Biodiesel Production from Algal Lipids

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Background

Algae not only ingest excess carbon emissions from the atmosphere, but they also convert it into energy dense lipids which can be harvested, and then transformed into biodiesel. The overarching goal of this project is to make algal lipid extraction more efficient through means of culturing the algae species Chlorella Vulgaris and evaluating biodiesel produced via H^1NMR, C^{13}NMR , and IR. Powdered algae was used to test and refine the biodiesel production procedure. A biodiesel standard was created from canola oil which was then compared to the powered algae biodiesel. The results are presented hereafter.

Introduction

Algae are aquatic organisms that convert carbon dioxide into biomass. Biomass consists of carbohydrates, proteins, and lipids. These lipids are mostly triglycerides, we will exploit that fact and execute a chemical reaction known as Transesterification which converts triglycerides into biodiesel (fatty esters). Algae is a promising alternative for its carbon neutrality, renewability, and high energy content. Compared to other crop-based biofuels, algae is extremely productive as it produces up to 10-300 times more oil per acre. Algae is also not a food source, unlike soy and corn. However, conversion of algae to biodiesel is a complicated process and takes a lot of time compared to petroleum fuels.

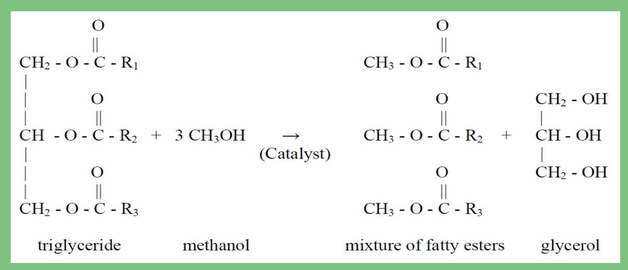
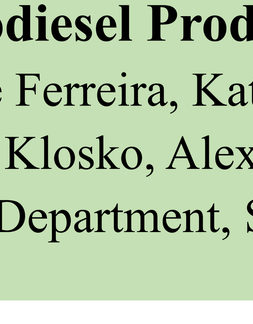


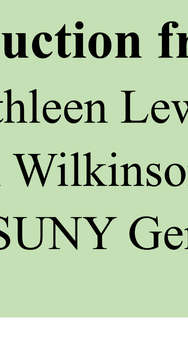
Figure 1. Biodiesel transesterification reaction

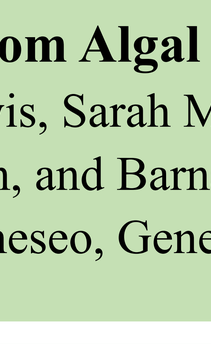
Methods

1. Lipid Extraction/Transesterification Of Powdered Algae

The algae was shaken in a 2:1 chloroform-methanol solution. This solution was then centrifuged and added to a separatory funnel with a 0.73% NaCl solution. The bottom layer was collected, and the chloroform was then separated using rotary evaporation. Transesterification reaction was run for 2 hours at 60ºC. A final IR analysis will be carried out in the future to determine if the synthesis was successful.

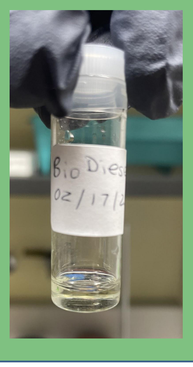


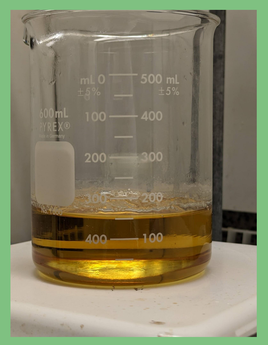




2. Canola Oil Biodiesel Production Standard

300 mL of canola oil was heated to 50℃. In a separate flask, 0.5 g of NaOH was combined with 32 ml of methanol and heated to 50 ℃, and was then poured into the canola oil. This solution was stirred vigorously for 45 minutes at 70℃. The oil and biodiesel was then removed from heat and allowed to cool. The top layer of biodiesel was poured off and then tested in IR.





Results

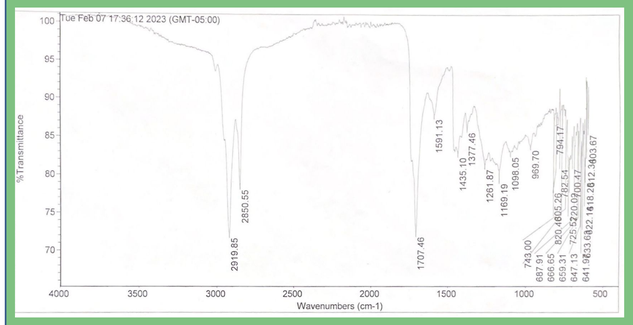


Figure 2 (left) : Biodiesel produced from powdered algal lipids. The sharp peak at 1707.46 cm^{-1} indicates the ester carbonyl bond of the biodiesel. The peaks at 2919.85 cm^{-1} and 2850.55 cm^{-1} indicate methyl groups.

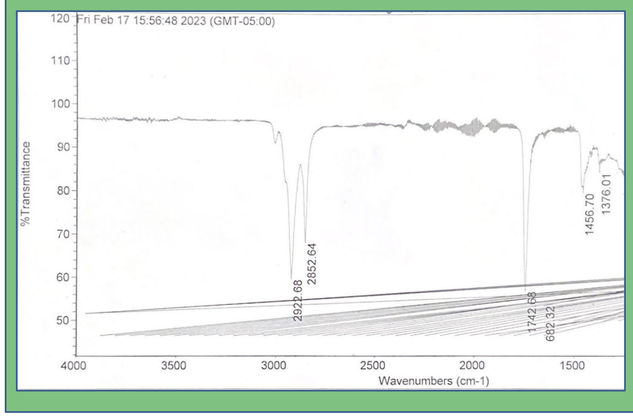


Figure 3 (left) : Biodiesel Standard from canola oil. The peak at 1742.68cm^{-1} demonstrates the the carbonyl group of the methyl ester biodiesel. The 2922.68 cm^{-1} and 2852.64 cm^{-1} peaks indicate methyl groups.

Conclusion

IR spectra of the biodiesel produced from the powdered algae suggests a successful lipid extraction and transesterification process, although there was very little yield. Culturing of live algae, grown in Bold Basal Media (BBM) is currently being done. Live algae conversion into biodiesel will be conducted in the upcoming fall semester. Future goals include comparing both the live algae biodiesel and powdered algae biodiesel to the canola oil biodiesel standard, which includes testing each biodiesel in H^1NMR and C^{13}NMR.

Acknowledgements and References

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