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Aggregation of microbial cells for improved fermentation

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The Jožef Stefan Institute has developed a method for controlled aggregation of microbial cells. The method is useful in different biotechnology fields such as plant and food biotechnology, environmental biotechnology, fermentation, remediation, biofouling, etc., where fermentation is employed. Partners are sought for technical cooperation or joint R&D projects to validate the technology in industrial environment.

Recently, microbiological research has indicated that the individual placement of particular cells is important for community functioning, since the microbes can transfer metabolites more efficiently, produce biofilms and develop particular niches based on the local physicochemical properties.

The systems of microbial (co-)culture are hard to optimise due to different growth dynamics of the strains and increased distances between cells when complex substrates are broken down to the level that is acceptable for use by producers of substances. For example, scavenging oxygen is hard to monitor within the whole culture and currently there are no easy ways to do this. Also, the fermentation process is often separated into two steps, aerobic and anaerobic, and managing the process with currently available techniques is limited in efficiencies due to the large distances between the cells.



The Jožef Stefan Institute has developed a method for controlled aggregation of microbial cells, which enables close contact between cells thus improving the fermentation. The interactions facilitate (i) exchanging growth substrates, secondary metabolites as well as quorum sensing molecules, (ii) scavenging oxygen due to the local increase of the oxygen consumption, enabling the formation of anaerobic niches within the aggregates.

Advantages

- Aggregated microbes transfer metabolites, produce biofilms and develop particular niches properties more efficiently
- Fermentation process is simplified and optimized by fewer necessary steps
- Biofilm grows up to 10.000x faster

The novel method enables layering of the microbial cells of the same or different type in a way that controls the size, structure and number of aggregates as well as the potential spatial distribution of the different species of cells within the aggregates. Microbial cells are coated with charged polyelectrolytes as well as magnetic nanoparticles, which enables building layers of microbial cells. The process is schematically shown in Figure 1. A laboratory experiment was successfully conducted on *Escherichia coli, Lactococcus lactis,* different *Staphylococcus* spp. and *Bacillus* spp. strains, and the cells were separated from the solution.

The technology has been developed at the Jožef Stefan Institute and IMMT d.o.o., Slovenia. The Jožef Stefan Institute is leading Slovenian research institute with more than 1000 employees. The research group of the Department of Environmental Sciences comprises experts in the field of microbiology, molecular biology, microbial genetics and microbial ecology.

We are looking for partners who use fermentation in their production process and would jointly test and apply our developed method in the frame of technical cooperation or R&D project.

Figure 1: Schematic illustration of cell aggregation mechanism.

Stage of development

TRL 3 Proof-of-Concept Demonstrated

Intellectual property Patent application filed in 2019

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