COMPARISON OF MICROALGAE HARVESTING EFFICIENCY BETWEEN INDUSTRIAL CENTRIFUGATION AND A MEMBRANE FILTRATION SYSTEM

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BACKGROUND

- One of the most important steps in the production of microalgae is the **harvesting** process, responsible for up to **30%** of the **total production cost** due essentially to its high energy demand.
- Two commonly used methods to industrially harvest microalgae biomass are **membrane microfiltration** and **centrifugation**.
- **Microfiltration** usually provides a high cellular concentration efficiency, allowing the handling of more delicate species by avoiding cell disruption.
- On the other hand, **centrifugation** also provides a high cell harvesting efficiency, but it is more energy intensive, often causing cellular damage that makes cells inadequate for numerous applications.

METHODOLOGY

Microalgae cultures of ***Nannochloropsis*** **sp.** were cultivated in semi-continuous mode in 19 m^3 tubular photobioreactors (TPBR)

These cultures were **harvested** from the TPBR and processed separately by **two different harvesting techniques**:

Microfiltration
(membrane filtration system, SANI Vibro-I™ module, 2.5 m^2, pore size: 0.6 µm)

n = 4

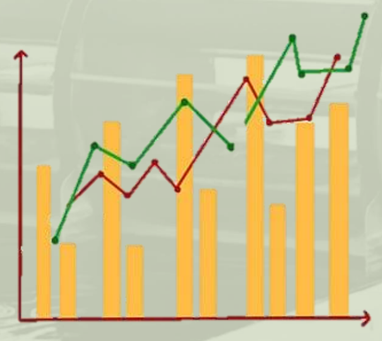
Centrifugation
(industrial batch centrifuge, Westfalia)

n = 3

Comparison of the concentration process of each technique at a relevant industrial scale through:

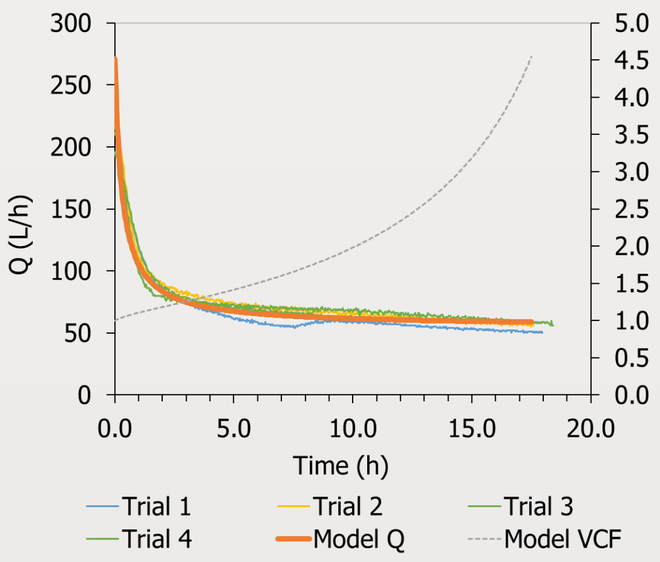
- Optical density (750 nm)

- Permeate flow rate (Q)
- Volumetric concentration factor (VCF)



RESULTS

PERMEATE FLOW RATE (Q)



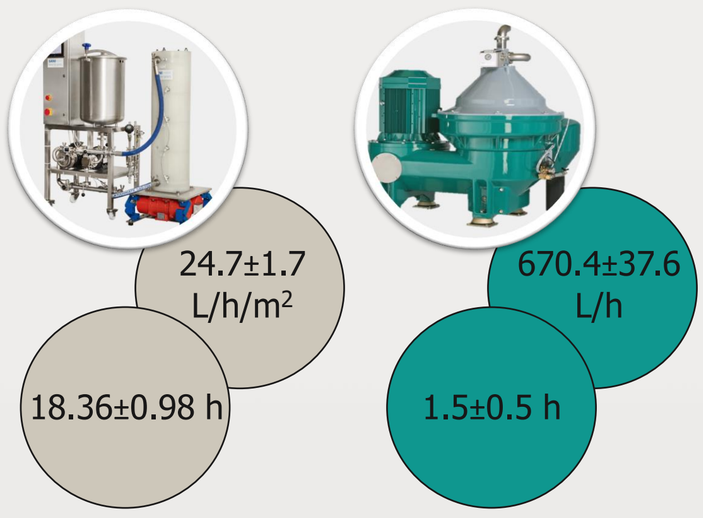


Figure 1: Permeate flow rate (Q) (L/h) and volumetric concentration factor (VCF) of *Nannochloropsis* sp. processed culture over time on the SANI Vibro-I™ membrane system (pore size of 0.6 µm and 2.5 m^2 membrane area).

- For the **SANI membrane system**, an average of 1550 L of *Nannochloropsis* sp. culture were concentrated in **18.4 hours** with a permeate flow rate (Q) per m^2 of **24.7 L/h/m²**. For the **batch centrifuge**, 1700 L were concentrated in **1.5 hours** with a Q of **670.4 L/h**.
- An **average Q** of 61.8±4.1 L/h and an **extremely low Q decay** in the linear phase of 1.6±0.2%/h for the SANI membrane system revealed a **steady state performance** of the concentration process while the centrifugation exhibited a 10-fold increase in the average Q (670.4±37.6 L/h).
- To attain the same centrifugation Q value, an approximate membrane area of **27 m²** (11 modules of 2.5 m^2) would be necessary.

VOLUMETRIC CONCENTRATION FACTOR (VCF)

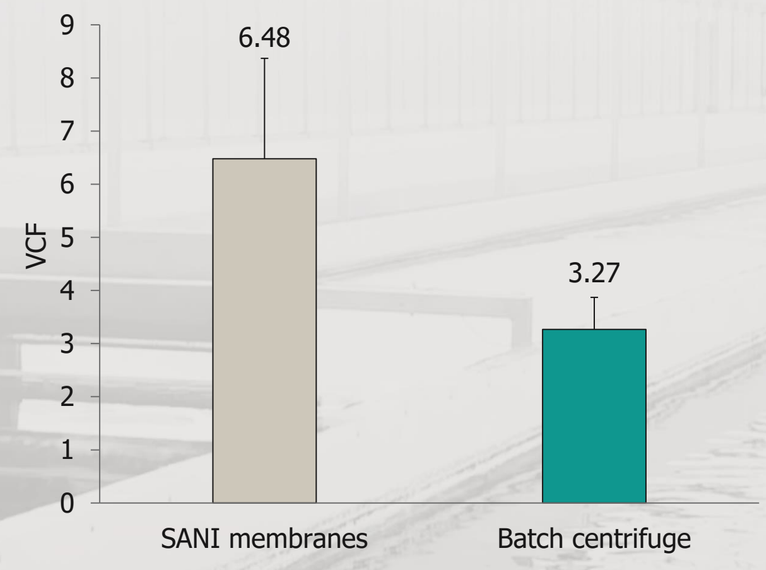


Figure 2: Volumetric concentration factor (VCF) of *Nannochloropsis* sp. processed culture through SANI Vibro-I™ membrane filtration system and Westfalia batch centrifuge.

- A VCF 2 times higher for the SANI membranes compared to the batch centrifuge demonstrates the **high capacity** and **efficiency** of the **microfiltration system** to concentrate *Nannochloropsis* sp. culture.
- However, the lower VCF observed for the centrifuge could be justified by the small processing volumes adequate for the equipment's capacity, and consequently, lower measuring precision.

FUTURE STEPS

An economic analysis is being performed to determine the best cost-efficient harvesting technique. However, the possibility of a synergetic combination of both industrial methods should be considered. This strategy constitutes one of many essential steps to reduce operational costs and optimize microalgae production processes with the aim of making microalgal products more profitable, sustainable and available worldwide.

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