Comparative Life Cycle Assessment of Microalgae Cultivation's Technologies for Add Value Compound Production

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Nowadays algae production is focusing more on high-value compounds, as their selling price can guarantee the return on investment and the market for bio-based nutraceuticals and cosmetic ingredients is growing. Against this background, the EU-project ABACUS is developing a new algal biorefinery concept for the production of added value compounds from microalgae.
Within this research project, we fully assess the acceptability of algal products and production processes through a comprehensive Life Cycle Analysis (LCA) and techno-economic analysis (TEA). In the project, several technologies are used to cultivate different strains in different conditions. We conducted a comparative LCA by analyzing the three most relevant photobioreactors (PBR) available on the market: the flat panel airlift (FPA), the horizontal tubular unilayer PBR (UHT-PBR) and the green wall panel (GWP). We studied the influence of the characteristics of the PBR location by carrying out a sensitivity analysis for both indoor and outdoor cultivation in different European regions and for some of them, we started to conduct a TEA quantifying key technology elements and converting these values into monetized values.
Our LCA results based on data from pilot scale production indicate that location has a significant impact due to different algae productivities and energy demand. We found that in particular for indoor systems, even with LED, the energy demand for lighting is the main contributor to the Global Warming Potential and this contribution would decrease significantly if the share of renewable energy would increase. For this reason, we have considered different scenarios to analyze the effect of local conditions, such as climate and availability of renewable energy, on the environmental impacts of algae technology. Moreover, we tried to quantify the potential loss and profit obtained using one technology rather than another one.
The project ABACUS receives funding from the Bio-Based Industries Joint Undertaking under the European Union's Horizon 2020 research and innovation program (Grant Agreement N° 745668).