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Production of organic acids and pH regulation in yeast and filamentous fungi

Increasing concern about climate change and fluctuation in fossil fuel prices has accelerated interest in development of new biomass based products and production possibilities. There is a huge potential for the creation of surplus value commodities from renewable sources, especially from biomass unsuitable for food production. Microbial production of organic acids can provide an environmentally sound, sustainable way of producing industrial chemicals.

My PhD thesis is related to the production of organic acids in yeast and filamentous fungi and addresses questions related to acid and pH tolerance and pH homeostasis, in order to develop efficient production hosts. For this research I employ a range of techniques including metabolic and bioprocess engineering, transcriptomics and bioinformatics.

My aim is to investigate and to develop via metabolic engineering new biocatalysts for the production of platform chemicals and monomers for synthesis of novel biopolymers from biomass sugars. Fungi that are metabolically engineered to produce specific organic acids are characterized, so that by understanding the physiology of the strains, the acid production capacity can be increased. Weak organic acids occur naturally and several organic acids are effective in preventing microbial growth. Production of such acids causes severe stress for the production host, whether it is an engineered strain or the strain naturally produces the compound. In particular, producing cells have to maintain their intracellular pH homeostasis in an increasingly acidic growth environment and adapt to stress caused by the produced acid.

We have produced high levels of D-xylonic acid from D-xylose with the yeast *Kluyveromyces lactis* and *Saccharomyces cerevisiae*. These yeasts were metabolically engineered to express heterologous D-xylose dehydrogenase from various sources. Studies of the physiology of the production hosts have shown that the cells accumulate large amounts of D-xylonic acid in the cytoplasm. Ongoing studies will consider the challenges which this creates for the host organism, as well as possible solutions.

The PhD thesis is part of the Finnish Centre of Excellence in White biotechnology – Green chemistry research within the field of producing chemicals and materials from renewable resources.