Application of Raman spectroscopy for optimizing and control of synthetic co-culture processes

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Project Description

In nature, microorganisms live in multi-species communities allowing microbial interactions. These interactions are lost upon establishing a pure culture, increasing the metabolic burden and limiting the metabolic potential of the isolated microbe. Therefore, synthetic microbial co-cultivation, using well-defined consortia of two or more microbes, was increasingly explored for innovative applications in biotechnology [1]. In contrast to naturally occurring co-cultures, synthetic co-cultures lack a natural equilibrium, resulting in instable cultures. The lack of synthetic co-culture stability and process controllability hinders the industrial implementation and, therefore, the full potential of synthetic co-culture processes as a sustainable alternative cannot be achieved [2].

Instable population dynamics are caused by external influences resulting in minor fitness differences between species. Consequently, one species can outcompete and overwhelm other species, destabilising the community and leading to decreased efficiency or population collapse [3]. In-depth understanding of these external influences requires analytical techniques that capture and quantify affected parameters, such as population dynamics. With that knowledge, culture stability can be optimized and a rational approach for process development can be applied.

In-line Raman spectroscopy-based process analytical technology (PAT) is implemented in other cultivation systems to obtain relevant cultivation data in real-time and in a non-invasive manner [4]. However, in-line Raman spectroscopy-based PAT for synthetic co-cultivations is not yet realized. Therefore, the overall aim of the project is to establish an in-line and real-time monitoring setup based on Raman spectroscopy to capture the influence of critical process and culture parameters on synthetic co-culture cultivation, with a focus on population dynamics and key metabolite and/or substrate concentrations. This will be employed for in-depth co-culture interaction and process understanding to accelerate rational process development, and to provide guidelines for co-culture control strategies.

References

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