UV-based Sulphate Radical and Hydroxyl Radical Advanced Oxidation Processes for Antibiotic Resistance Gene Degradation

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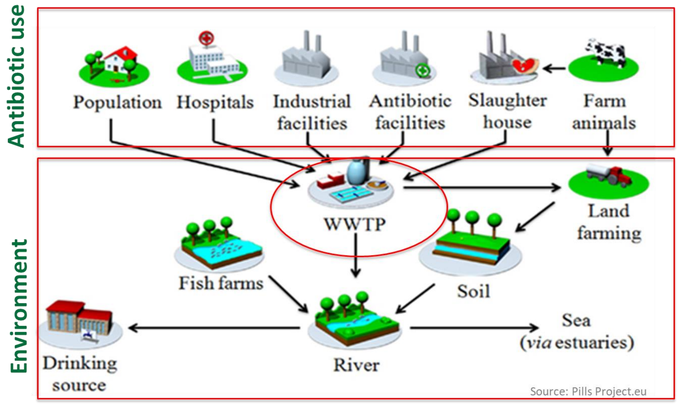
INTRODUCTION

Antibiotic resistance (AR) is a 'silent' pandemic.

Enteric antibiotic resistant bacteria (ARB) and antibiotic resistance genes (ARGs) have been discovered in raw water sources, wastewater effluents and drinking water[1]. Wastewater treatment plants (WWTPs) are identified as major sources of ARB and ARGs released into water environments. Effective wastewater treatment can serve as a barrier to the release of ARB and ARGs into the environment. Chlorination and UV inactivate ARB but ARGs are not effectively degraded. AOPs are promising technologies for AR mitigation. The fundamental kinetics of AOPs in ARG degradation and horizontal gene transfer prevention are necessary for setting treatment operating conditions.

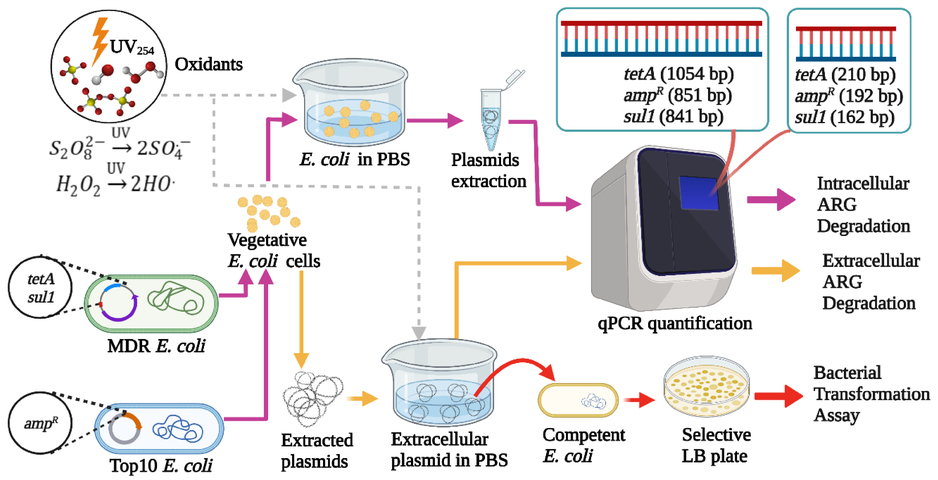


Research Questions

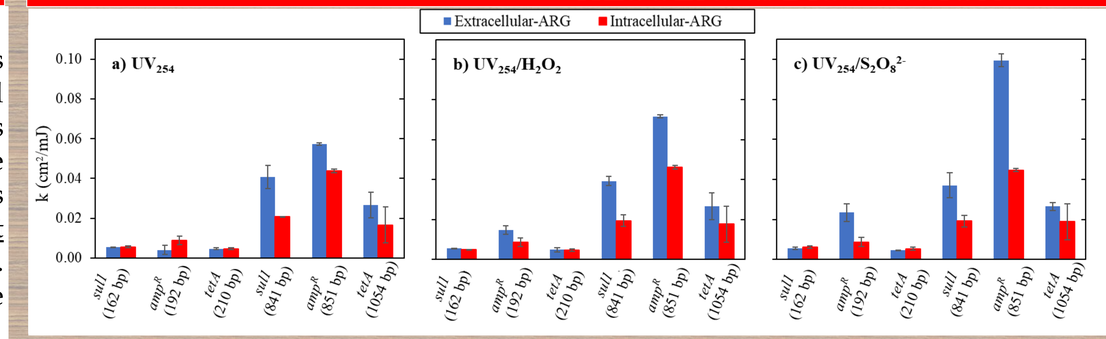
What are the effects of target qPCR amplicons on ARG degradation kinetics using UV_{254}, UV_{254}/H_2O_2, $UV_{254}/S_2O_8^{2-}$?

Is ARG degradation rate by qPCR a good estimate of ARG deactivation?

METHODS

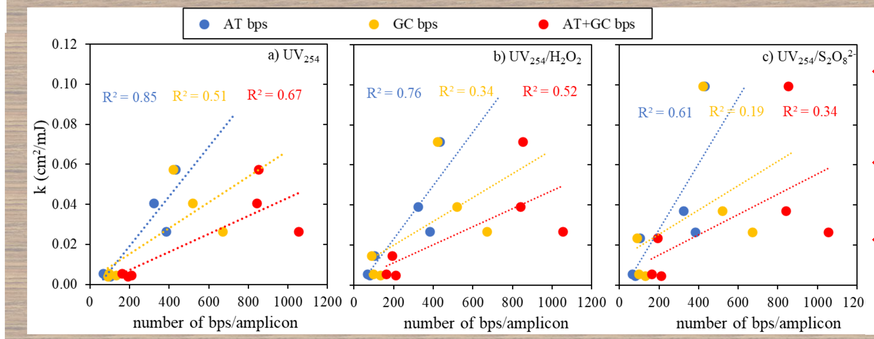


RESULTS & DISCUSSION



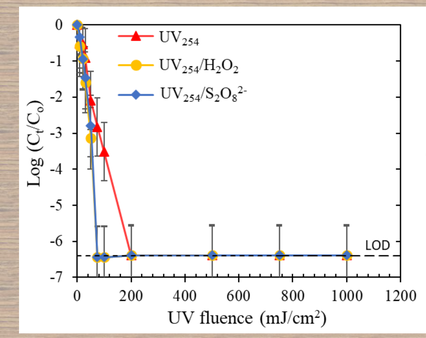
Degradation kinetics of ARGs (pH 7, 0.2 mM oxidant concentration)

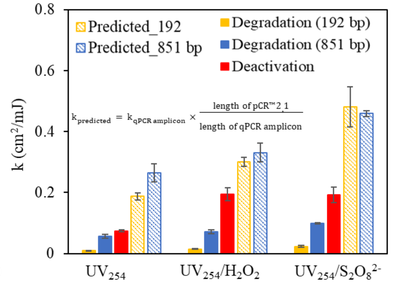
- $UV_{254}/S_2O_8^{2-}$ degraded ARGs faster than UV_{254}/H_2O_2 and UV_{254}. Extracellular ARG degraded faster than intracellular ARG.
- Higher degradation rate with longer qPCR amplicon.



Analysis of Nucleotide Contents

- **AT-rich** *ampR* amplicon degraded **faster** than GC-rich *tetA* and *sul1* for all treatments.
- Degradation kinetics showed weak relationships (<90%) with amplicon length.
- Other nucleotide element: singlets (A, T, G, C), doublets (AA, TT, CC, GG), triplets (AAA, TTT) or their combination influenced the relative reactivities.





Deactivation kinetics of ARGs

- ARG deactivation was **2.6 times** faster for $UV_{254}/S_2O_8^{2-}$ and UV_{254}/H_2O_2 than UV_{254}.
- Deactivation kinetics were **~8-13 times** faster than degradation kinetics observed for short ampR amplicon.
- The predicted degradation rates for the entire plasmid overestimated the deactivation of the plasmid.

CONCLUSIONS

- ARG degradation kinetics followed the order $UV_{254}/S_2O_8^{2-} > UV_{254}/H_2O_2 > UV_{254}$.
- Overestimation of the potential risks of ARG presence with short qPCR amplicon. Longer qPCR amplicon estimated ARG deactivation better than short amplicons.

ACKNOWLEDGEMENTS

Reference

[1] Stalder *et al.*, 2012. Front. Microbiol.

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