Process chain development of five algae-to-product value chains, integrating novel process technologies

P.M. Slegers[1], G. Olivieri[2,3], A.J.B. van Boxtel[1], L. Sijtsma[4]

[1]: Biobased Chemistry and Technology, Wageningen University and Research, PO Box 16, 6700 AA Wageningen, The Netherlands
[2]: Dipartimento di Ingegneria Chimica, dei Materiali e della Produzione Industriale – Università degli Studi di Napoli Federico II – Piazzale V. Tecchio 80, 80125 Napoli, Italy
[3]: Bioprocess Engineering, AlgaePARC, Wageningen University and Research, PO Box 16, 6700 AA Wageningen, The Netherland
[4]: Food and Biobased Research, Wageningen University and Research, PO Box 16, 6700 AA Wageningen, The Netherlands

Abstract

Biorefinery of microalgal biomass allows fully valorising the valuable components present in microalgae. The commercial biorefinery of microalgae is still limited, mainly due to unfavourable economics and lack of biorefinery processes at scale. The EU-MIRACLES project aims at developing integrated, multiple-product biorefinery technologies for producing microalgal specialties for food, aquaculture and non-food products. Two essential criteria are the economic feasibility and sustainability. We assess the performance of microalgal biorefineries at large-scale conditions based on data provided by MIRACLES project partners and from literature. The process integration, scale-up and economic analysis were aided by SuperProDesigner® software.

The novel biorefinery technologies are clustered in five product value chains, established with four microalgal strains. The processing design steps are: 1) calculate mass and energy balances, 2) determine size and number of equipment units, 3) define scheduling procedures for batch operations, 4) analyse economics (CAPEX, OPEX, cost breakdown).

For each chain the scenario with best product yield and cost was determined. The scenarios are combinations of value-chain, strain and cultivation conditions. The first results show that harvesting with micro-filtration, followed by concentration by centrifugation reduces the CAPEX tremendously. The efficiency of centrifugation strongly depends on the diameter of algae cells, thus various species ask for different number of parallel units. For chains including extraction CAPEX are expected to be the real bottleneck of the process. More detailed results will be presented at the congress. Next steps within EU-MIRACLES are assessing the environmental sustainability through LCA and the marketability of the selected value chains.

Keywords: microalgal biorefinery, conceptual process design, economic evaluation, value chains

Acknowledgement

The authors acknowledge funding from EU MIRACLES project (7th Framework Program - Grant Agreement No. 613588).