Enhancing the biomethane production of alkaline pre-treated lignocellulosic waste through bioaugmentation of anaerobic digestion

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Introduction

- The ongoing energy crisis is characterised by i) increased natural gas and fossil fuel costs, ii) growing energy demand & iii) insufficient energy supply
- Current waste management routes are deemed inefficient due to their i) negative environmental impact & ii) high energy requirements
- Anaerobic digestion (AD) is a waste-to-energy technology that can confront global waste and energy issues
- Lignocellulose waste has a rigid physicochemical structure: incomplete hydrolysis, slow degradation rates & low yields
- Bioaugmentation of cellulolytic microorganisms offers the potential to increase biomethane production of lignocellulosic biomass and lower operational costs

Aim and Objectives

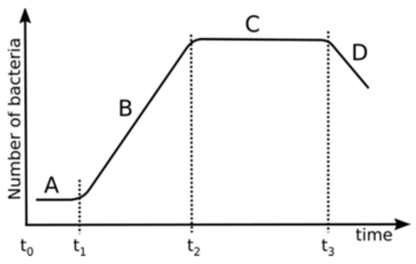
To assess the potential of bioaugmentation using facultative, cellulolytic microorganisms to enhance the production of biomethane using corn stover as the primary substrate. This will primarily be achieved by:

- Investigating biomethane yields output using alkaline pre-treatment and optimising the C/N ratio (20:1; 25:1; 30:1)
- Determining the enhancing effect on biomethane yield using augmented bacterial pure cultures: BMP level
- Investigating the bioaugmentation effects & structural changes in the microbial community : pilot-scale level

Methodology

Substrate preparation & characterisation

Pre-treatment process & analysis



Microbial calibration curves & enzyme assays

BMP (bench-scale) AD: C/N optimisation & bioaugmentation ($4x10^{10}$ CFU/mL) microbial loading tests

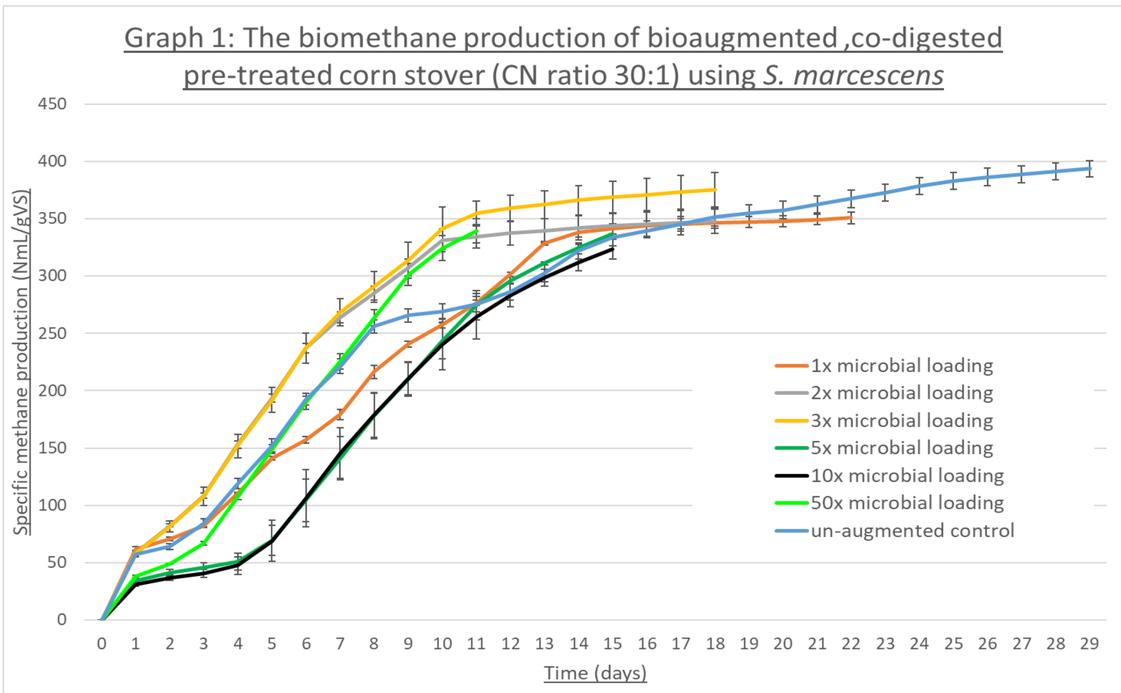
Pilot-scale AD tests & and microbial community structure analysis

Current Conclusions

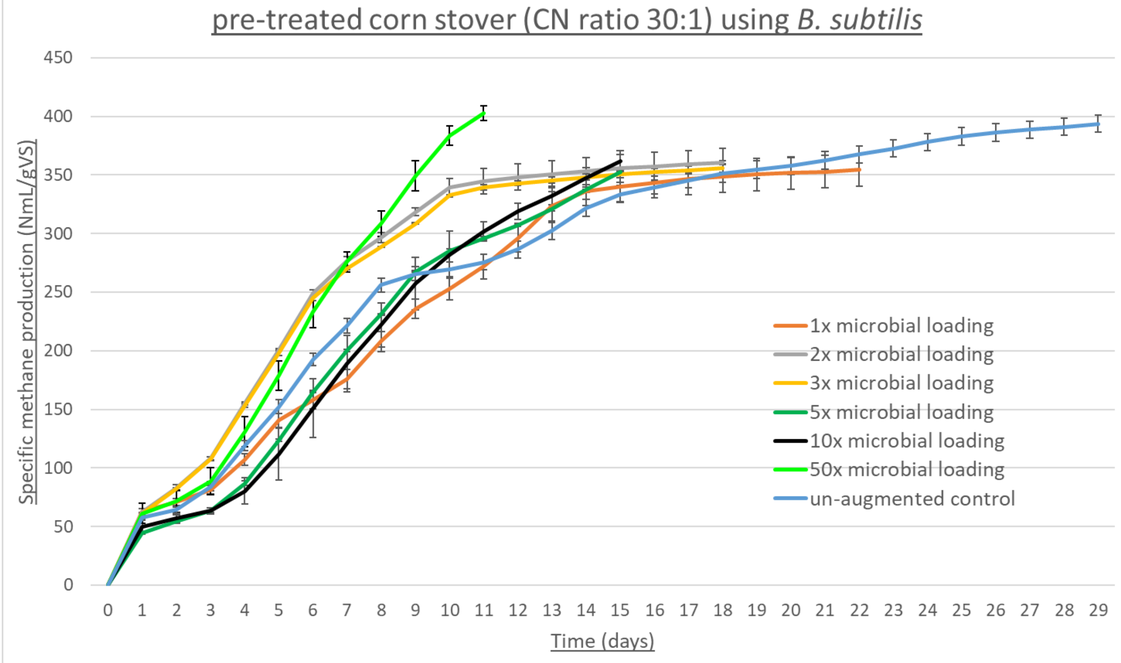
- Co-digestion (C/N ratio 30:1) with food waste provided the highest un-augmented results
- Bioaugmentation of all three strains, for all microbial loadings (using a standardised $4x10^{10}$ CFU/mL) showed shortened retention times
- Bioaugmentation with 50x microbial loading (in progress) potentially offers enhancement of biomethane yield

Main Results

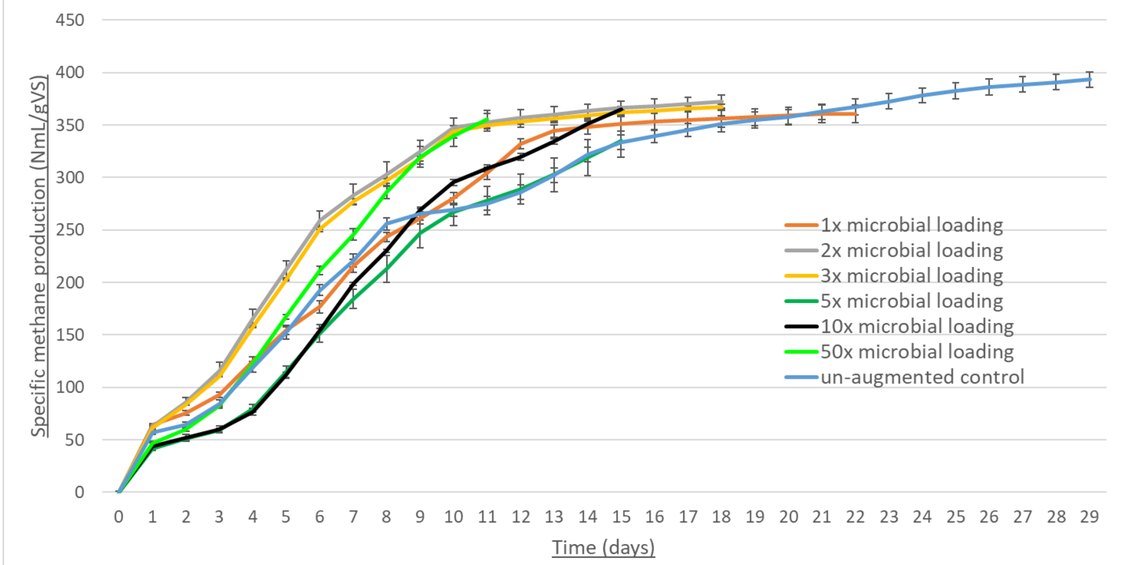
Graph 1: The biomethane production of bioaugmented ,co-digested pre-treated corn stover (CN ratio 30:1) using *S. marcescens*



Graph 2: The biomethane production of bioaugmented ,co-digested pre-treated corn stover (CN ratio 30:1) using *B. subtilis*



Graph 3: The biomethane production of bioaugmented ,co-digested pre-treated corn stover (CN ratio 30:1) using *B. licheniformis*



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