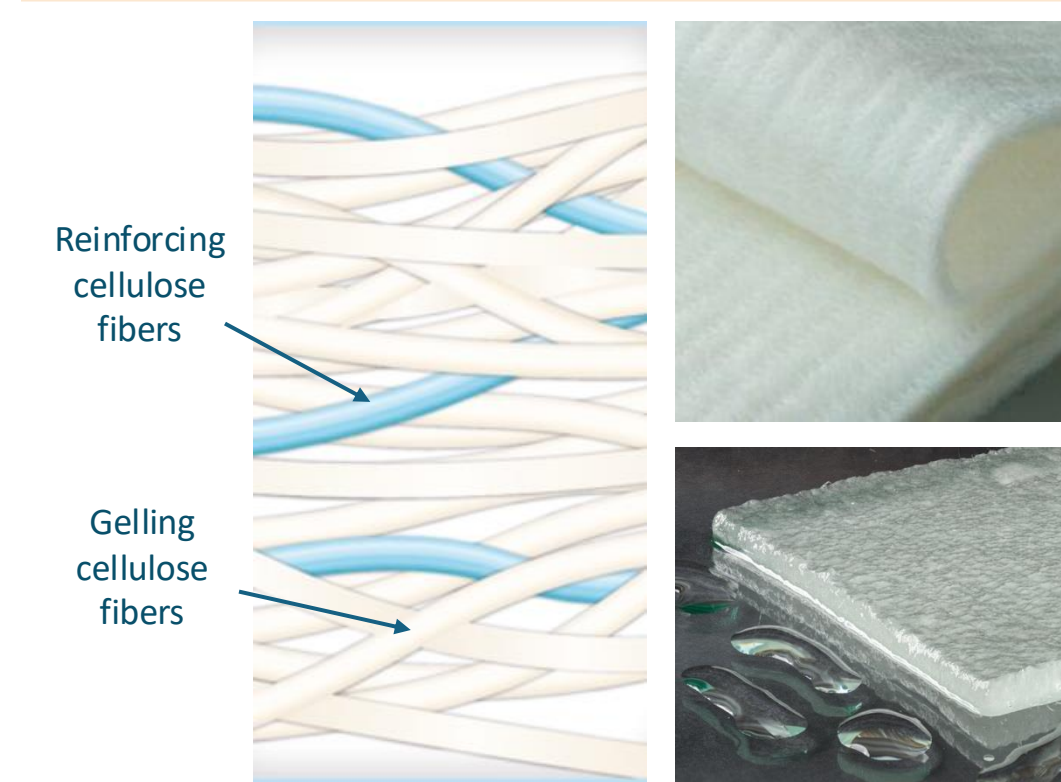


Figure 5. Representative image of gelling fibers incorporating C24 QPEI

- Gelling fibers: Sodium carboxymethyl cellulose (CMC) fibers that make a soft, conformable, non-woven wound dressing
- Scalable incorporation of C24 QPEI into gelling fibers containing antimicrobial properties
- Strong and stable binding between fibers and C24 QPEI

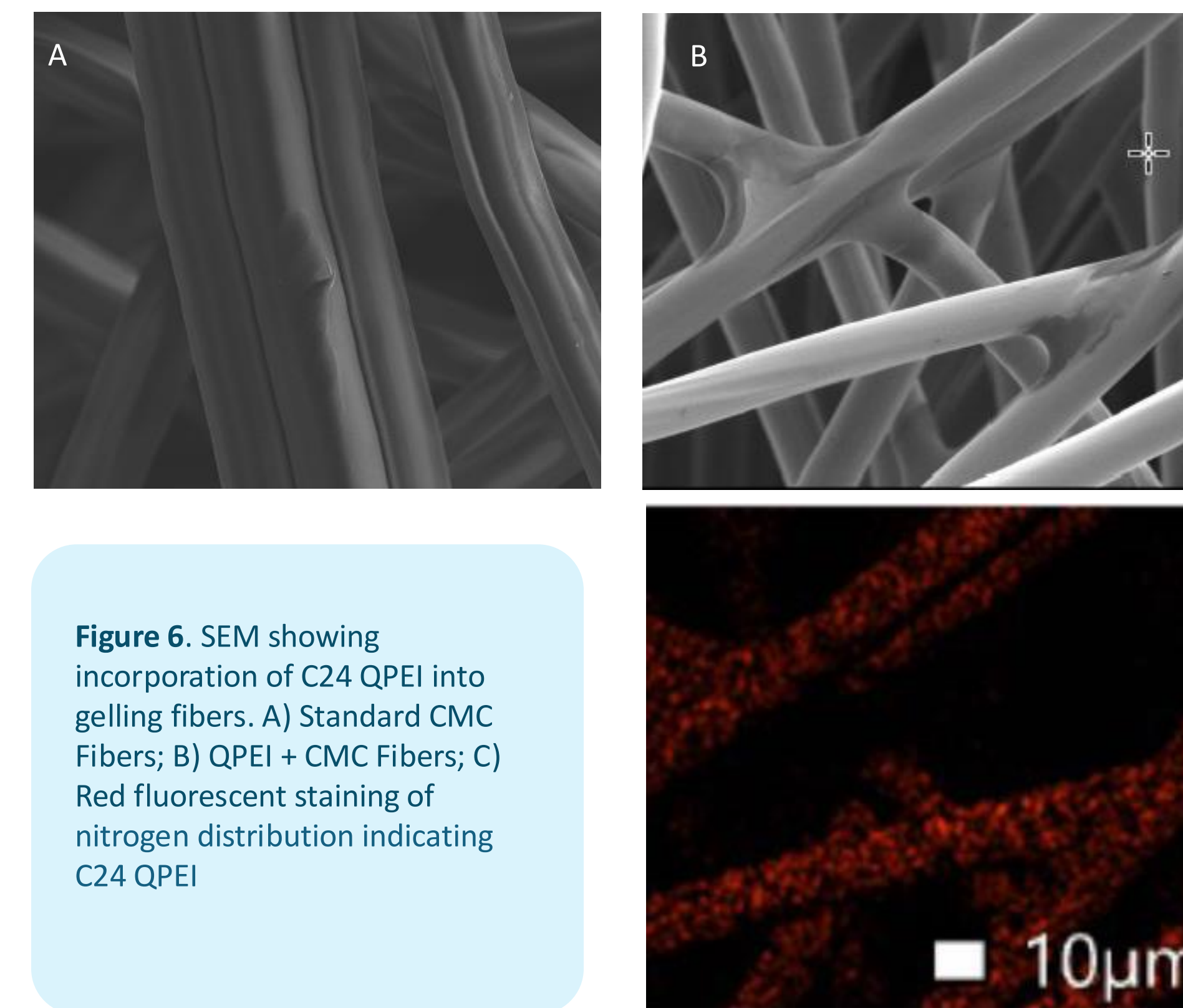


Figure 6. SEM showing incorporation of C24 QPEI into gelling fibers. A) Standard CMC Fibers; B) QPEI + CMC Fibers; C) Red fluorescent staining of nitrogen distribution indicating C24 QPEI

#### Performance of C24 QPEI-incorporated dressings

##### C24 QPEI-induced reduction in bacterial growth

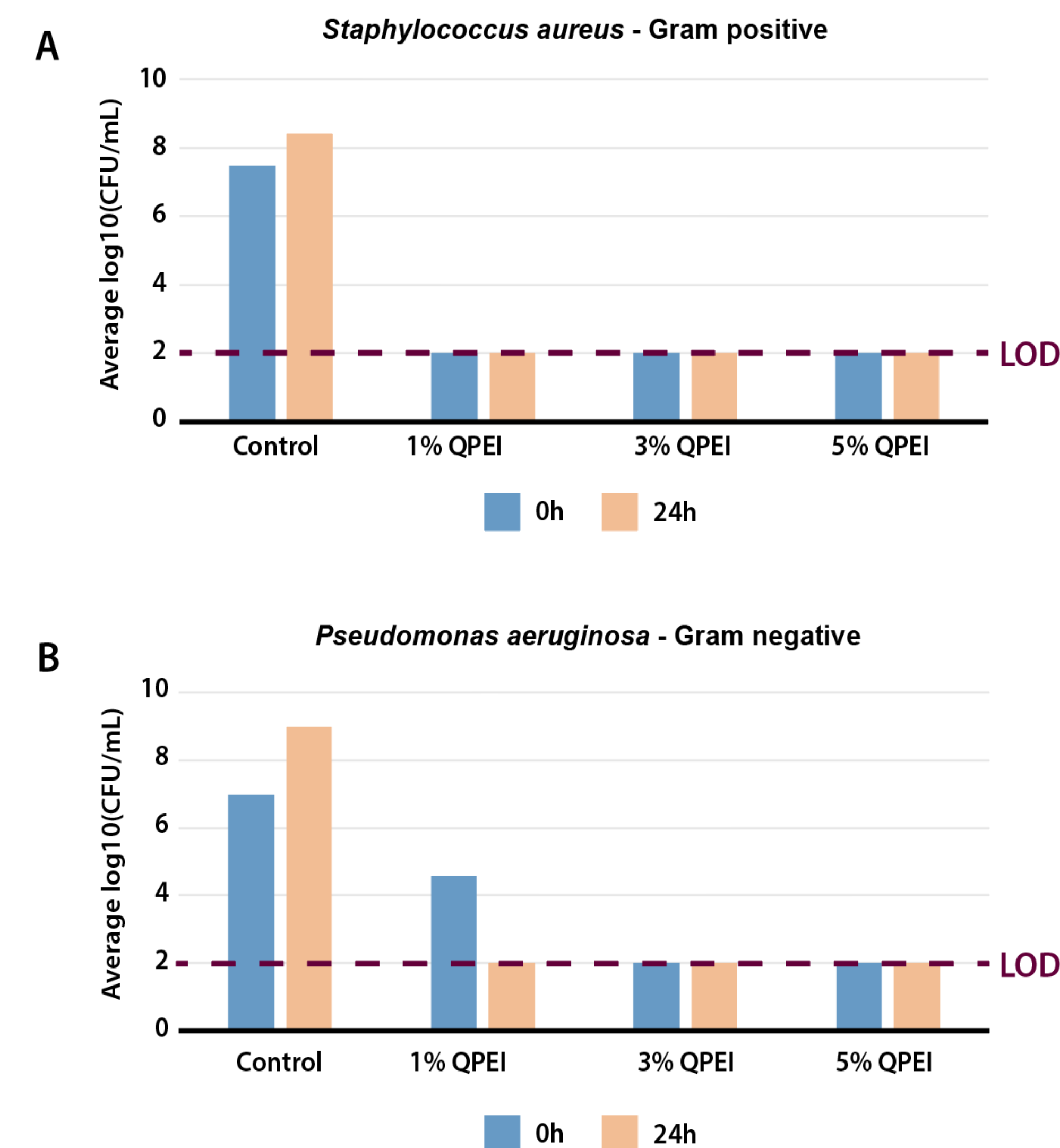


Figure 7. AATCC-100 test shows log<sub>10</sub> reduction in bacterial growth for (A) *S. aureus* and (B) *P. aeruginosa*. LOD = limit of detection.

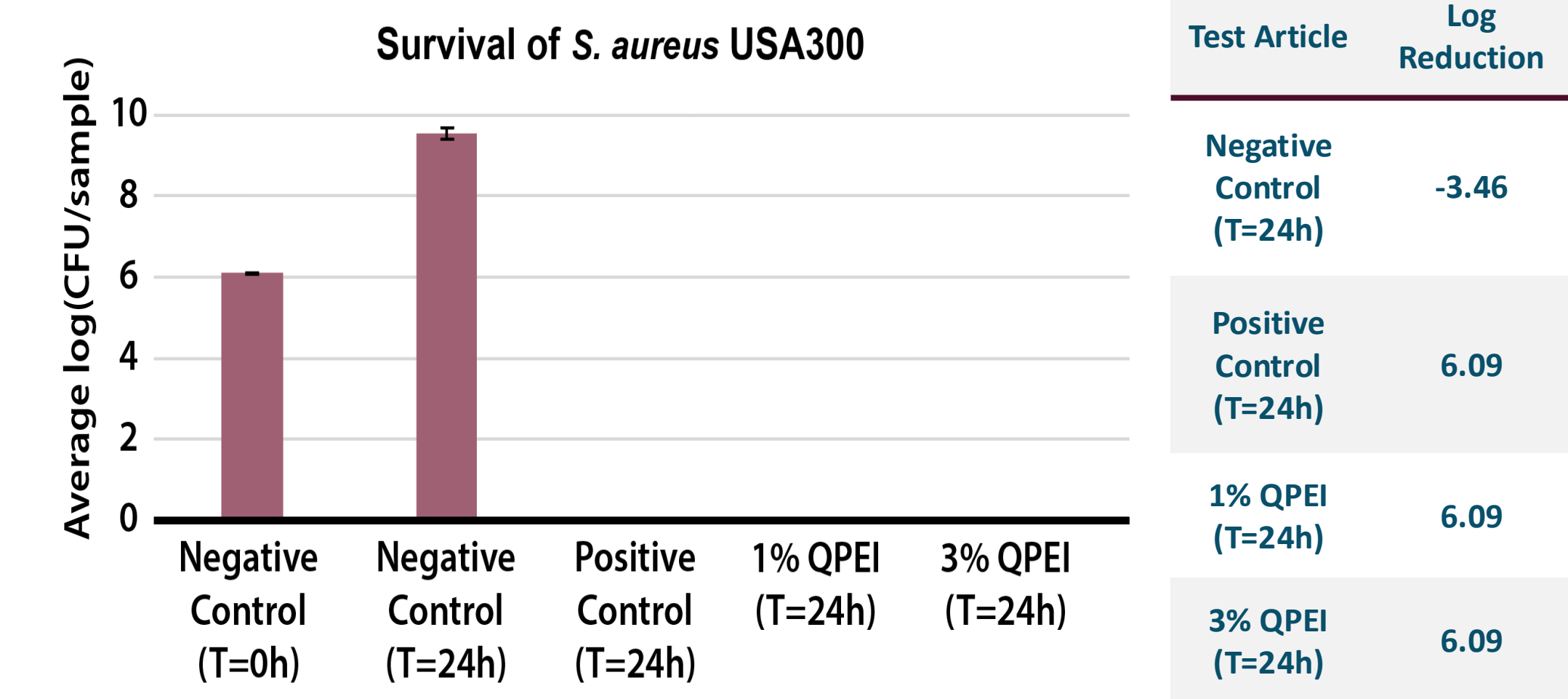


Figure 8. AATCC-100 after simulated wound fluid exposure. 6 days simulation of wear time demonstrate preservation of antimicrobial activity

#### C24 QPEI demonstrate effective antibiofilm activity

Table 1. Antibiofilm activity on a porcine skin model

Biofilm log reduction	Total protein difference compared to:	
	Untreated skin (%)	Control dressing (%)
CMC+C24 QPEI (1%)	>2.0	+78.84
CMC+C24 QPEI (3%)	>3.0	+76.09

#### C24 QPEI extraction in polar and non-polar solvents

Table 2. UV-VIS evaluation on CMC incorporating 1% C24 QPEI at 37 °C for 72 h

Hexane extraction	LOD
Water extraction	LOD
0.9% NaCl in water extraction	2%

## Conclusions

- C24 QPEI show **antibacterial efficacy** and **antifungal efficacy** over a wide range of micro-organisms.
- CMC incorporating C24 QPEI show **reduced bacterial growth** within the dressing compared to controls and are **effective in biofilm reduction** in a porcine skin model.
- C24 QPEI incorporation into wound dressings offers a **broad-spectrum** method to prevent bacterial growth by acting via a physical mechanism that **may bypass AMR**.

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