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Towards improved bioprocess kinetics for C1 feedstock fermentation in acetogens

Petrochemical-derived commodity chemicals are a non-sustainable source of bulk chemicals produced on a large scale to satisfy global demands. However, their significant contribution to increasing carbon dioxide levels has promoted research into alternative production methods to make these chemicals from renewable or sustainable sources. In this project we aimed to develop an enzyme system that could be used at a commercial level for the biological utilization and specifically its incorporation into the synthesis of (R)-1,3-butanediol (1,3-BDO) initially by using purified enzymes and subsequently by cloning the genes for the enzyme system into an organism that can grow on simple C1 gases. The current production of (R)-1,3-BDO is not very efficient and hence the cost of this specific enantiomer is very expensive. Our biochemical pathway allows for the specific synthesis of the (R)-enantiomer and hence by improving the yields of material from a biological source there is an opportunity to produce this material in a cost-effective manner. The work has been built on technology held by both our industrial partner, ZuvaSyntha, and the University of Kent. The project was focused around an enzyme that has an interesting side reaction – that is it is able to convert acetaldehyde into 3-hydroxybutanal. The enzyme, DERA, was engineered in such a way that this activity was increased. We identified a number of variants of this enzyme with improved enzymatic activities in comparison to the wild type enzyme. The enzyme was then targeted to specific regions in the cell to allow its effective concentration to become much greater and hence allow greater flux of the unstable acetaldehyde through the pathway. This project therefore applied synthetic biology approaches to a current real-world problem and in so-doing has developed technology that has clear benefit to industry. The project will keep the UK at the cutting edge of metabolic engineering and in delivering process-led innovation to meet the demands of industry. This project has shown that the research has the capacity to generate a safe, reliable, renewable (non-petrochemical) and affordable source of this commodity. The researcher involved in the project has acquired a broad range of new skills and techniques thereby helping in their personal development.