

Pretreatment of cyanobacterial *Chroococidiopsis* biomass prior to hydrothermal liquefaction for enhanced hydrocarbon yield and energy recovery

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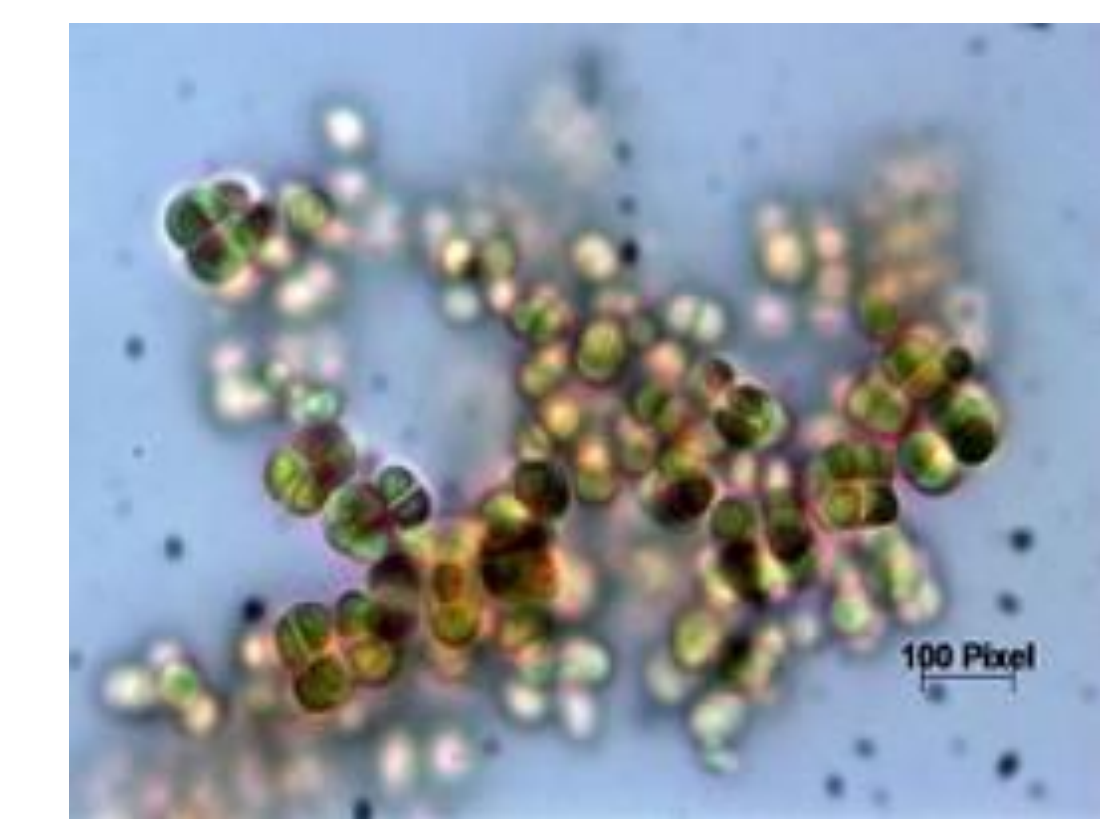
Abstract

Chroococidiopsis sp. was grown in 200 L open raceway pond. Biomass density and average biomass productivity were 0.41 g/L and 16.1 g/m²/d. *Chroococidiopsis* biomass was harvested by self-settling. Self settled biomass was further subjected to centrifugation to obtain a biomass paste with 25-30% solid content. Centrifuged biomass was dried at 80 °C overnight and used as a feedstock for pretreatment step. Biomass was pretreated in water at 105 °C for 15 minutes. A slurry containing 15 wt% pretreated and untreated biomass (control) in deionized water was prepared and subjected to hydrothermal liquefaction for biocrude oil production. Hydrothermal liquefaction for the both pretreated and untreated biomass was conducted at temperatures ranging from (275, 300, 325, 350 °C) in a 500 mL high pressure PARR reactor for 30-minute reaction holding time. Maximum biocrude yields for pretreated and untreated biomass was 42.4 % and 26.4 % based on ash free dry weight basis. Biocrude oil was characterized for hydrocarbons using GC-MS technique. Biocrude oil obtained from pretreated and untreated biomass contained 58.9% and 41.01% (C₈-C₁₉) hydrocarbons. Higher heating values for biomass and biocrude oil were 16.93 and 31.28 MJ/kg, with an energy recovery value of 41.1%.

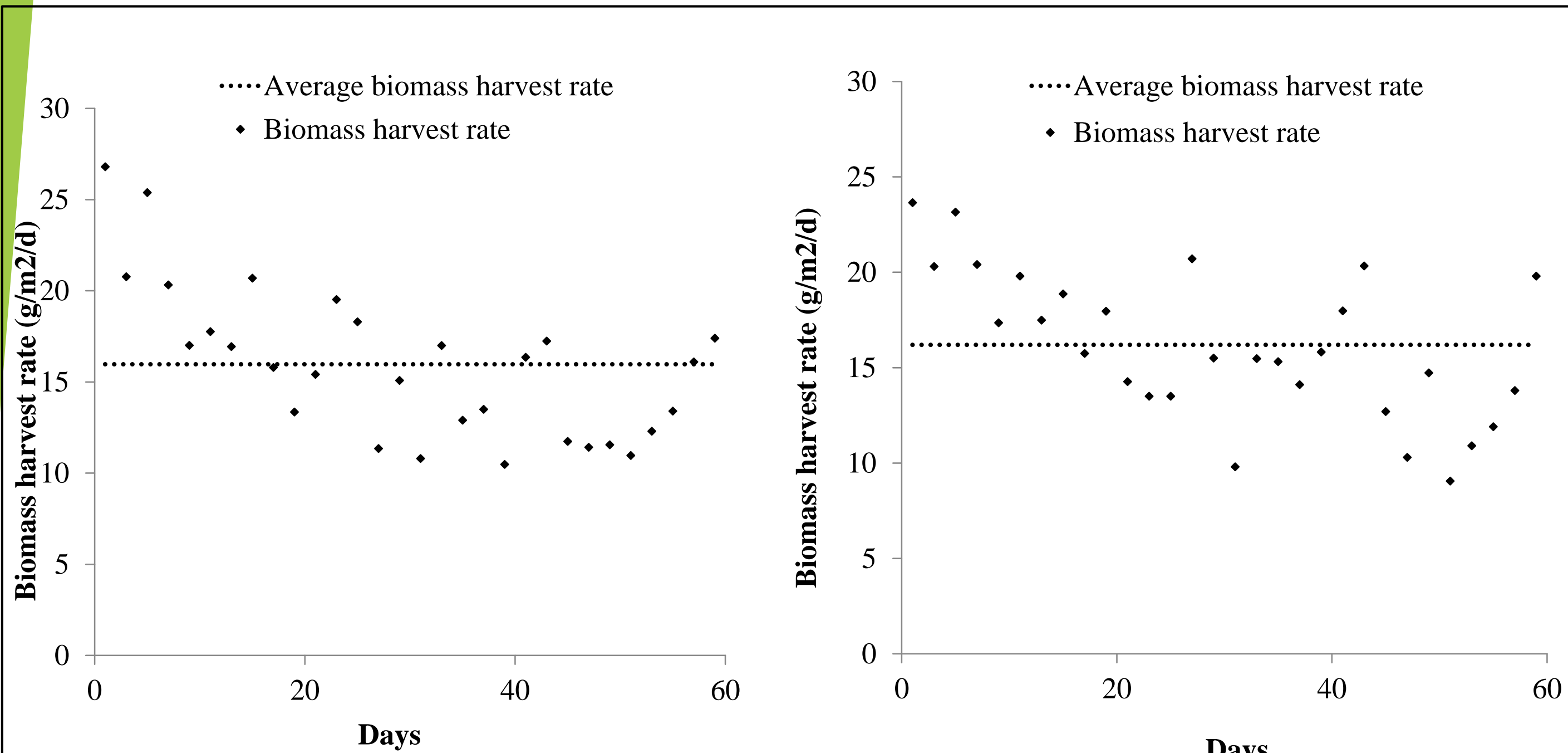
Methodology

- Chroococidiopsis* sp. marine cyanobacterial strain was used in this research work. *Chroococidiopsis* sp was grown indoor at 25 °C in 1 L Duran bottles in triplicates.
- For the large scale biomass production, 1 liter culture of any strain was inoculated into a 10 L plastic PBR 4 of these 10 L PBRs were inoculated in two 200 L raceway tank.
- All the nutrients were added as modified Guillard f/2 concentrations in seawater.
- When culture reached stationary phase, biomass was harvested using self-settling ability of *Chroococidiopsis* sp.
- Self-settled biomass was centrifuged at 5000 RPM for 10 mins.
- Biomass pastes obtained from centrifugation was sun dried and kept in a cool place for further analyses and HTL experiments.
- Elemental analysis was conducted for microalgae biomass and Biocrude oil. Higher heating values were obtained using Dulong formula: Heating value (MJ/kg) = 0.338C + 1.428 (H- O/8) + 0.095S
- Energy recovery was calculated as (%) using following formula ER (%) = HHV of biocrude/HHV of feedstock x Biocrude yield.
- Hydrocarbons were analyzed by GCMS and compounds in biocrude were identified by NIST database

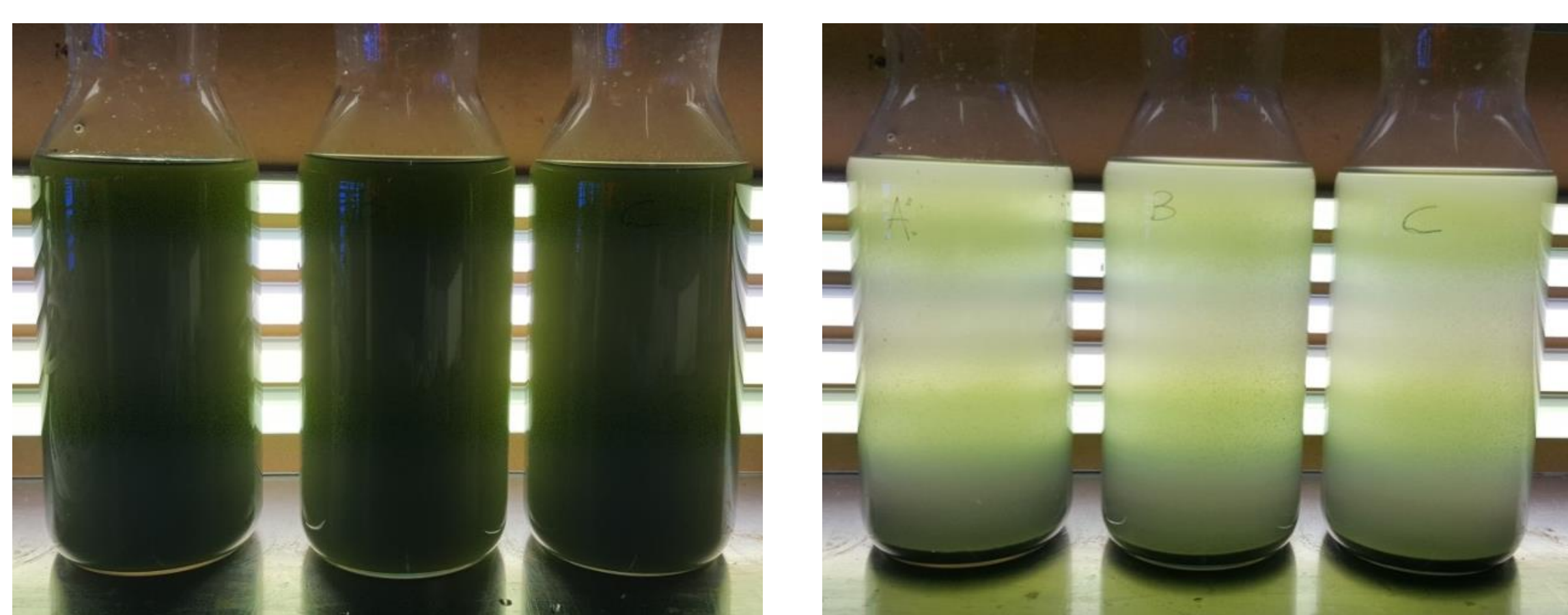
Chroococidiopsis sp. culture in 200 L raceway pond



Outdoor continuous cultivation of *Chroococidiopsis* sp. in 200 L raceway tanks

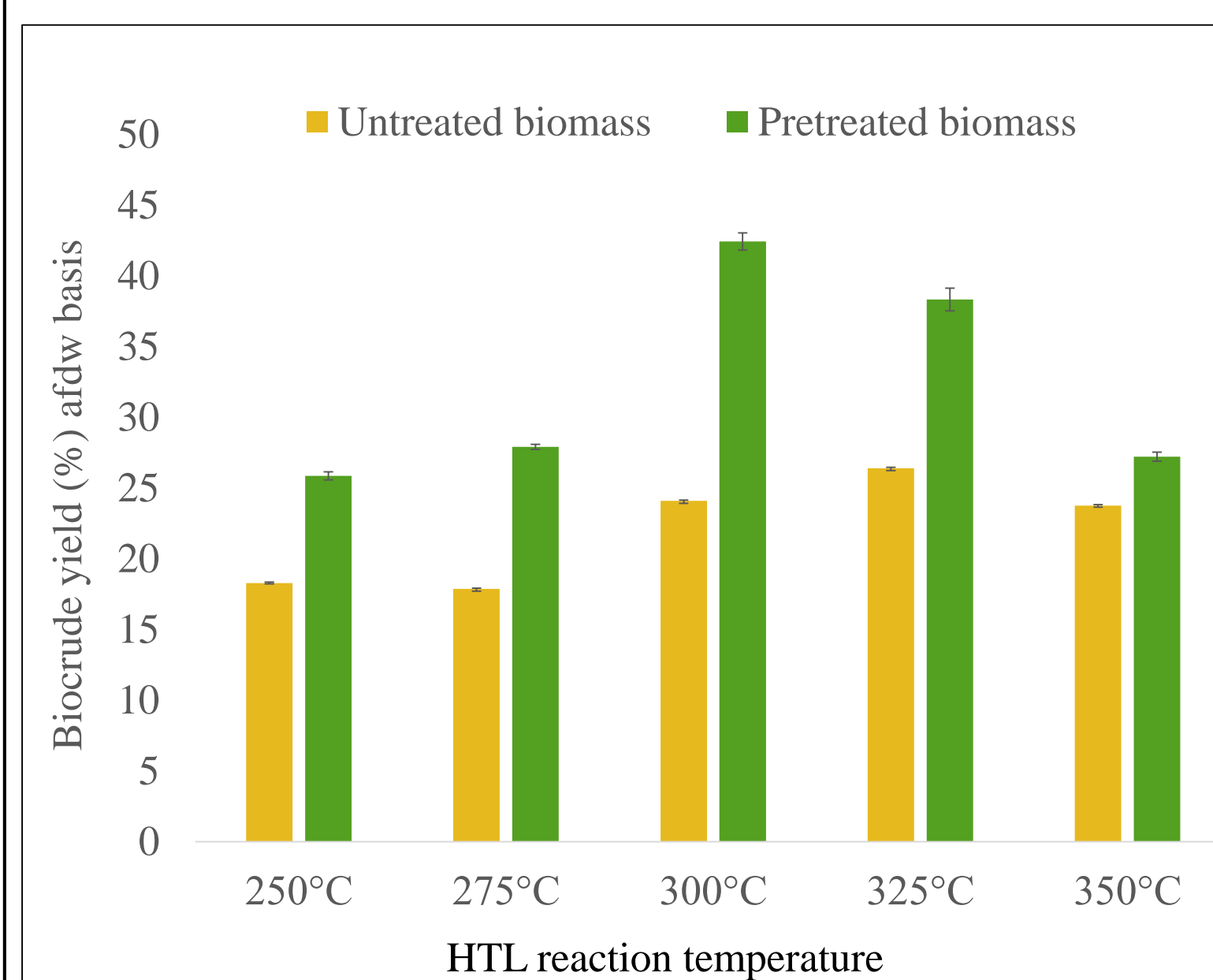
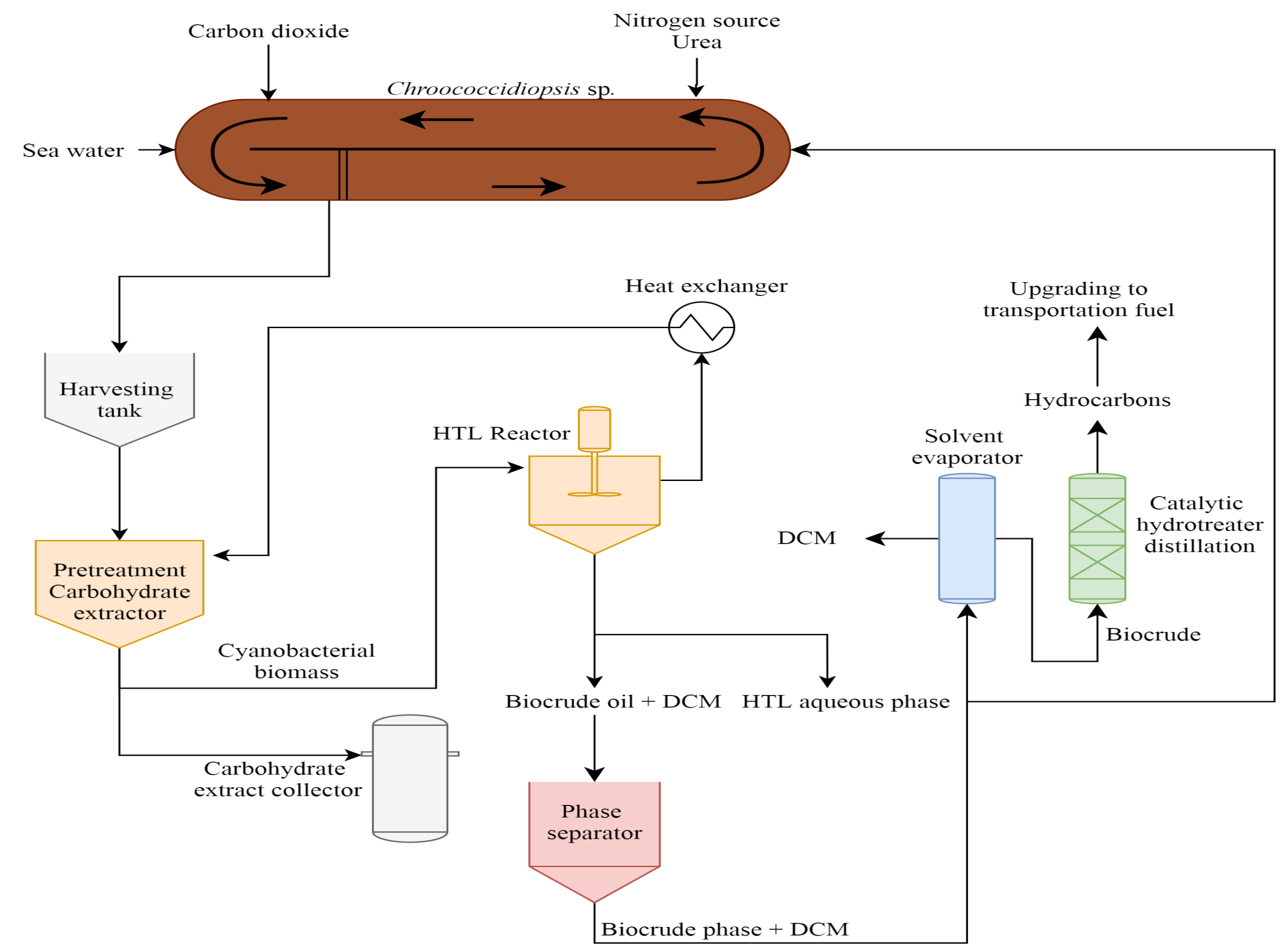


Biomass harvest rate in tanks, Tank 1 (left) and Tank 2 (right)

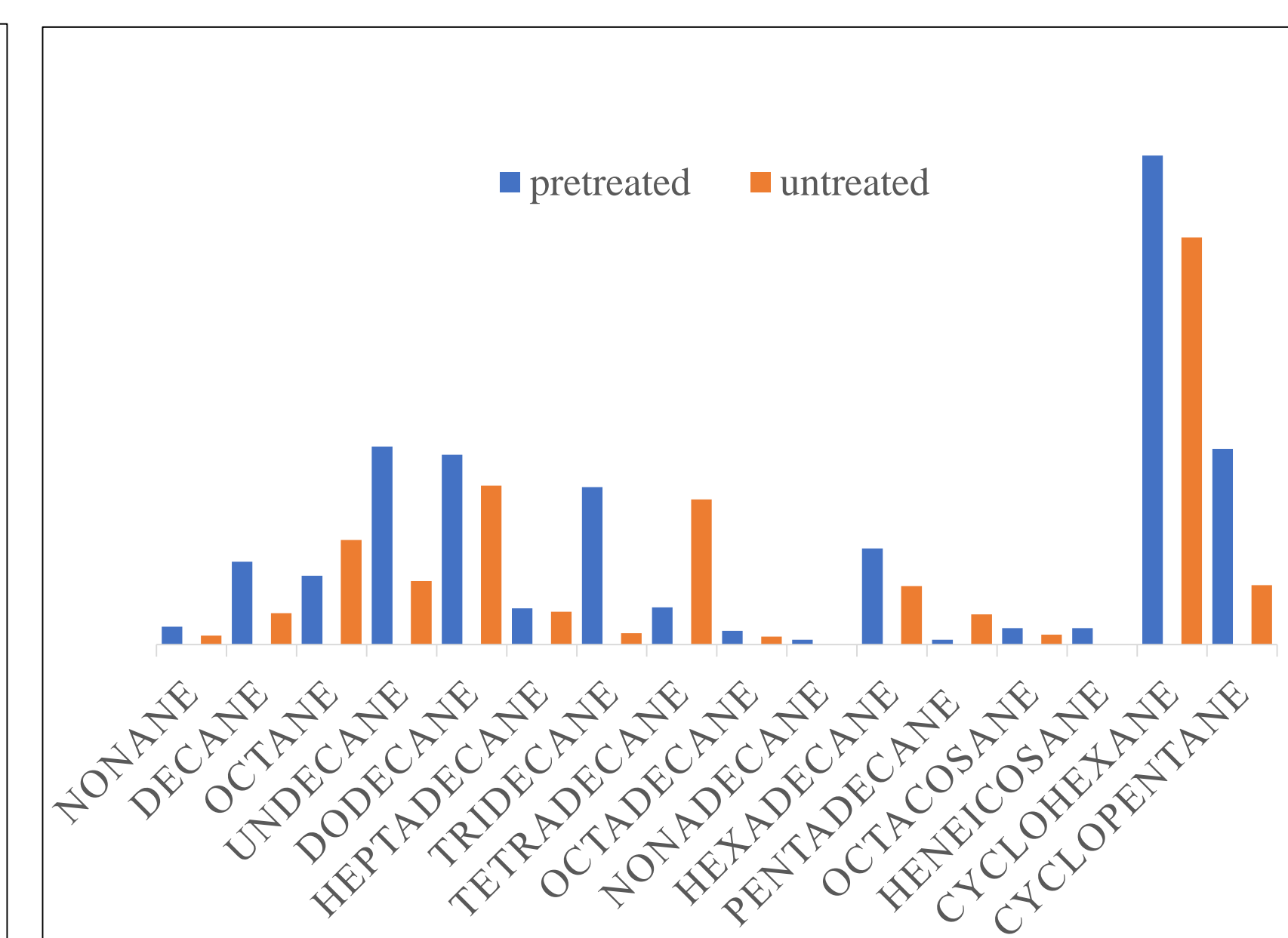


Left – Initial *Chroococidiopsis* culture Right – self settling *Chroococidiopsis* after 60 minutes

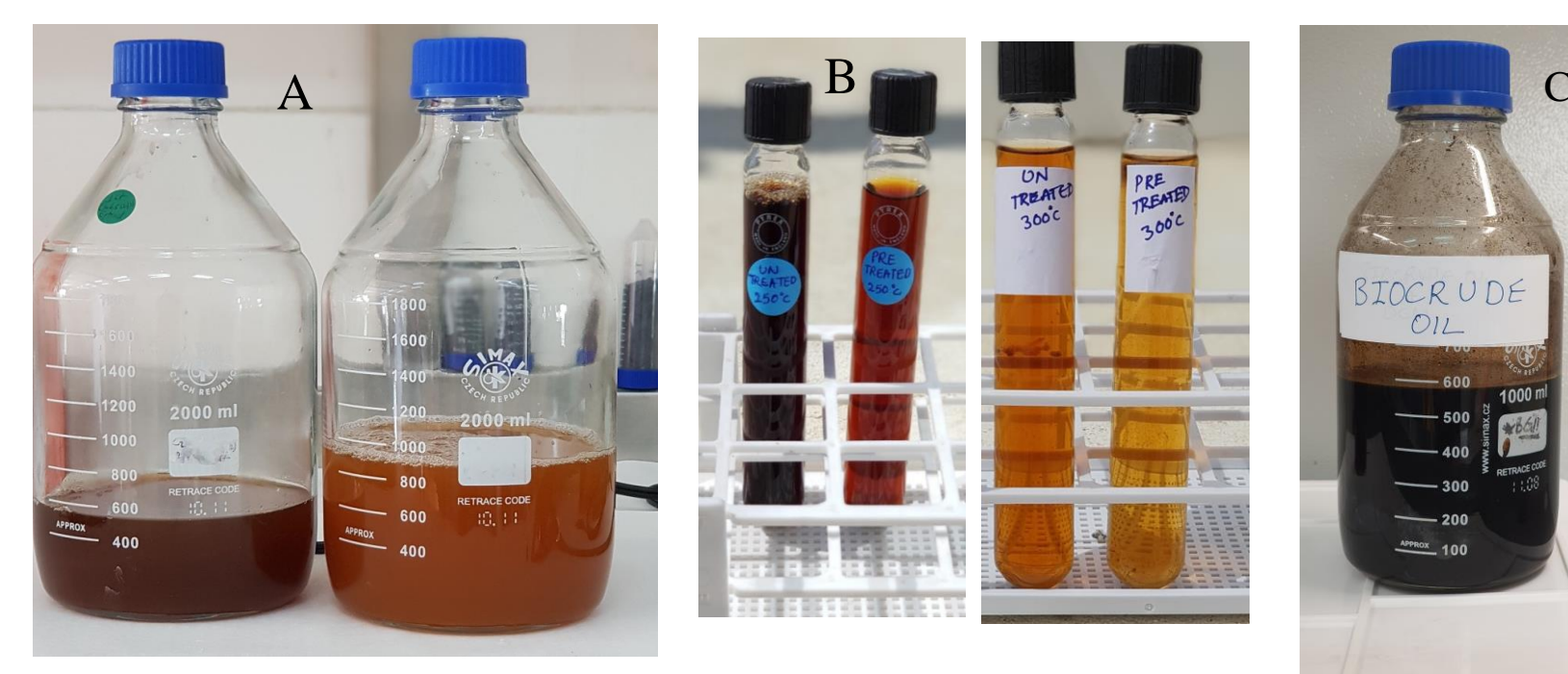
Process schematic



Biocrude yields obtained from pretreated and untreated biomass at different HTL reaction temperatures



Comparison of hydrocarbons (alkanes) obtained from HTL of treated and untreated biomass.



Left to right – (A) Carbohydrate extract from pretreated biomass, (B) HTL aqueous phase from pretreated and untreated biomass, (C) Biocrude oil

| | C | H | N | O | HHV (MJ/kg) |
|---------------------------------|------|-----|-----------|------|-------------|
| <i>Chroococidiopsis</i> biomass | 30.2 | 6.4 | 3.1 | 60.3 | 16.9 |
| Biocrude oil | 69 | 7.9 | 4.49 | 18.6 | 31.28 |
| Energy recovery (%) | | | 41.16 (%) | | |

Table 1- Higher heating value and energy recovery from HTL of *Chroococidiopsis* biomass

Conclusion

Self settling ability of *Chroococidiopsis* reduces energy consumption during harvesting process
Pretreatment of biomass prior to HTL possibly removed carbohydrate fraction from biomass thereby enhanced biocrude oil yield at lower reaction temperatures
Pretreatment of biomass enhanced (C₈-C₁₉) hydrocarbon within the biocrude oil making it a potential feedstock for bio jet fuel feedstock.
Around 41% of energy could be recovered by producing biocrude oil from *Chroococidiopsis* using HTL technique
Carbohydrate extracted during pretreatment step could serve as a feedstock for bioethanol production.

Acknowledgment

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References

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