Microalgae biorefinery: An integrated approach towards sustainable biofuels production

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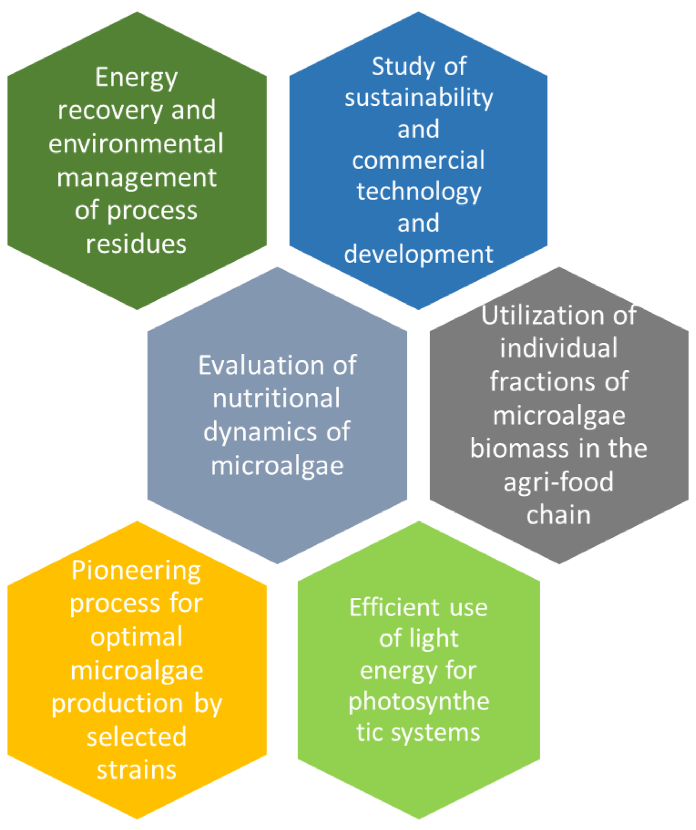
Introduction



Sunfeeding project

Microalgae cultivation under a biorefinery concept → providing primarily food supplement and animal feed
→ high-value chemicals and renewable fuels co-production
Life cycle assessment (LCA) microalgae biorefinery
→ environmental impacts quantification
→ sustainable biofuels & biochemicals production routes *(Sun et al 2019; Ubando et al 2023).*

Objectives

LCA study microalgae (*Chlorella Sorokiniana sp.)* biorefinery → wide range products for food supplement, animal feed & renewable fuels

- Experimental, literature data, databases were utilized
- Process simulation model for lipids upgrading via catalytic hydrotreatment (Aspen Plus V. 11)

Assumptions
► microalgae Chlorella Sorokiniana grown in open raceway ponds
► biomass after its harvest processing → animal feed
► extracted lipids → yogurt food supplement & renewable fuels via catalytic hydrotreatment

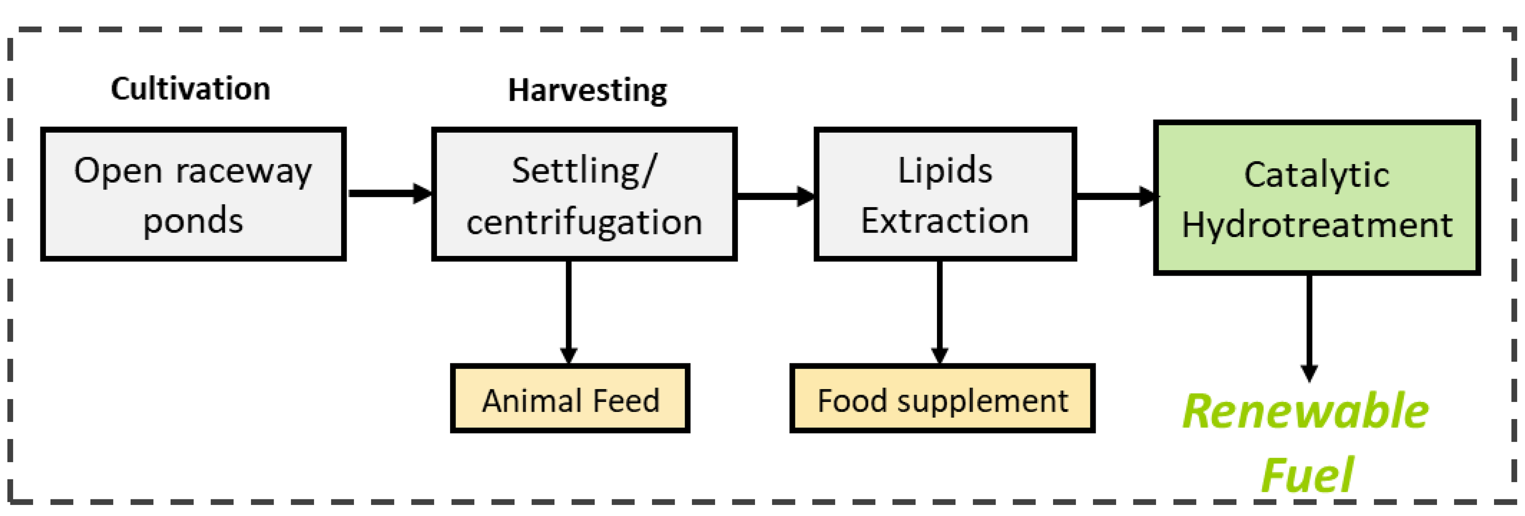
Results & Discussion

System boundaries production process → cover all stages from microalgae cultivation to renewable fuels production through catalytic hydrotreatment.

Life-cycle impacts quantification

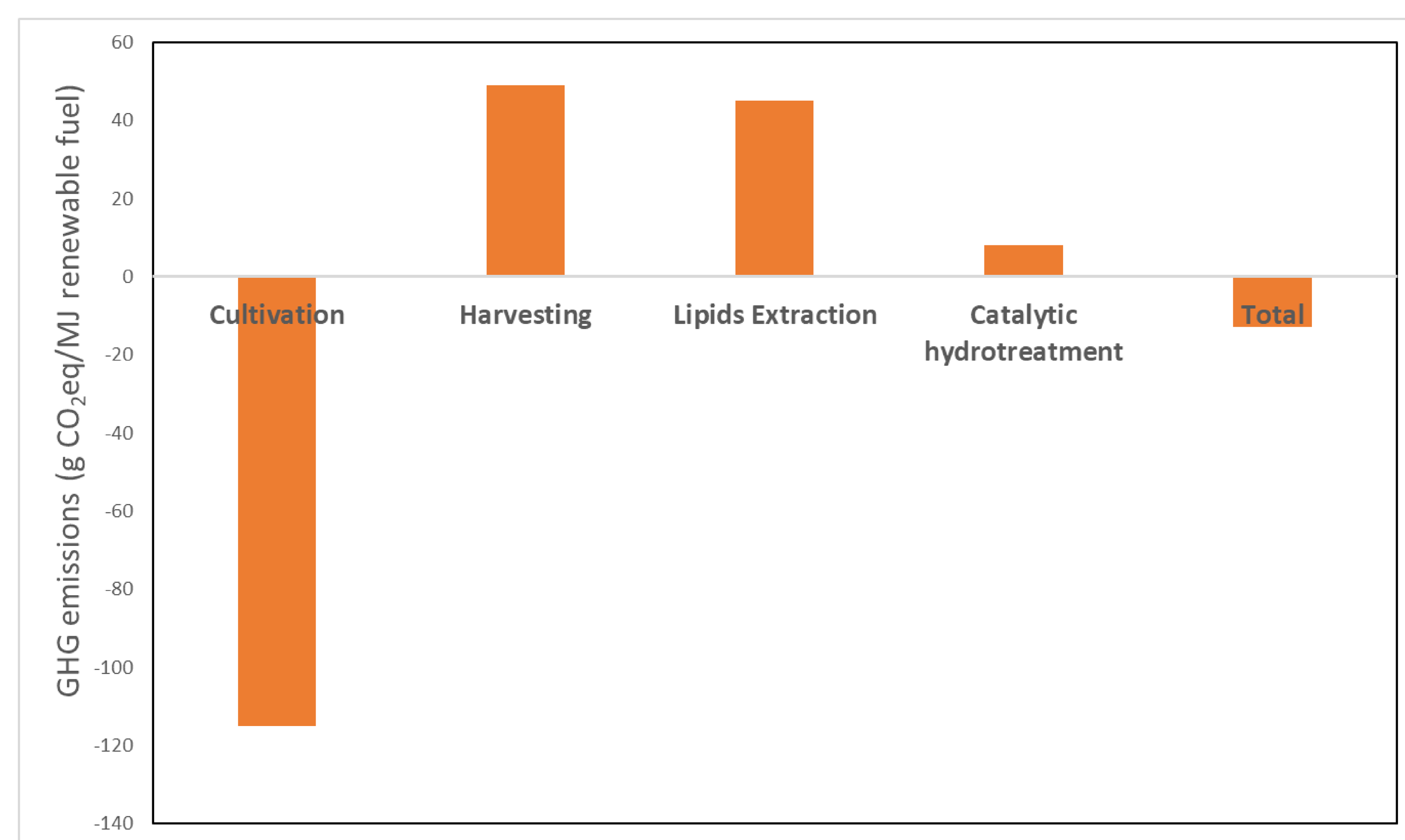
- NER (Net Energy Ratio) : ratio of energy consumed to energy produced
- GWP (Global Warming Potential) : key link between biofuel production and environmental impacts.

Microalgae based biorefinery system's boundaries

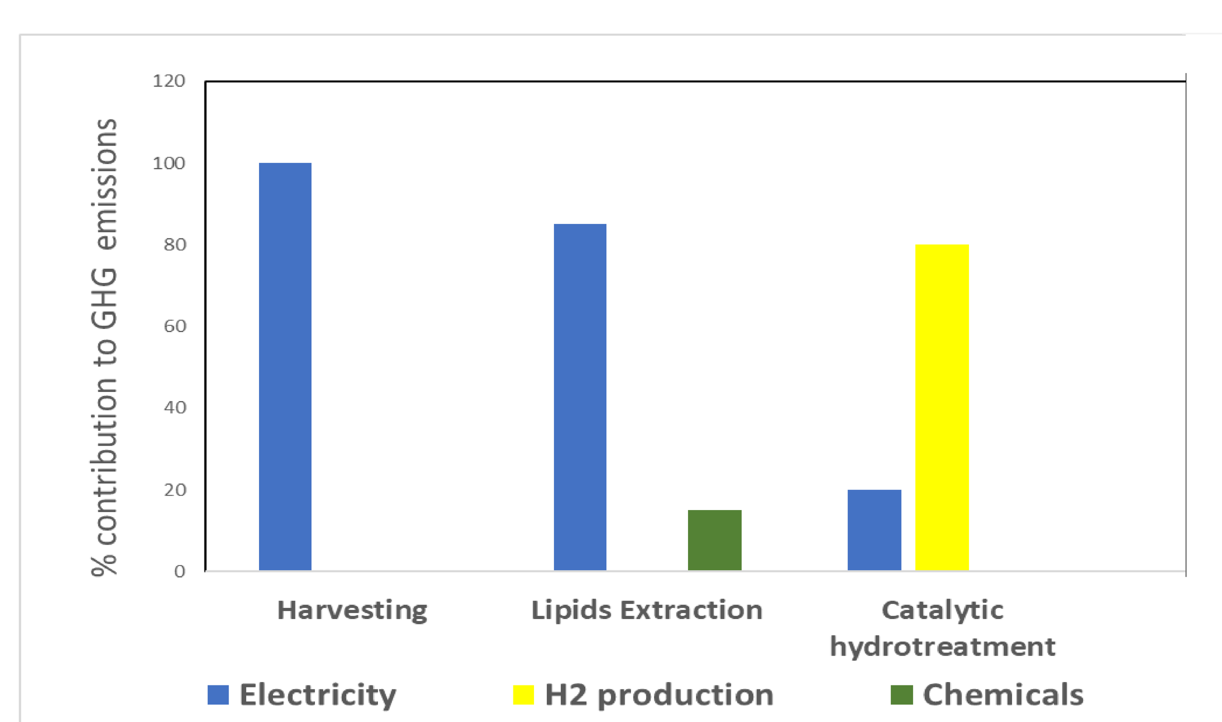


- Low NER in HDT process → greater energy output can be obtained via lower energy input
- Minimum GHG emissions → sustainable & eco-friendly bio-refinery
  - Harvesting and lipids extraction emit significant GHG amounts

Process stage	NER
Cultivation	0.758
Harvesting	0.174
Drying	
Lipids Extraction	0.328
Catalytic hydrotreatment	0.009
Total	1.269



- Electricity production via burning fossil fuels contributes significantly to the GHG emissions of harvesting and lipids extraction.
- H_2 production is the main contributor to the carbon footprint of the catalytic hydrotreatment.
- Renewable energy sources utilization → decrease energy intensity
- Microalgae strain and biomass yields, cultivation system, biomass oil content differ considerably between studies, which usually adopt an optimistic scenario to perform prediction LCA studies.



Conclusions

- Microalgae biomass constitutes a potential bioenergy feedstock towards biofuels production
- Zerowaste biorefinery approach at early development stage but yet is promising based on environmental aspects
- Further pilot-scale studies → zero-waste microalgal biorefinery sustainability validation

References

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Acknowledgments

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