FEVIS - FErmentation VIsualised & Simplified)

Seed Money Project Presentation

14 December 2023 – Janine Verbokkem, Puneet Mishra, Martijn Bekker

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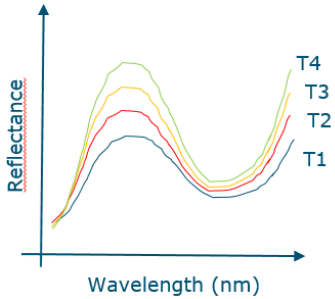
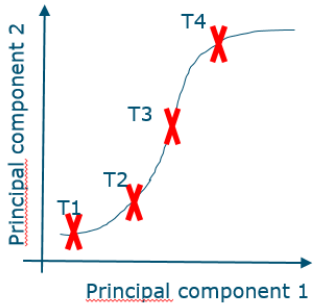
Project concept

- Determine the applicability of Raman spectroscopy for detailed following of various fermentations
- Develop a method that can be used by factory process operators that can follow fermentations in great detail
- Identify the differences for 3 separate processes that are scaled using samples from the partner processes





NO Palm Ingredients

FrieslandCampina nourishing by nature

ENOUGH

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Fermentalg

AVANTES enlightening spectroscopy

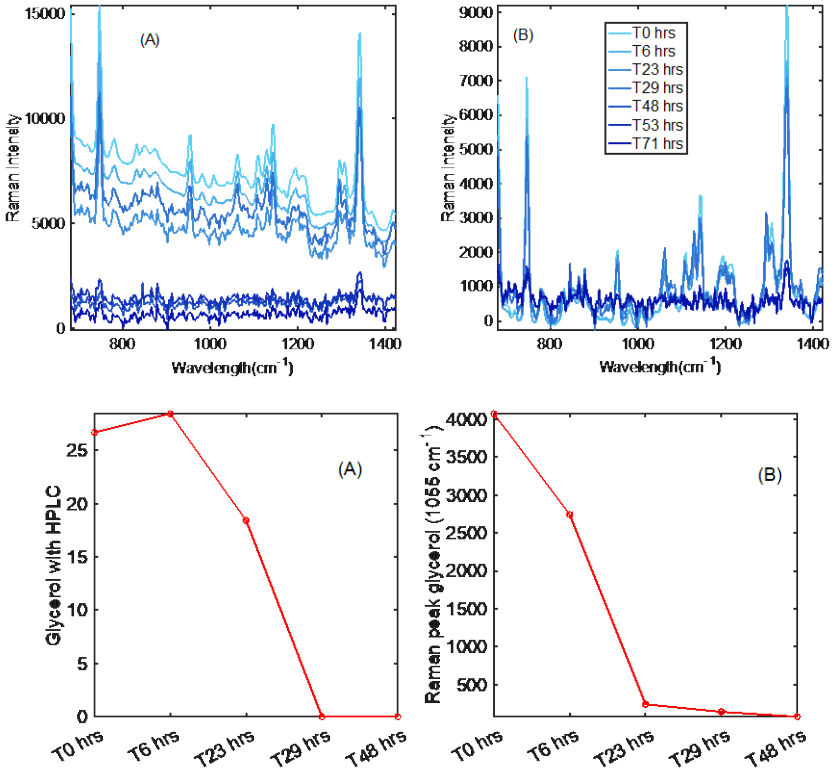
Results 1 – Following key fermentation parameters in in-house fermentations

Experimental results

Four fermentation processes studied

- 3 taxonomical kingdoms
- Batch and fed-batch processes
- Biomass, carbon consumption and (by-)product formation were followed in relevant fermentations

- Raman dataset correlated to HPLC measurements & OD600



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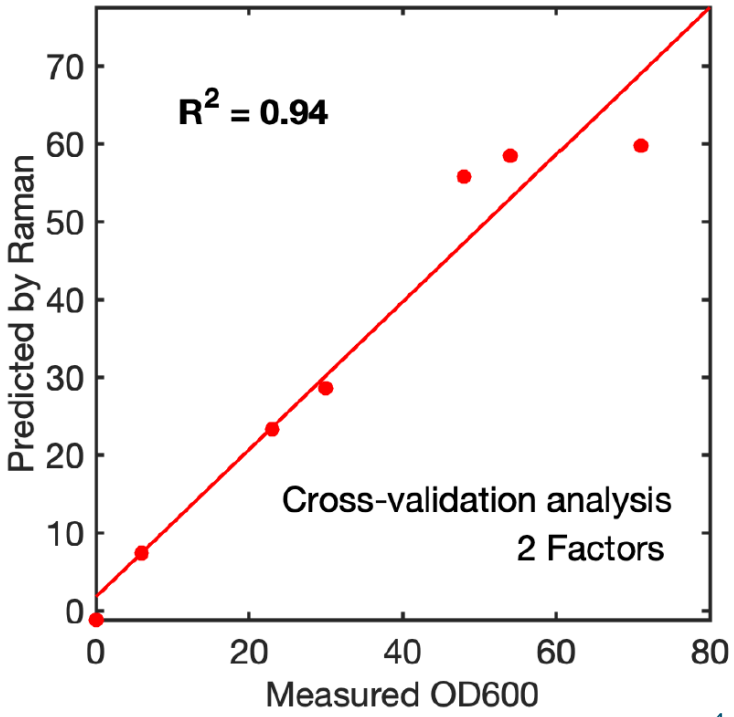
Results 2 – Predicting biomass formation using Raman and optical density

Microbial growth

- Traditionally determined with OD600 or biomass probes
- Determined with Raman together with carbon compounds in 1 measurement
- Cross validation between OD600 and Raman predicted optical density



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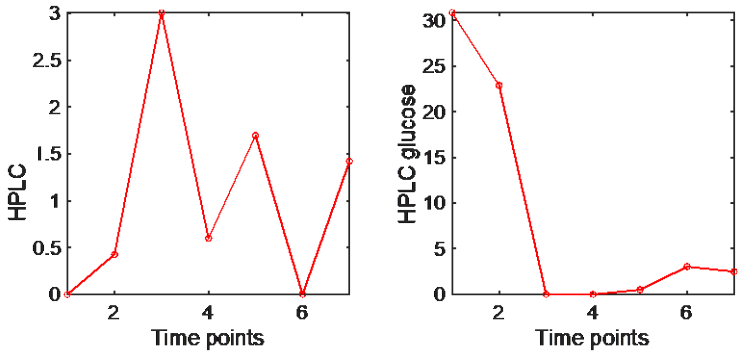
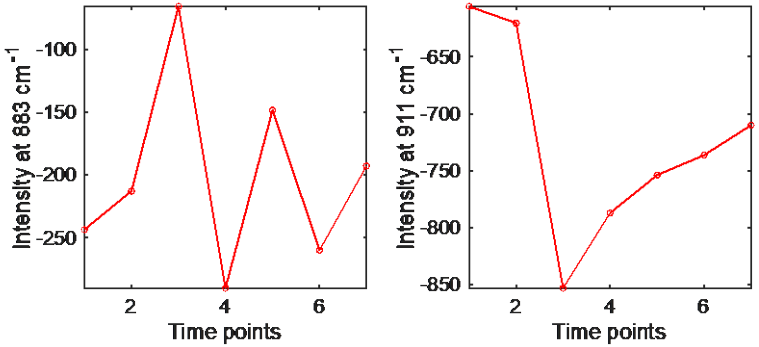
Results 3 - Following key compounds of the ENOUGH fermentation process

- Key compounds of the process were indicated by ENOUGH and confirmed with HPLC
- Similar patterns were measured with HPLC and Raman spectroscopy
- Measurements in line with company expectations

HPLC



Raman



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Most important conclusions

- Comparison between HPLC generated data and Raman generated data on carbon compounds show similar trends
    - Optimisation of chemical analysis is needed
    - Expand compound library
- Linear correlation between optical density and Raman predicted optical density for following biomass accumulations
- Proven ability to measure several key parameters within one measurement

- Measuring in-line and directly at partners sites was not possible within the project
    - Technical difficulties to fit the probe within the bioreactors and ensure sterility of industrial processes
- Bottlenecks of current project addressed in TKI follow up

Next steps (propositions, which consortium, how)

- FEVIS expanded as a TKI proposal (3 years)
- Focus on implementing Raman as a predictive monitoring tool for fermentation processes provided by the consortium
- Continue development in-line measurement tools and correlation between Raman and traditional analysis methods
    - This project has highlighted both areas of potential as well as improvement for moving forward

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