Código: 06-006

CO_2 Biosequestration from simulated industrial flue gas using *Chlorella* sp. and its conversion into renewable hydrocarbons through catalytic pyrolysis.

Karine Oliveira[1]; Gislane Oliveira; Joemil Junior; José Alves; Júlio Marques; Dulce Melo; Renata Martins[2]

[1]Pesquisadora no Laboratório de Tecnologia Ambiental da Universidade Federal do Rio Grande do Norte, Natal – RN. E-mail: karinefonseca.quimica@gmail.com

[2]Docente do curso de Pós Graduação da Engenharia Química da Universidade Federal do Rio Grande do Norte, Natal – RN.

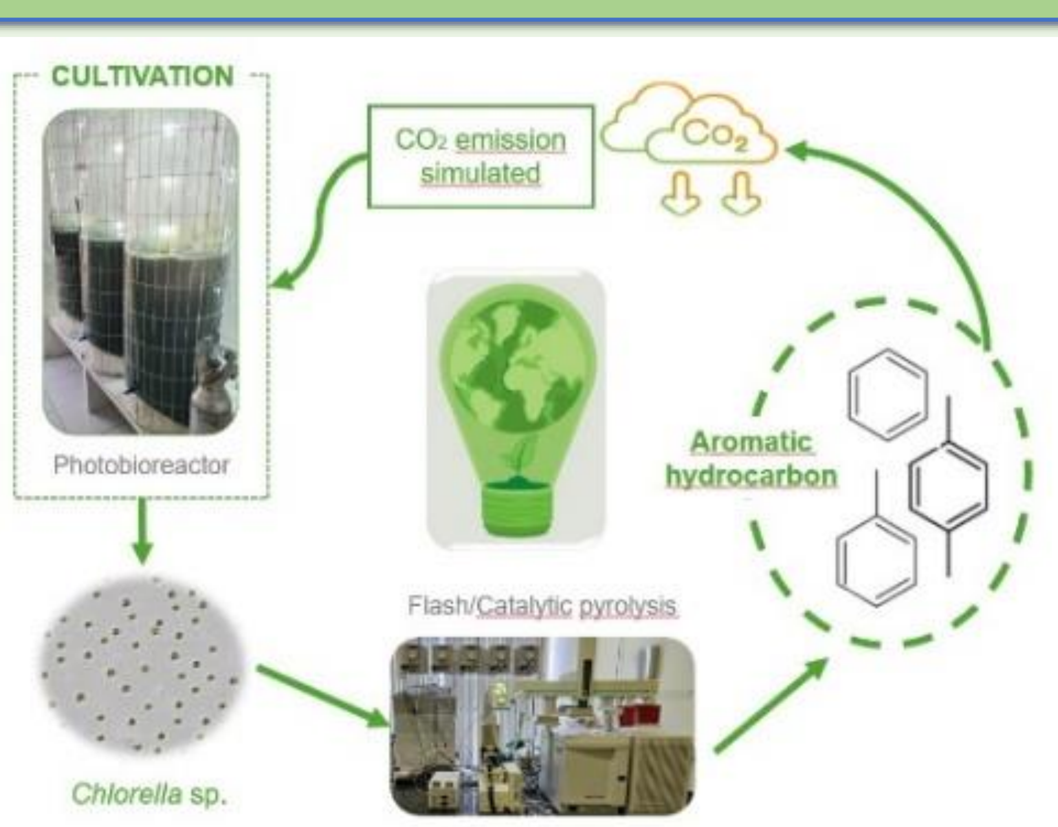
1. Introduction

Microalgae, as third-generation biomass, has been considered promising for producing biofuels such as biodiesel, because rapid growth, versatility, and the ability to capture CO_2 (Yang *et*. al, 2023). Integrating microalgae cultivation with CO_2-rich industrial effluents enhances their environmental benefits by capturing CO_2 while generating valuable biomass, contributing to the United Nations' 2030 Agenda for Sustainable Development. Microalgae can undergo pyrolysis, a process of thermal decomposition without oxygen, to produce a bio-oil as an alternative to the one obtained from fossil fuels (Jafarian *et*. al, 2018). However, some limitations exist in directly using this bio-oil as fuel, such as high nitrogen and oxygen content, leading to a low calorific value, high acidity, and viscosity. Therefore, catalytic pyrolysis is a promising approach to deoxygenate and denitrify the bio-oil, improving its quality. However, it is necessary propose alternative low-cost and environmentally friendly catalysts that can offer comparable efficiency to conventional ones, making catalytic pyrolysis a more viable option for commercial-scale bio-oil production from microalgae.

2. Objectives

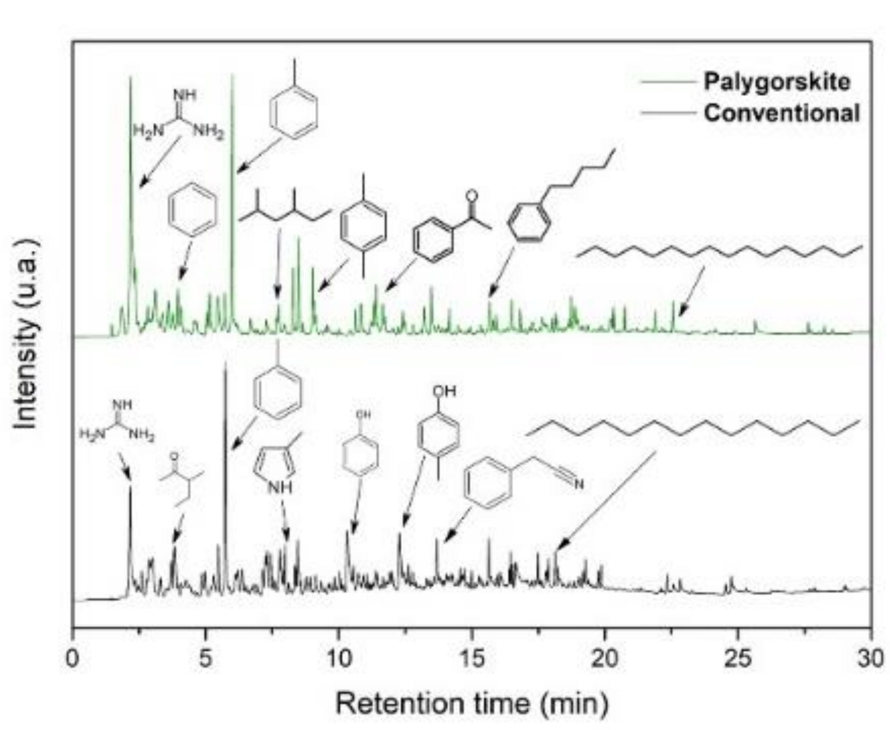
This study aims to achieve dual objectives in the context of bioenergy with carbon capture and storage: first, the cultivation of *Chlorella* sp. microalgae using a simulated industrial flue gas (with 10 vol.% CO_2) as a strategy for CO_2 emission mitigation; and second, the assessment of palygorskite's suitability as a catalyst for catalytic pyrolysis to obtain a viable precursor for low-carbon transportation fuels.

3. Materials and Methods



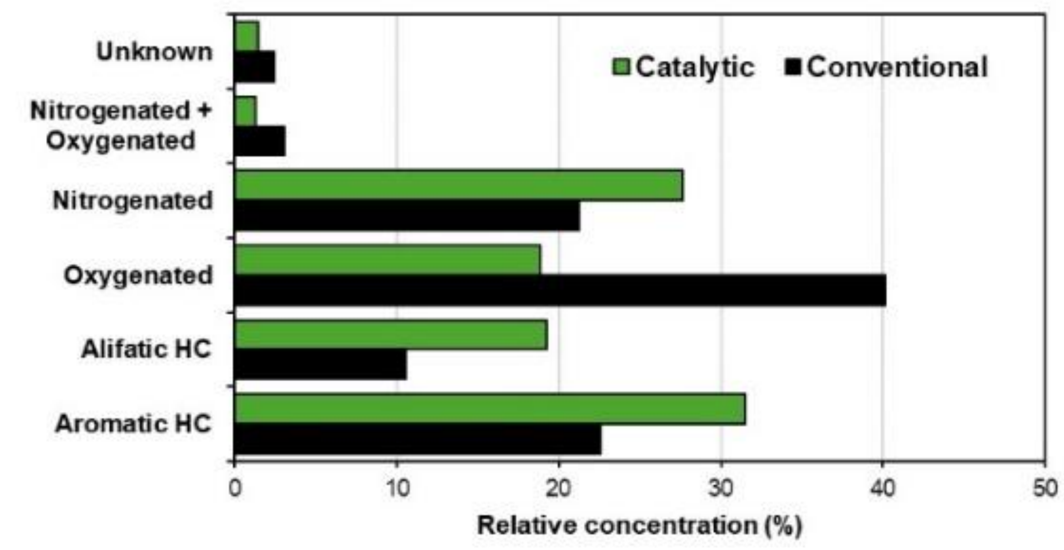
4. Results and Discussion

Figure 1. GC/MS chromatogram of pyrolysis product non-catalytic and catalytic pyrolysis.



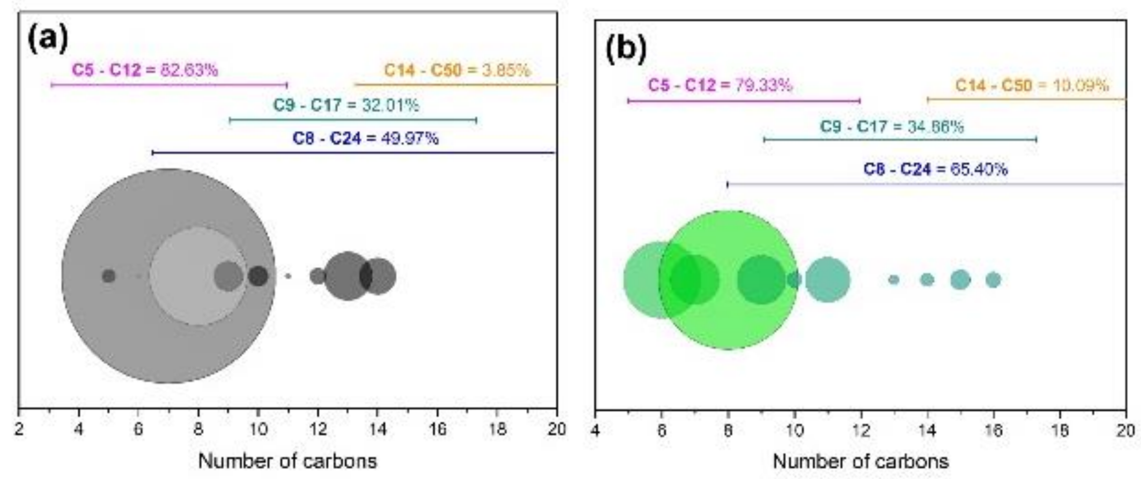
Conventional pyrolysis of *Chlorella* sp. produces condensable vapors rich in nitrogenous and oxygenated compounds such as alcohols, phenols, ketones, and furans. However, these compounds are undesirable because they increase the acidity and viscosity of the bio-oil produced, making it challenging to refine and use directly as biofuel. In contrast, results show that the catalyst palygorskite enhances the bio-oil product quality by inducing deoxygenation and aromatization reactions.

Figure 2. Conventional and catalytic pyrolysis product distribution



The large amount of aromatics formed leads to the production of hydrocarbons equivalent to gasoline. Furthermore, since this bio-oil has aromatic hydrocarbons in its composition, it can be added to gasoline to improve its octane rating or incorporated into the production of biokerosene.

Figure 3. Hydrocarbon distribution based on carbon number distribution in prevalent transportation fuels (a) noncatalytic (b) catalytic pyrolysis



4. Conclusions

The integration of pyrolysis-based microalgae biorefinery into the industry sector could serve a multi-purpose: (a) decarbonize industrial flue gas by capturing CO_2 emissions, (b) sustainable and producing biomass for (c) sustainable production of low-carbon transportation fuels.

5. References

Jafarian, et. al, 2018. A comparative study on the quality of bioproducts derived from catalytic pyrolysis of green microalgae Spirulina (Arthrospira) plantensis over transition metals supported on HMS-ZSM5 composite. Int. J. Hydrogen Energy 43, 19902–19917.

Yang, H., et. al, 2023. CO2 capture and lipid production performance of microalgae in the S-shaped photobioreactor under different culture modes. Enzyme Microb. Technol. 165, 110194.

6. Acknowledgments