Integrated microalgae valorization via lipid extraction and fast pyrolysis of biomass residue

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Introduction

Figure 1. Microalgae biomass - *Chlorella Vulgaris*

Microalgae have received increasing attention in recent years as a promising source of renewable energy and bio-based products due to their high growth rate and high lipid content. The integrated microalgae valorization process, which involves the extraction of lipids from microalgae and the subsequent catalytic fast pyrolysis of the remaining biomass, represents a promising approach to maximize the utilization of microalgae to produce valuable products while minimizing waste and environmental impact.The extracted lipids can be processed into biofuels and other value-added products. The remaining biomass can be subjected to catalytic fast pyrolysis, which can be optimized to produce bio-oil with desirable properties, such as high energy density, low acidity, and low oxygen content by selecting appropriate catalysts and process conditions. The resulting bio-oil can be further upgraded by processes as hydrotreating, hydrodeoxygenation, and esterification, to produce biofuels and other high-value products.

Experimental/methodology

Figure 2. Py/GC-MS

Lipids from the Chlorella vulgaris microalgal biomass where extracted using the Blye & Dyer method (B&D). The lipid fraction was characterized after transesterification with methanol (1:5 w_{lipids}/v_{MeOH}) and H_2SO_4 (1:20 v/v) as a catalyst with GC-MS and GC-FID analysis of the relative esters. The fast pyrolysis and the catalytic fast pyrolysis of both the initial microalgae biomass and the residue after lipid extraction was studied on a Py/GC-MS (QP2010 Ultra, Shimadzu) (Figure 2) system and on a fixed pyrolysis reactor.

Figure 3. Soxhlet apparatus for lipids extraction

Results & Discussion

In the Py/GC-MS spectrum of the initial biomass (Figure 4), the peak of the phytol acetate is clearly visible, while in the spectrum of the biomass residue after lipids extraction, there is no peak, confirming the complete extraction of chlorophyll in the lipid fraction. Figure 4 also shows the peaks of n-hexadecanoic acid, which is a free fatty acid of the microalgae biomass, and cis-9-hexadecanal, which is a degradation product due to high temperature in Py/GC-MS tests. Figure 5 still shows the peak of n-hexadecanoic acid, which testifies to the incomplete extraction of fatty acids from the biomass with the chosen method. Indole is derived from the thermal degradation of tryptophan. 2,3 dimethylpentanal is derived from thermal reduction and acid isomerization of the biomass. In catalytic fast pyrolysis, aliphatics and BTX aromatics were produced.

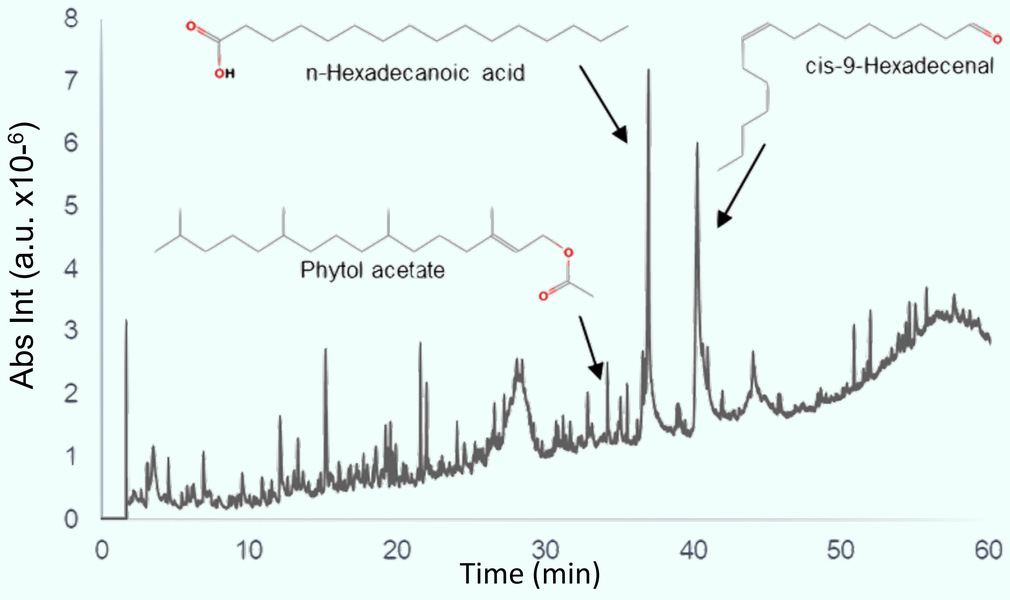

Figure 4. Py/GC-MS spectrum of initial microalgae biomass.

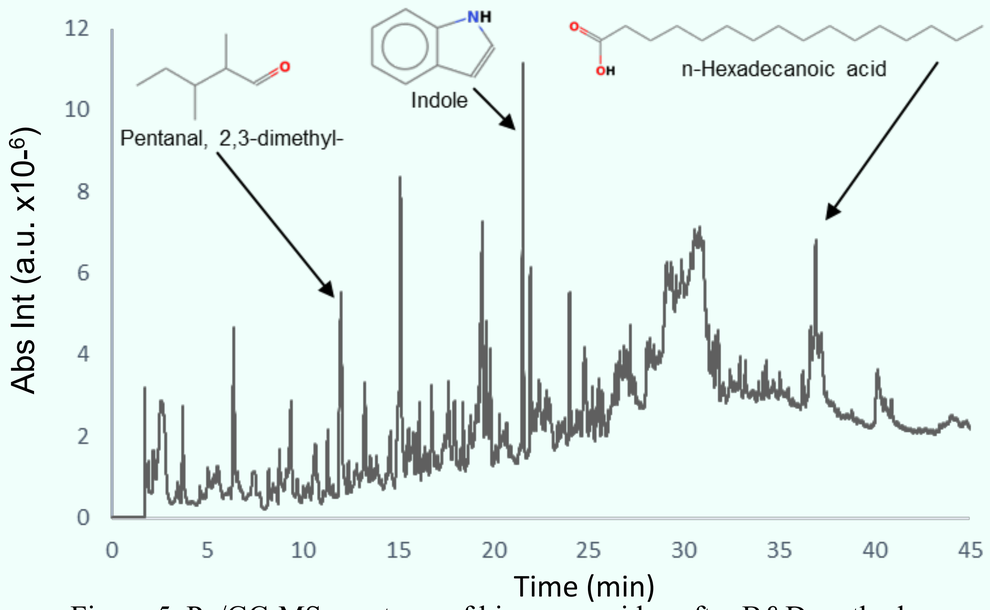

Figure 5. Py/GC-MS spectrum of biomass residue after B&D method.

Conclusions

- ✓ B&D method does not extract the whole lipidic content from the tested *Chlorella Vulgaris* strain and adjustments need to be made for total lipid removal.
- ✓ Catalytic fast pyrolysis of biomass residue in a Py/GC-MS analysis shows the potential for valorization of the residual biomass

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