Product emulsification in multiphase fermentations

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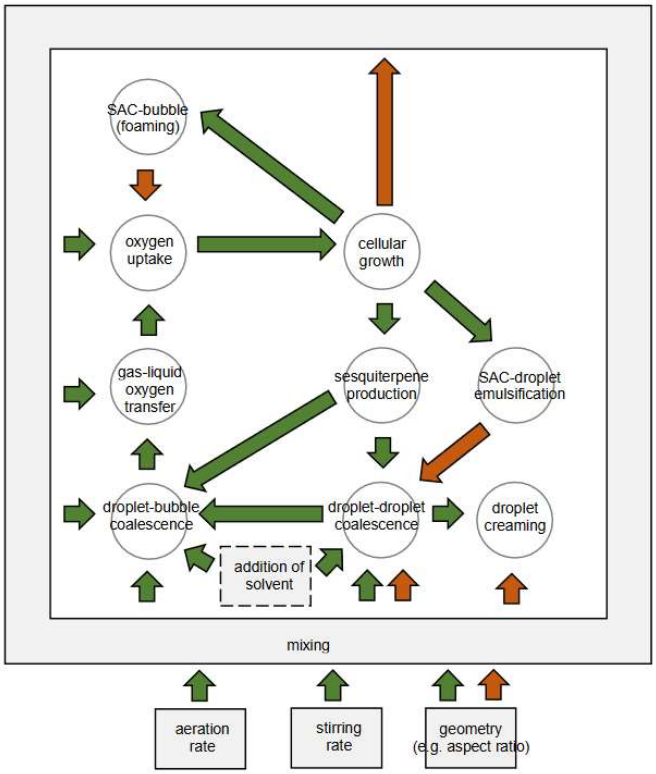
Description

Sesquiterpenes are a versatile group of 15-carbon molecules, traditionally extracted from plants for diverse applications ranging from fuels to fine chemicals and pharmaceuticals.

The challenges of microbial sesquiterpene production process addressed in this thesis are the emulsification of the product in the reactor, the loss of product in the off-gas due to evaporation, and the modification of the gas-liquid oxygen transfer mechanisms in a multiphase system. These issues derive from a complex network of mechanisms, where the modification of one parameter has an effect in several aspects of the process. For example, when production pathway is coupled to growth metabolism, cellular growth can lead to sesquiterpene production. This increases the concentration of oil phase, which in turn enhances the rate of droplet-droplet coalescence. Consequently, there is a larger averaged droplet size and droplet creaming is enhanced. On the other hand, higher cell concentrations imply higher concentration of SACs in the medium (e.g. extracellular proteins, exopolysaccharides, cell, cell debris), which can stabilize droplet and bubble surface preventing droplet growth by coalescence. In addition, the viscosity of the fermentation broth rises with the concentration of cells. This reduces the degree of mixing in the system, affecting coalescence, creaming and oxygen transfer mechanisms. Although the insolubility of sesquiterpenes in the aqueous medium can be advantageous for product recovery, the complexity of a multiphase system should not be underestimated when scaling-up the production process.

In this work, the different mechanisms, their interconnections, and their impact on the process scale-up have been studied.



Dissertation

Pedraza-de la Cuesta Cuesta, S., Product emulsification in multiphase fermentations: The unspoken challenge in microbial production of sesquiterpenes. PhD Thesis, Delft University of Technology, 2019.

Publications from the dissertation

Pedraza-de la Cuesta Cuesta, S., Knopper, L. , van der Wielen, L. A. and Cuellar, M. C. (2019), Techno-economic assessment of the use of solvents in the scale-up of microbial sesquiterpene production for fuels and fine chemicals. Biofuels, Bioprod. Bioref., 2019. 13: 140-152.

Pedraza-de la Cuesta, S., Keijzers, L., van der Wielen, L.A.M., Cuellar, M.C., Integration of Gas Enhanced Oil Recovery in Multiphase Fermentations for the Microbial Production of Fuels and Chemicals. Biotechnol J, 2018.;13(4):e1700478.