Representing EBNet Biochars for Pollution Prevention WG at the 10th International Conference on Engineering for Waste & Biomass Valorisation

Introduction

Two members of the EBNet Biochars for Pollution Prevention Working Group (WG) attended WasteEng2024 in Sendai, Japan where they gave two oral presentations, chaired a session, and presented a poster for a third working group member who could not attend.

Report from Dr Meredith Barr

Dr Meredith Barr, who coordinates the working group, presented her research on "Lignocellulosic and Poultry Litter Biochars as a Two-Pronged Approach to Plant Nutrient Regulation". This work focuses on controlling nutrient concentrations in soil using a combination of animal-waste-derived biochars as a slow-release fertilizer and plant-waste-derived biochars as a sorbent material. Adsorbing excess nutrients from soil and releasing them only as required by plants prevents pollution of waterways by excess nutrients from agriculture. Nutrient pollution results in algal blooms that shade and kill submerged plants, whose decomposition alongside that of the algae itself consumes oxygen vital to the survival of all aquatic organisms. Some algal blooms also produce toxins that threaten human health. Regulating soil nutrients controls the growth of aquatic (micro)algae in order to preserve the aquatic ecosystem critical to maintaining water security and aquacultural productivity.

Moreover, controlling nutrient concentrations in soil facilitates engineering the soil microbiome, ensuring plant health, agricultural productivity, and thereby food security.

The work Meredith presented considers how pyrolysis conditions affect the selectivity of nutrient leaching and sorption. Her group is investigating how the way in which biochars are produced affects which nutrients they release and immobilise in soil, which in turn affects their influence on the soil microbiome.

Poultry litter, being readily available on farms, is itself widely used by farmers as a fertiliser (in some cases so excessively as to be responsible for severe nutrient pollution in nearby waterways). When converted to biochar, nutrient release is not only slowed, reducing the risk of nutrient pollution, but poultry litter is also sterilised, neutralising the threat of pathogen pollution. Introducing pathogens from animal waste to agricultural land is a hazard to plant and human health with long-term effects on the soil microbiome. By pyrolysing this natural fertiliser, Meredith's research group engineers the composition of the soil microbiome by allowing symbionts to outcompete the far smaller concentrations of pathogens naturally introduced by wildlife. This work fits squarely within the EBNet Pollutants and Media theme, incorporating elements of engineering microbial systems at the Water-Wastes-Soil nexus. The research aims to prevent both soil and water pollution by valorising waste via control of environmental microbiota.

Outreach

Meredith also chaired a session on waste and biomass gasification. She invited the audiences of both her presentation and this session to join the EBNet Biochars for Pollution Prevention working group. Attendance of this conference as enabled by the travel bursary generously provided by EBNet has resulted in the discussion of several new collaborations as well as identification of a future conference of potential interest to working group members (Bio-Char IV).

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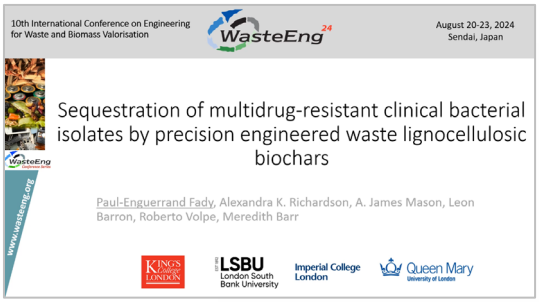
Report from Dr Paul-Enguerrand Fady

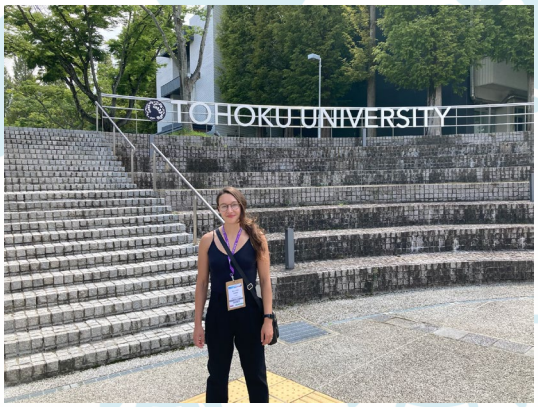
In August 2024, I travelled to the WasteEng2024 conference held Sendai (Japan) thanks to a generous travel bursary provided by EBNet. I was fortunate enough to be selected to present an interdisciplinary research project which arose from a collaboration between three members of the EBNet-funded "Biochars to Prevent Pollution" working group, led by Dr Meredith Barr. WasteEng2024 proved an excellent vehicle for disseminating our findings, as well as connecting with international experts in the fields of waste engineering and biochar applications.



The work in question concerns the design and development of bespoke biochars derived from waste lignocellulosic biomass, to create novel wastewater filters which remove both antimicrobial compounds and multidrug-resistant bacteria. This is an exciting application of technology to biological waste streams which contributes to the remediation of bacterial antimicrobial resistance (AMR). Bacterial AMR is a very serious health threat, directly responsible for 1.27M deaths/annum and linked to almost 5M deaths (as of 2019). The costly and inefficient development of new antimicrobials will not suffice to stem the rise of AMR, and novel solutions such as the one developed and tested by the three working group members are key to tackling this threat.

I presented our findings, which show (among other things) that upwards of 95% of specific drug-resistant clinical bacterial isolates and 91% of clarithromycin (an antibiotic which drives AMR development) can be removed from wastewater through inline filtration with our system. This was a fairly unique presentation at WasteEng, which was attended by few microbiologists and even fewer colleagues with clinical expertise. The presentation was well received and acted as a good catalyst for discussions around precision applications of biochars.

This project links applied microbiology (using patient-derived clinical strains) with engineering and systems optimisation of biochars from agricultural waste. Our work on fine-tuning the ability of biochars to sequester bacteria has a range of exciting applications at the water-wastes-soil nexus, including this preventative application but also developing a better understanding of the production conditions which could be employed in remediative soil applications (e.g. soil microbiome seeding). WasteEng2024 provided an excellent sandbox for exploring these thoughts with colleagues from all different disciplines.



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