Enhancing the attenuation of antibiotic resistance genes in anaerobic digestion systems using conductive materials

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BACKGROUND

- Antibiotic resistance genes (ARGs) are prevalent in sewage by extension of the indiscriminate use of antibiotics.
- If these genes are not sufficiently attenuated during anaerobic digestion (AD), the recycling of digestate to arable land may constitute environmental and human health risks.
- This study explored the prospects of using granular activated carbon (GAC), a conductive material, to mitigate the proliferation of ARGs and enhance methane recovery during AD.

METHODOLOGY

- Two upflow anaerobic sludge blanket (UASB) reactors were fed with synthetic wastewater and operated for 33 days at 20°C. Granular activated carbon (GAC) was applied to one of the reactors while the other reactor without GAC served as the control (Figure 1).
- Methane yield was quantified via gas chromatography. Specific methanogenic activity (SMA) was accessed using acetate and H_2/CO_2 as substrates.
- The dynamics of ARGs in the sludge from the two reactors and in the biofilm attached to GAC was tracked through shotgun metagenomics (Illumina Hiseq). The sequencing data was analysed with ARGs-OAP pipeline (v3.1.1)[1].

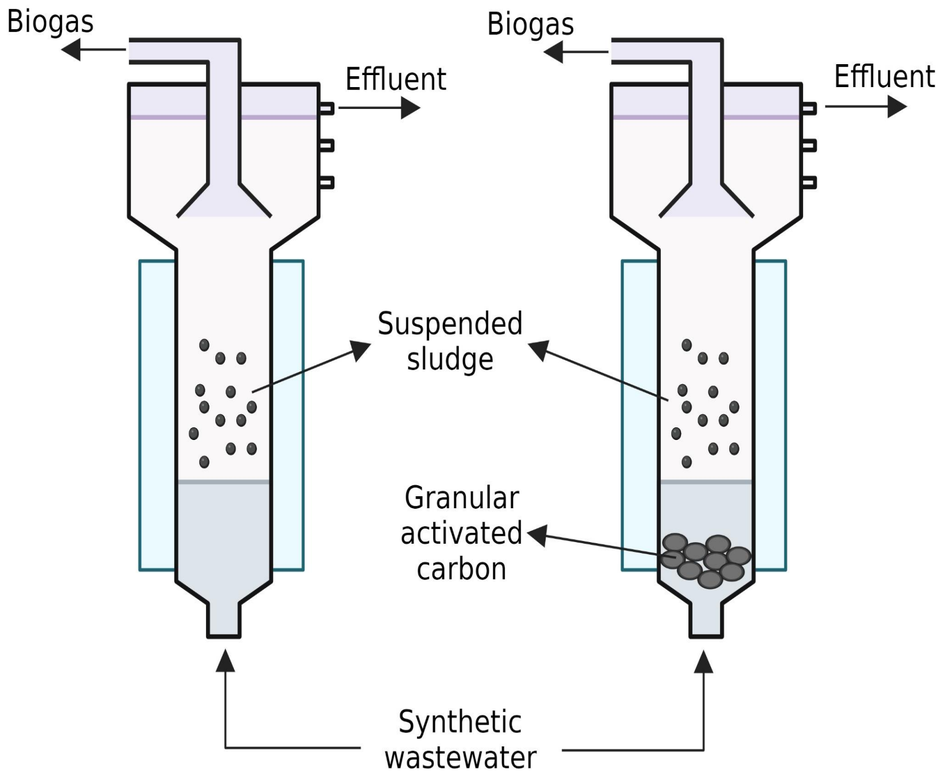

Figure 1: GAC-amended and unamended UASB reactors.

CONCLUSION AND NEXT STEP

- The addition of GAC to UASB enhanced the overall process performance, increasing methane recovery and attenuation of ARGs.
- The impact of GAC on methanogenesis may stem from its capacity to facilitate direct interspecies electron transfer (DIET).
- Further work to optimise ARG attenuation using conductive materials is underway.

PRELIMINARY RESULTS

- **Methane recovery**
  - The addition of GAC increased the daily methane yield by ~11% (Figure 2).
  - The removal efficiency of COD increased from ~81% to ~84%.
  - The GAC-amended reactor had about 82% higher acetate SMA and 24% higher H_2/CO_2 than the unamended reactor.

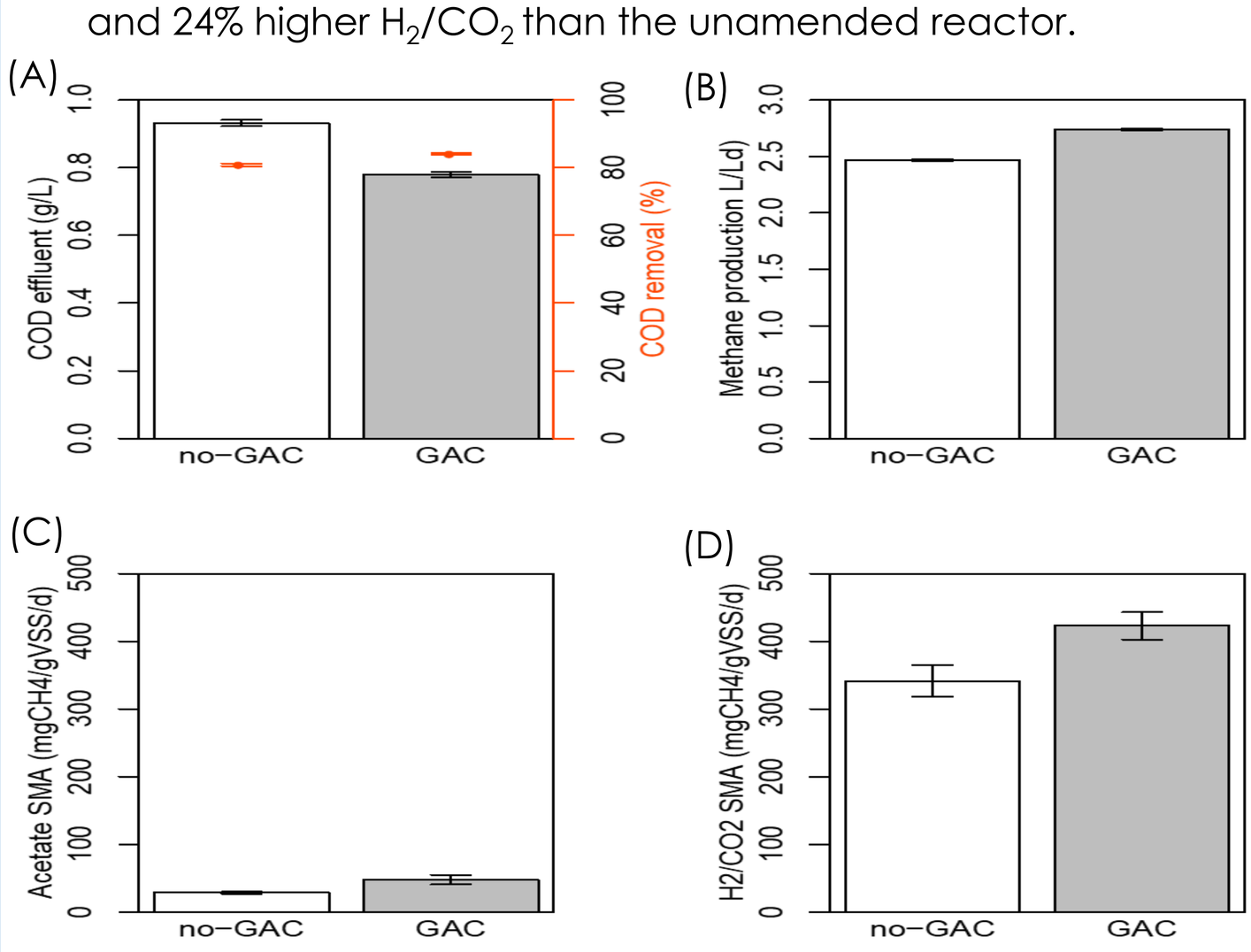

Figure 2: Comparison of COD removal (A), methane production (B), acetoclastic SMA (C), and hydrogenotrophic SMA (D) in GAC-amended and unamended reactors.

- **Dynamics of ARGs**
  - The abundance of ARGs in sludge and biofilm from the GAC-amended reactor were respectively 15% and 7% less when compared with the sludge from the unamended reactor (Figure 3).

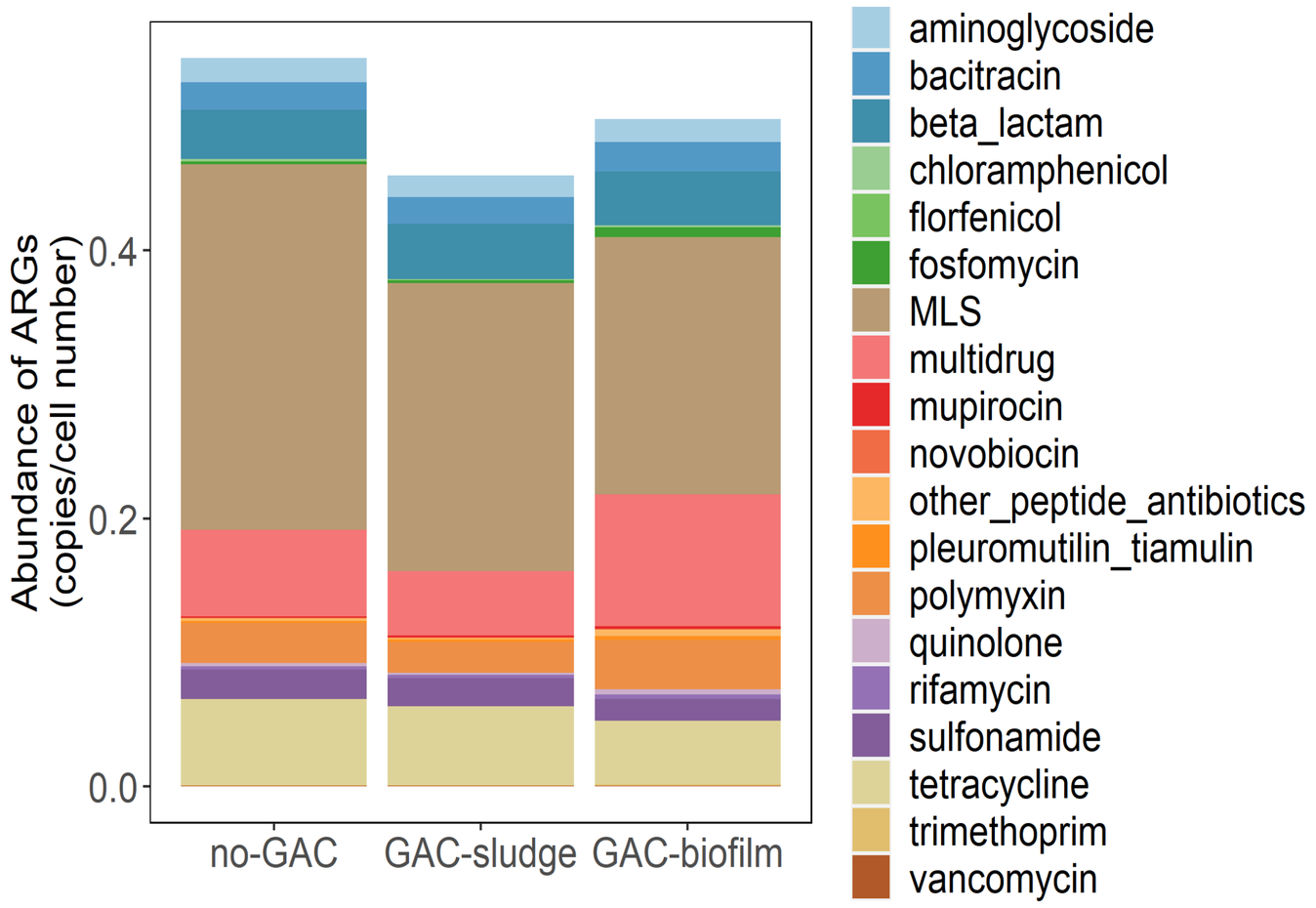

Figure 3: Dynamics of ARGs in sludge GAC-amended and unamended reactors.

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References
[1]Yin *et al.* (2018) *Bioinformatics.* https://doi.org/10.1093/bioinformatics/bty053