# Sustainable biorefinery process for the valorisation of algae into industrially relevant ingredients


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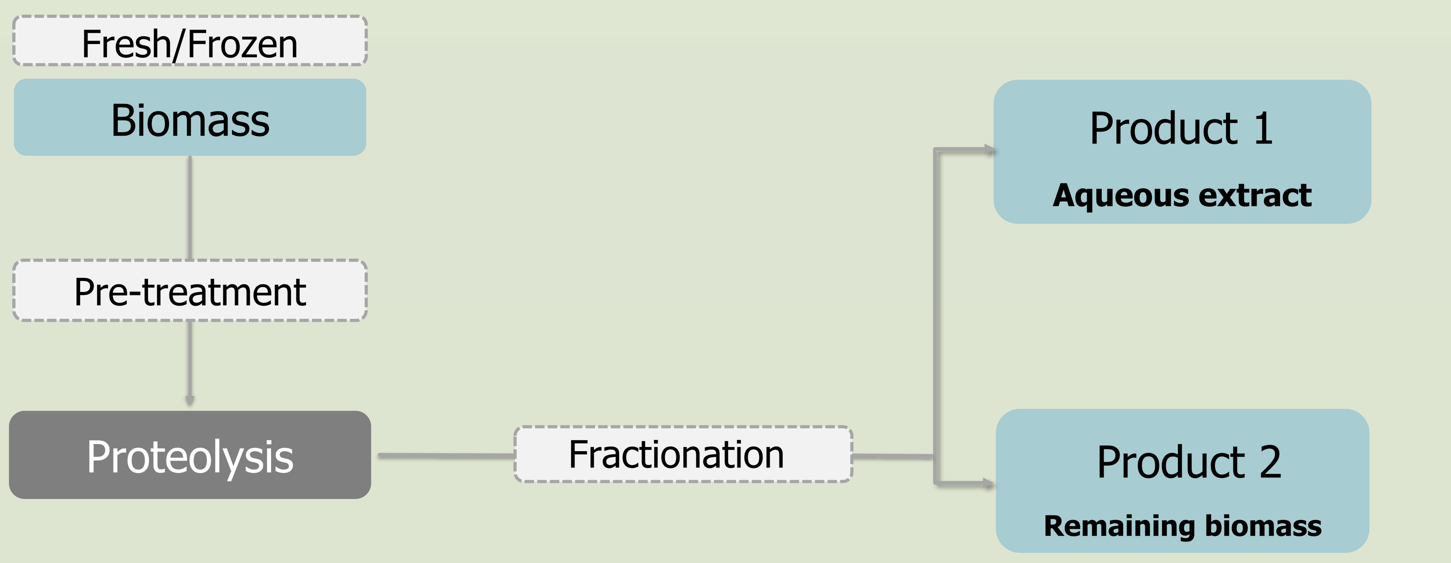
## State of the art

Microalgae are increasingly recognised as promising and sustainable feedstocks for the production of high-value bioactive compounds. Their integration into biorefinery processes enables the **full valorisation** of biomass through sequential steps such as cellular disruption, fractionation and stabilisation.

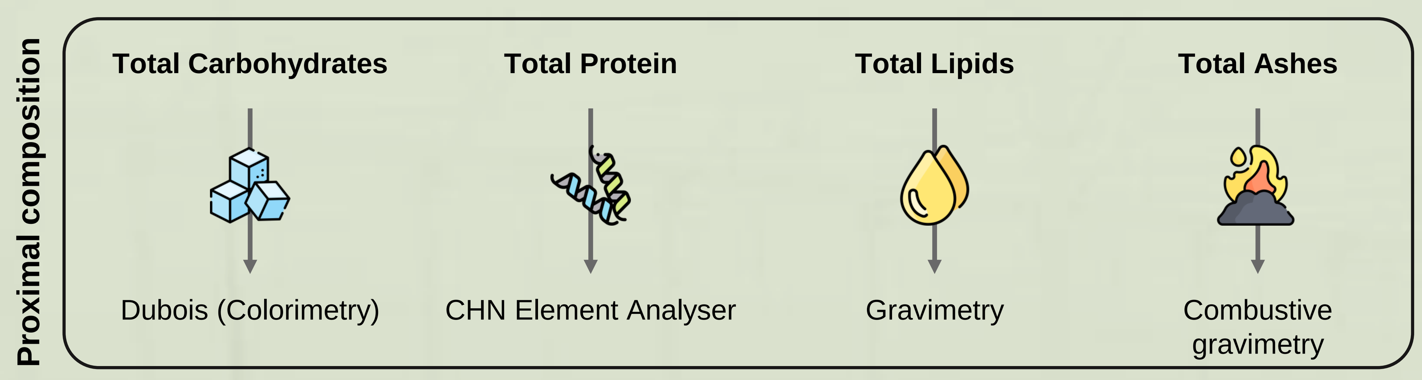
Despite advances at the laboratory scale, the transition of biorefinery pipelines to industrial settings often encounters significant challenges, particularly concerning sustainability, process complexity and cost-effectiveness. These bottlenecks can compromise both **scalability** and the consistency of the resulting ingredient profiles. In this context, optimising existing biorefinery processes is essential to enable a viable scale-up without compromising the biochemical integrity and yield of the targeted fractions.

This work focuses on the optimisation of a previously developed pipeline, aiming to **simplify operations, reduce costs and support industrial implementation.**

## Methodology




Dashed boxes represent the critical steps to be evaluated by this biorefinery pipeline.




## Discussion and future perspectives

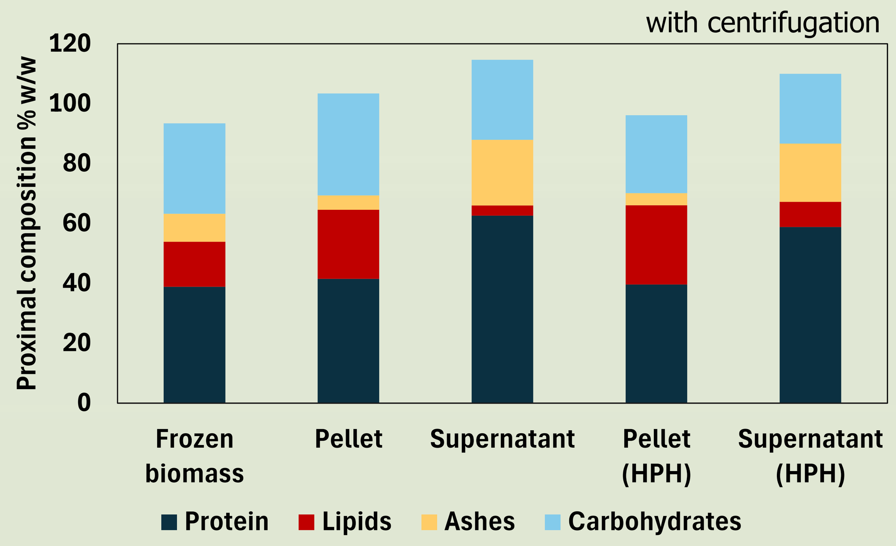
- The impact of HPH pre-treatment is biomass and species-dependent. It can significantly enhance the solubilisation of compounds in fresh biomass, but its effect is minimal in frozen biomass.

  ►HPH may be omitted in certain processing scenarios, contributing to reduced complexity and operational costs.
- Microfiltration shows similar biochemical profiles to centrifugation and can be considered a viable alternative at larger scales, however yields need to be further investigated.
- Overall, the simplification of the pipeline can support a more scalable and economically viable biorefinery process.
- Optimisation strategies should remain flexible and species-specific, balancing processing cost with the targeted quality and yield of bioactive fractions.

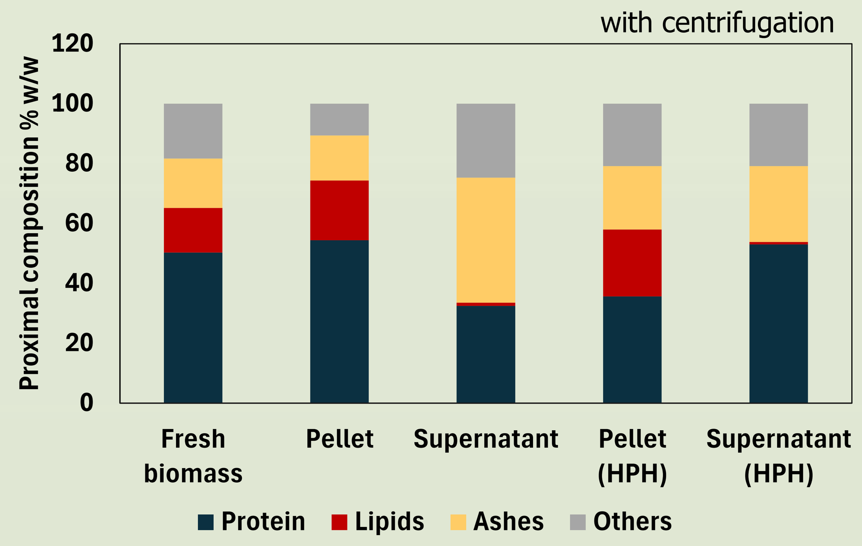
## Results

### HPH Pre-Treatment

**Frozen *T. obliquus* biomass**



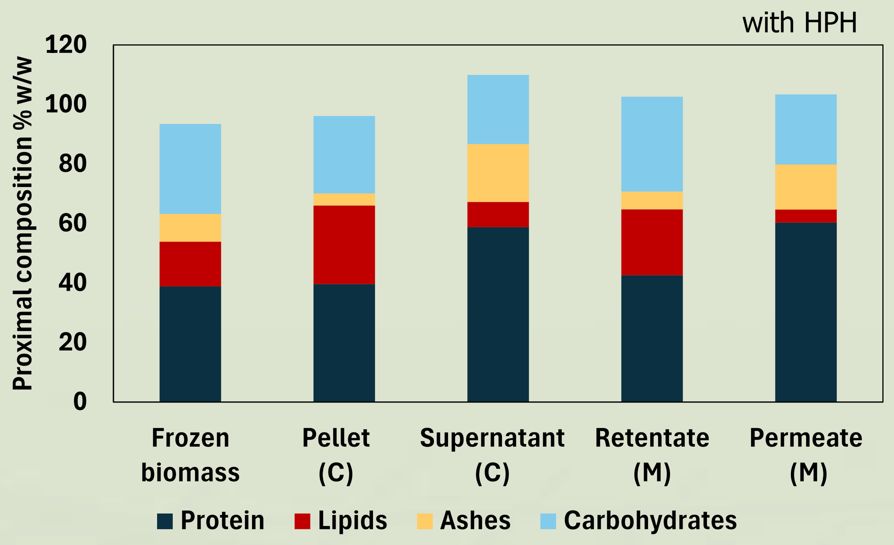

**Fresh *T. obliquus* biomass**



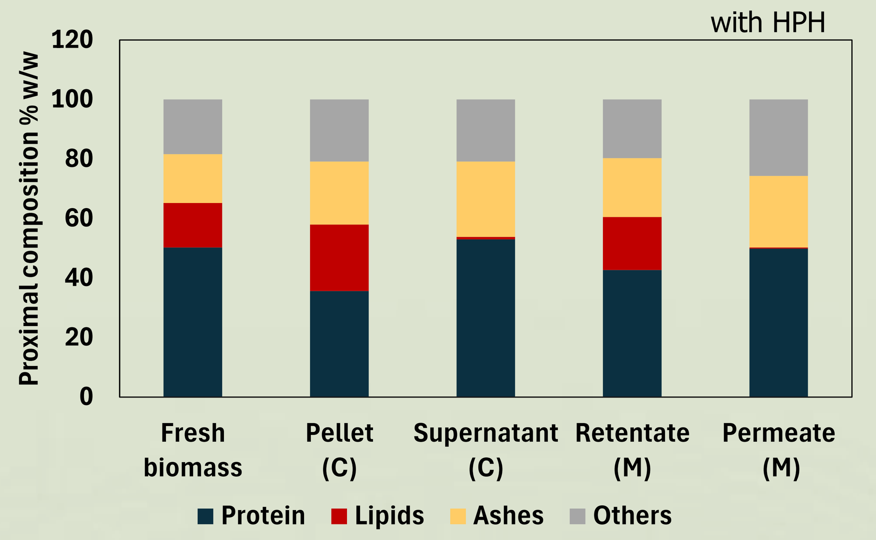

- For frozen biomass, the biochemical composition remains similar with or without HPH, indicating limited release of intracellular components.
- For fresh biomass, HPH enables a clear increase in solubilised compounds such as proteins, confirming its effectiveness in cell disruption.

### Centrifugation VS Microfiltration

**Frozen *T. obliquus* biomass**

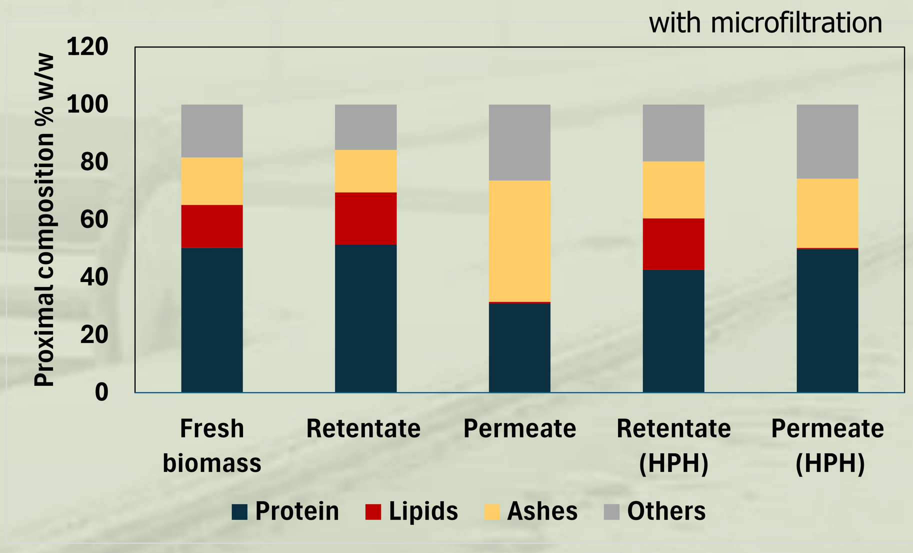


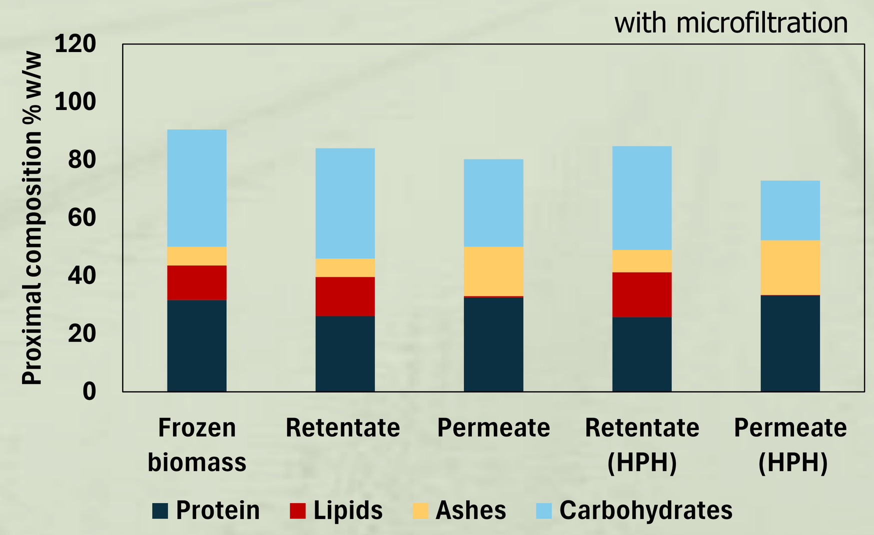

**Fresh *T. obliquus* biomass**




- For both fresh and frozen samples, centrifugation and microfiltration yield comparable biochemical compositions, indicating similar separation efficiency.

### *Tetradesmus obliquus* VS *Chlorella* sp.




- In contrast to *T. obliquus*, Chlorella sp. shows a slight increase in the solubilisation of compounds such as proteins upon HPH treatment. However, the overall composition remains mostly unaffected.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