



# MICRO-ALGAE PRE-TREATMENT: A SUPERSTRUCTURE OPTIMIZATION PROBLEM

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# MICRO-ALGAE PRE-TREATMENT: A SUPERSTRUCTURE OPTIMIZATION PROBLEM

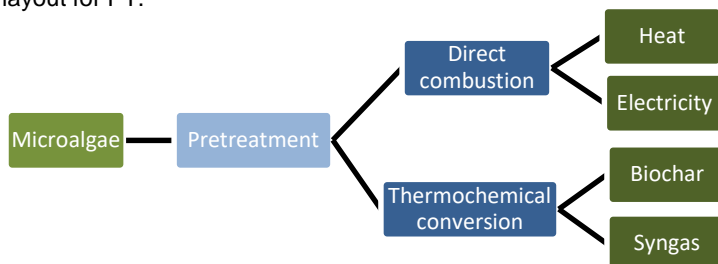
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## INTRODUCTION

Nowadays, biofuels or energy production from microalgae biomass (MA) have been widely studied. However, some of MA characteristics - moisture and ash content and nitrogen presence - can be drawbacks in the contexts of valorization through thermochemical processes or direct combustion.

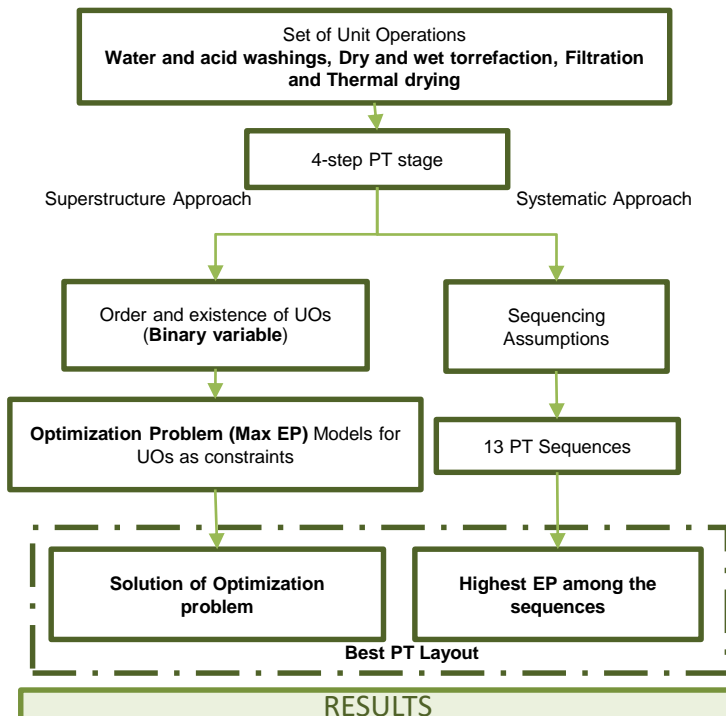
Thus, the goal of this work is to study a **multi-step pretreatment (PT) stage**. The novelty of this study is the set of pretreatment unit operations (UO) considered and the use of two different approaches to combine those UOs and find the best layout for PT.



## METHODOLOGY

### Criteria for selecting PT layouts - Energetic Potential (EP)

$$EP = \frac{\text{Useful heat in final MA (kWh)} - \text{Energy consumption of PT (kWh)}}{\text{Dry MA initial mass (kg)}}$$



## RESULTS

**Biomass :** MA (Chlorella V.)

### Cases:

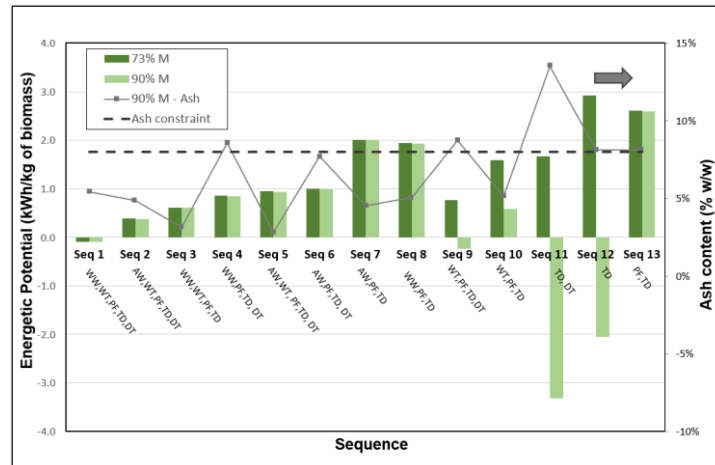
- I. Initial moisture fraction = 73% wt (73%M)
- II. Initial moisture fraction = 90% wt (90%M)
- III. II + Final Ash fraction < 8% wt (90%M-Ash)

For all cases, Final moisture fraction < 10% wt

### Operations:

Water Washing(WW), Acid Washing (AW), Filtration (PF), Thermal drying (TD), Dry torrefaction (DT), Wet Torrefaction(WT)

## SYSTEMATIC APPROACH



## BEST PRETREATMENT LAYOUTS

CASE	SEQUENCE	U. OPERATIONS	EP kWh/kg
I – 73%M	12	Thermal Drying	2.92
II – 90%M	13	Filtration+ Thermal Drying	2.59
III – 90%M -Ash	7	Acid Washing+ Filtration+ Thermal Drying	2.00

## SUPERSTRUCTURE APPROACH

G A M S	OPTIMIZATION VARIABLES	Binary variables (y) indicating which unit operation (UO) is present in each step (st)	EP kWh/kg
	CASE	Optimization variables	
	I – 73%M	y ('TD',1) = 1	2.92
	II – 90%M	y ('PF',1) = 1; y ('TD',2) = 1	2.59
	III – 90%M -Ash	y ('AW',1) = 1; y ('PF',2) = 1; y ('TD',3) = 1	2.00

## CONCLUSION

In a nutshell, this study compared two approaches for determining best layout for pretreatment of microalgae. Results obtained from both were in good agreement in terms of unit operations arrangement and evaluation criteria (EP).

For the future, the optimization-based approach will be use and the next steps are:

- Addition of upstream (MA production) and downstream (Thermochemical valorization) processes;
- Use of more detailed models for PT unit operations;
- Addition of economics and life-cycle analyses is also considered.

## BIBLIOGRAPHIC REFERENCES

- [1] Weschler, M.K., Barr, W.J., Harper, W.F., Landis, A.E.: **Process energy comparison for the production and harvesting of algal biomass as a biofuel feedstock**. Bioresource Technology. 153, 108-115 (2014). <https://doi.org/10.1016/j.biortech.2013.11.008>
- [2] Sanchez-Silva, L., López-González, D., Garcia-Minguillan, A.M., Valverde, J.L.: **Pyrolysis, combustion and gasification characteristics of Nannochloropsis gaditana microalgae**. Bioresource Technology. 130, 321-331 (2013). <https://doi.org/10.1016/j.biortech.2012.12.002>
- [3] Vassilev, S.V.: **Composition, properties and challenges of algae biomass for biofuel application: An overview**. 33 (2016)