Popular science summary

As the world struggles with the environmental impacts of the plastic industry, finding sustainable alternatives is crucial. In 2023, over 400 million tonnes of plastic were produced, a number that is only expected to increase. Traditional plastics, derived from fossil fuels, contribute significantly to greenhouse gas emissions, making the shift towards a circular and sustainable economy. One promising solution is the production of biobased plastics, which are made from renewable resources like the biomass of plants.

An important chemical derived from plant biomass is 5-hydroxymethylfurfural (HMF), which is used as a platform to produce valuable compounds. This project explores the potential of HMF as a precursor of 2,5-furandicarboxylic acid (FDCA), a biobased compound that can be used to create more sustainable plastics.

FDCA is particularly promising because it is a fundamental ingredient in producing polyethylene furanoate (PEF), a sustainable alternative to conventional plastics like PET. The process of converting HMF to FDCA involves different reaction steps that can be done by chemical (involving high energy consumption) or biological methods, which can sometimes be inefficient.

The research aimed to improve this conversion process by using genetically modified bacteria. *Gluconobacter oxydans* is a recognized bacteria used in the biotechnology industry to produce valuable compounds. This bacterium is capable do most of the conversion steps fron HMF to FDCA, except for one intermediate (HMFCA). By modifying *G. oxydans* and another bacterium, *Escherichia coli*, it was expected to achieve a full conversion of HMF into FDCA.

The study showed that by using only *E. coli*, an 84% conversion of HMFCA to FDCA was achieved. On the other hand, using *G. oxydans* led to complete conversion of HMF, and a 90% conversion of HMFCA to FDCA. The most exciting result of the study was using both bacteria together, which made the process more efficient and showed potential to scale up the production of FDCA.

This research contributes to the field of biotechnology aimed at creating sustainable materials. By enhancing the efficiency of HMF conversion through genetic engineering, the future to an increase in the production of eco-friendly plastics is coming closer, benefiting both society and the environment. Future studies will focus on optimizing these processes and scaling up production to meet global demands.