AN INTEGRATED APPROACH TO EXPLORE A NOVEL PARADIGM FOR BIOFUEL PRODUCTION FROM LIGNOCELLULOSIC FEEDSTOCKS

PRINCIPAL INVESTIGATORS

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ABOUT THE PROJECT

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In this project we intend to demonstrate that it is more sensible (logical and economic) not to pre-treat lignocellulose so harshly, and have a more "holistic" approach to the process delivering the desired products whilst minimising overall process energy and cost by working on the optimisation of generating partial breakdown products and ensuring that the subsequent fermentation organism is able to convert these directly to product. The most commonly employed class of fermentation organisms – yeasts – will be engineered to be able to convert the oligomeric sugars directly. However, there is a class of organisms – Geobacillus – that have been quite extensively studied by one of the UK groups, which already naturally has the propensity to utilise oligomeric sugars and can also be readily engineered to optimise key metabolic pathways. Therefore, in this project we will use a representative of this group of bacteria to compare performance with the engineered yeast. We also propose to consider three different lignocellulosic feedstocks in this study, all of which have the potential to be used for sustainable fuels and chemicals production: Brazilian cane straw – which is current left in the fields after harvesting, Miscanthus – which is grown in the UK for burning in power stations (co-firing) and has a lot of similarities to cane straw, and Eucalyptus forestry residues, which are abundant in Brazil and represent a different type of opportunity and material to evaluate. Some of the team involved will focus on developing methods to convert these to oligosaccharides that can be taken up by these new strains. This will be a combination of less severe (than currently) pre-treatment and the use of selected enzymes to produce the oligo-saccharides required. Another part of the team will focus on producing the enzymes required for these conversions to oligosaccharides, while a third group will engineer the yeast strains to use oligosaccharides of both xylose and glucose. To increase the energy efficiency of the feedstocks in the new lignocelulose mills we are going to recover chemicals and biogas from the liquid effluents, vinasse and hemicellulose hydrolysates, by integrating anaerobic digestion (AD) to the process. AD with mixed culture fermentation will improve the energy ratio bringing biogas production and fertilizers as products. Underpinning all this is the need to ensure that the outputs of this work remains relevant to the industry processes that they potentially feed into. Therefore, we have a team of LCA experts ensuring that feedstock/ product choice is appropriate, that the proposed process optimisation approaches are delivering a positive impact on process performance and pinpointing where further changes/ modifications could be made to further improve matters.