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LIFE CYCLE ASSESSMENT (LCA) OF EUGLENA GRACILIS CULTIVATION ON FOOD INDUSTRY RESIDUES UNDER PURPLE LED STRIPS LIGHTS

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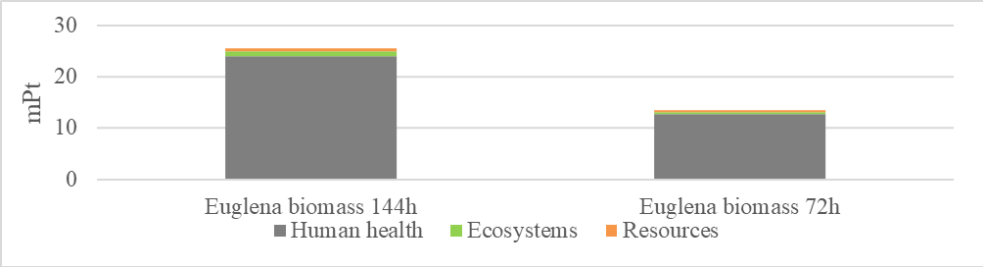
Abstract – Microalgae provide a promising alternative for aquaculture, containing more than 40 % of protein, and up to 80 % of carbohydrates as β-1,3-glucan. The cultivation cost of Euglena biomass at a laboratory scale is estimated at €2.14 per kilogram, while at industrial scale it exceeds €5 per kilogram, highlighting the need to explore more cost and resource-efficient approaches. This study focuses on Life Cycle Assessment (LCA) of Euglena gracilis cultivation on liquid digestate and vinasse under purple LED strip lighting during a 144-hour growth period, which provides the highest biomass and paramylon production at laboratory scale. The research was performed using SimaPro software (version 10.1, 2022), and Ecoinvent database (version 3.10). Environmental impact assessment was carried out using the ReCiPe 2016 Midpoint (H) and Endpoint (H) methods. The system boundaries focus on the core stages of microalgae production, including sterilisation, cultivation, harvesting and drying, while upstream and downstream processes were excluded. The results show that nearly 93 % of the total environmental impact originates from the cultivation stage, which accounts for 0.8005 kg CO_2 eq. out of a total Global Warming Potential impact of 0.8551 kg CO_2 eq. Meanwhile impacts associated with the sterilisation, harvesting and drying stages were negligible for most categories, accounting for less than 6 %. Following this observation, the cultivation duration was assumed to be reduce by 50 %, while maintaining the approximate biomass amount and higher paramylon accumulation during this period. The results demonstrate that halving the cultivation duration from 144 to 72 hours reduced the total environmental damage from 25.55 to 13.51 mPt, corresponding to a 47.15 % decrease, indicating a highly dependence of total environmental performance on cultivation time. These findings suggest that optimising cultivation duration can improve the environmental performance of Euglena biomass production, while also reducing energy use and associated costs at a potential industrial scale. Although laboratory studies on the LCA of microalgae production remains limited, these results can provide essential insight to support the implementation of cultivation processes at industrial scale for aquaculture applications.

Keywords – Euglena gracilis; microalgae cultivation; Life Cycle Assessment (LCA); algal biomass production



Endpoint single score results (mPt) for 144 h and 72 h cultivation durations

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