Synthetic Microbial Communities for the Production of High-Value Compounds

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Motivation

Microbial communities have gained attention as production platforms for high-value compounds due to certain advantages over traditional single-strain methods, such as increased substrate utilisation and division of labour strategies[6]. Community simulation methods can be used to screen for optimal community compositions *in silico* and guide selection of community members. This master project, which is part of the Cell4Chem project, aims to **evaluate the predictive abilities of current methods for genome-scale metabolic modelling of synthetic communities** by comparing simulated results with results from real case-studies. The goal is to identify and understand the current limitations of these methods.

Cell4Chem

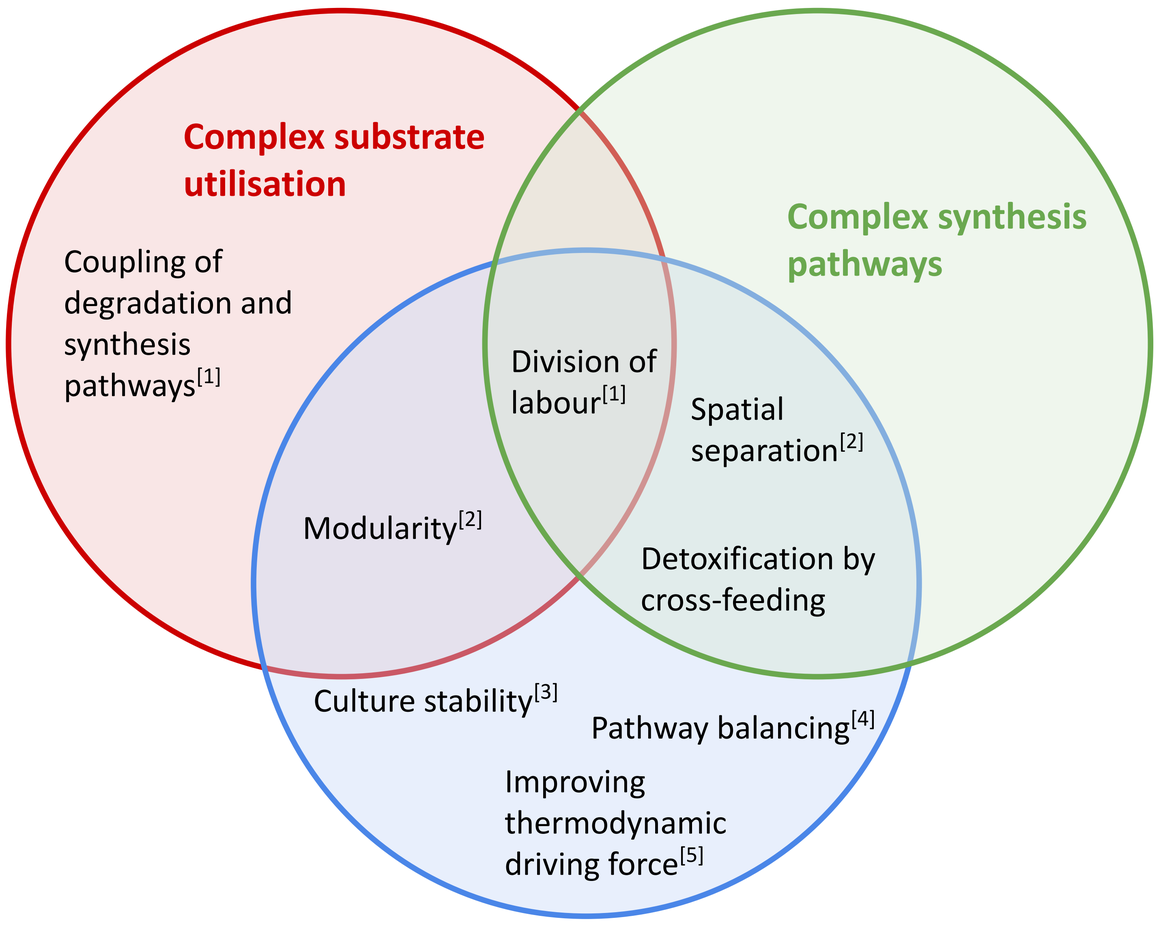
Cell4Chem is a collaborative project between several European institutions. The project goal is to design and build a microbial consortium for the production of industrially valuable **medium-chain carboxylates** (MCC) from lignocellulosic biomass. The main stages of the project consist of:

- engineering metabolic specialists for cellulose degradation and lactate production
- combining engineered strains with WT strains into a consortium for MCC production
- process engineering to steer fermentation towards MCC formation

In order to guide the design of the synthetic consortium for optimal MCC production, genome-scale metabolic models will be used to screen for consortia compositions with the predicted highest theoretical MCC yields.

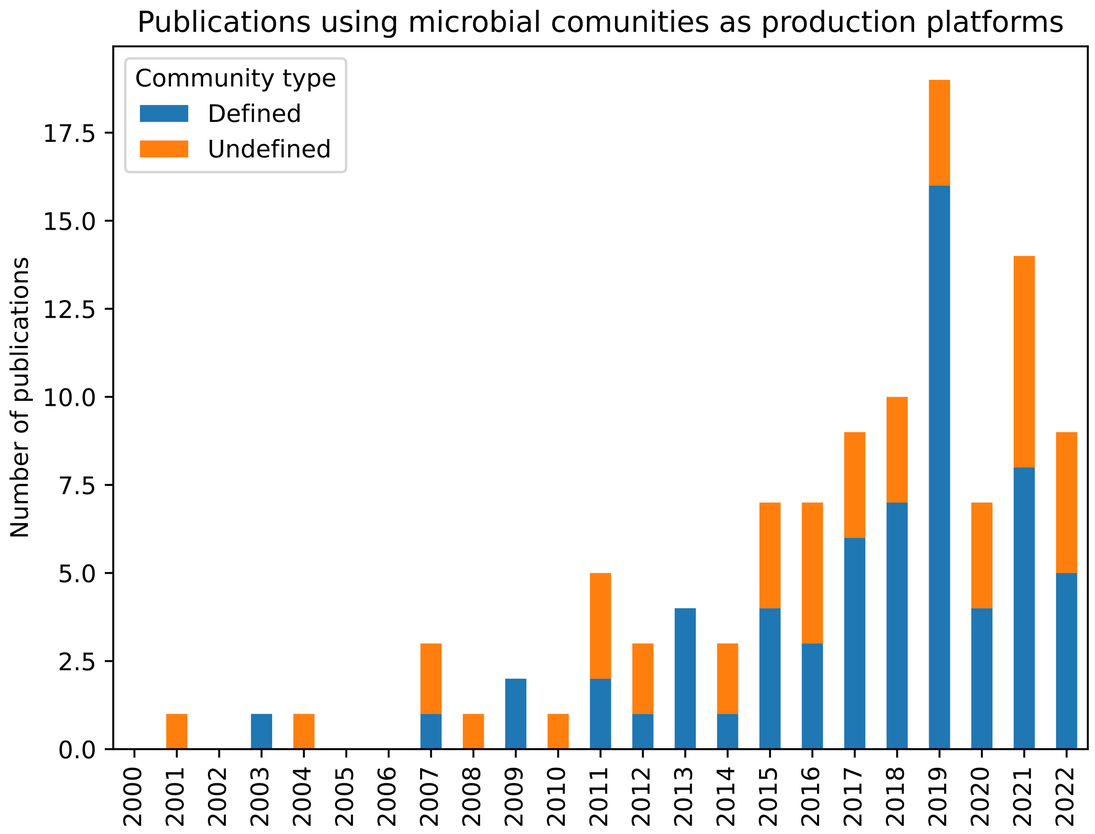
Why use consortia?

Community platforms have shown **improved production yields** over monoculture methods, and can make **more complex pathways** feasible.



Literature survey results

A literature survey of 112 case studies from 2000 to 2023 where microbial communities have been used to produce a target compound showed:



- There is an increased interest in **microbial communities as production platforms** for industrially relevant products.
- **Glucose** and **lignocellulose** are the most common substrates.
- ***E. coli*** and ***Clostridium*** bacteria are the most common community members.
- There is high diversity in products, ranging from simple alcohols (butanol, ethanol) to complex plant compounds.
- For undefined communities the majority of studies are concerned with hydrogen gas production from waste products.

Lignocellulose is an **abundant**, **renewable**, and **inexpensive** resource, and is suggested as an alternative to high-cost refined sugars and edible biomass[1]. Several community studies have therefore been motivated by engineering communities to utilise lignocellulose as substrate in combination with the production of high-value compounds.[1, 2]

Master project description

Goal: identify and understand the current main limitations for designing synthetic microbial consortia using genome-scale metabolic models.

- Literature search of successful cases where microbial communities have been used in production of industrially relevant compounds
- Build or retrieve genome-scale metabolic models for strains, and attempt to reproduce experimental results from case studies using different community simulation methods
- Compare simulated and experimental results and discuss limitations and possible improvements to modelling frameworks

References

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