Microalgae cultivation for the valorisation of carbon dioxide from biogas streams and digestate

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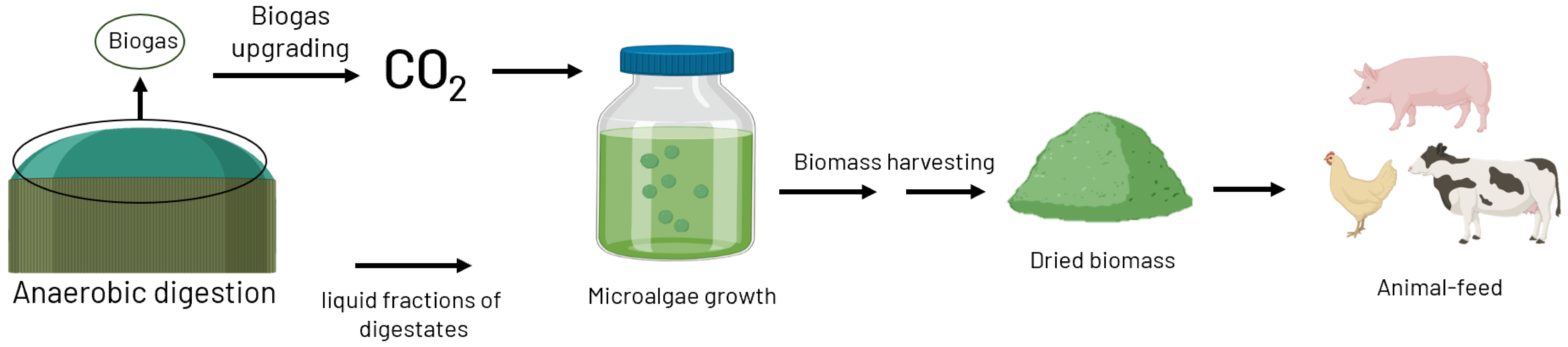
BACKGROUND

- Anaerobic digestion (AD) is the most established and widespread technology for solid waste management, and it produces biogas, a renewable carbon-neutral fuel mainly composed of methane (CH_4), carbon dioxide (CO_2), and trace gases. Biogas upgrading, with the objective of separating CH_4 and CO_2, is needed to ensure the quality of the biomethane for further applications. Therefore, CO_2 can also be used as a powerful raw material.
- Concretely, several studies have shown microalgae and phototrophic purple bacteria have the potential to utilize CO_2-rich streams as a carbon source, and recently, research interest has focused on producing biomass with high protein content, suitable for animal feed. Moreover, nutrient recovery linked to biomass production is reported to be feasible while feeding microalgae cultures with different feedstocks, such as liquid fractions of digestate.



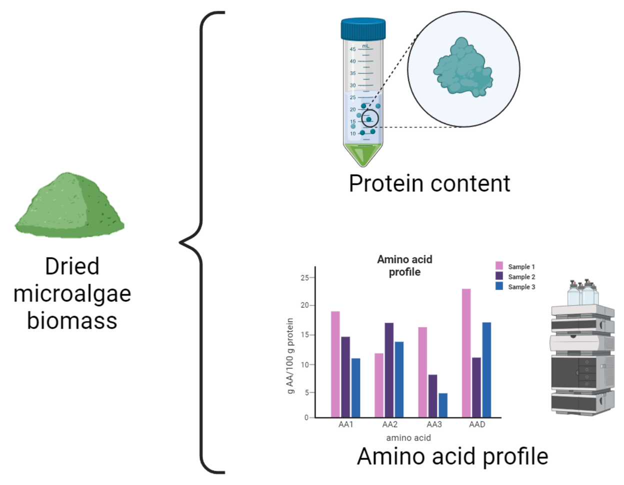
OBJECTIVES

- Screening of different microalgae strains (*Chlorella vulgaris, Scenedesmus obliquus* and *Chlorella kessleri*) for CO_2 valorisation
- Optimization of the operational parameters with the selected microalgae strain, in lab-scale tests, in order to determine the optimal conditions in pilot-scale operation
- Microalgae grown using, as nutrient source, liquid fraction of digestates from different origins
- To scale up the process, with the lab-scale results, in a pilot tubular photobioreactor (PBR) fed with CO_2 recovered from biogas and with digestate

METHODOLOGY

Key points

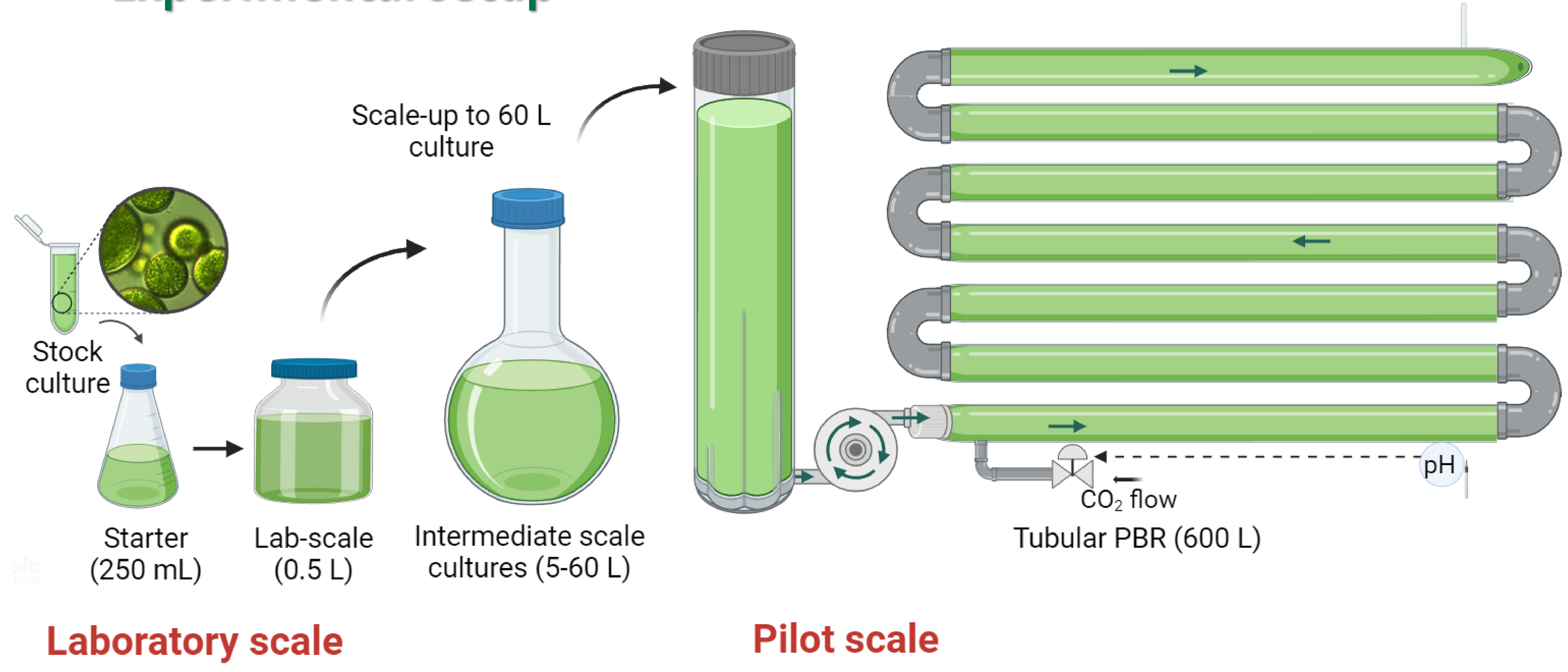
- ✓ Microalgae strains growth
- ✓ Digestates as nutrient source
- ✓ CO_2 from biogas as carbon source
- ✓ Biomass characterization: protein content and amino acid profile



Analytical methods

- Biomass growth (OD 670 nm, dry weight, cellular density) and microscopic check
- Physicochemical parameters and nutrient content (pH, total Kjeldahl nitrogen (TKN), total phosphorous (TP), and ammonium ($N\text{-}NH_4^+$))
- Protein content and amino acid profile

Experimental setup



EXPECTED RESULTS

- To demonstrate that the microalgae strains employed in the lab-scale experiments have a high-protein content and an amino acid profile that aligns with the nutritional requirements of livestock. Therefore, it could be suitable for animal feed formulations.
- To select a microalgae strain from the prior experiments and to optimize the process in lab-scale tests as a crucial step towards scaling up the system to a pilot-scale PBR.
- To validate the feasibility of cultivating microalgae using CO_2 recovered from biogas streams and liquid fractions of digestates. Furthermore, to confirm that the produced biomass obtained from these residual sources fits as alternative protein sources, particularly for animal feed formulations, as an appealing substitute to conventional sources such as soy.
- CO_2 neutral: The previously outlined results highlight the potential of microalgae systems for capturing CO_2 and recovering nutrients from diverse residual feedstocks, such as liquid fractions from digestates. This could position microalgae as a promising technology for achieving carbon neutrality and substantially mitigating greenhouse gas emissions. Moreover, these findings hint at the possibility of microalgae contributing to water recovery from residual streams. Consequently, this research holds significant potential for enhancing the sustainability of these processes.

ACKNOWLEDGEMENTS

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