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Conversion to Ethanol and Biodiesel from Microalgae

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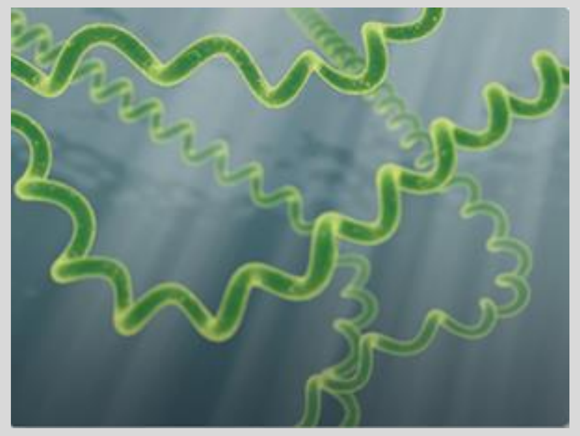
Abstract

There have been many attempts in finding alternative, more environmentally safe, ways to produce ethanol and biodiesel. Different algae strains have been used and studied. *Spirulina* and *Selenastrum* were used in this experiment to produce ethanol and biodiesel respectively. Alcohol conversion was conducted by first fermenting *Spirulina* followed by simple and fractional distillation. Fermentation converts the carbohydrates into the resulting alcohol. Distillation purifies the alcohol, lowering the density as more water is removed from the product. Analysis of the resulting product was then gathered by determining density of the product. For biodiesel production, KOH and methanol were mixed to produce methoxide ion, converting *Selenastrum* into a biofuel. Several ways to lyse the cell wall were explored.

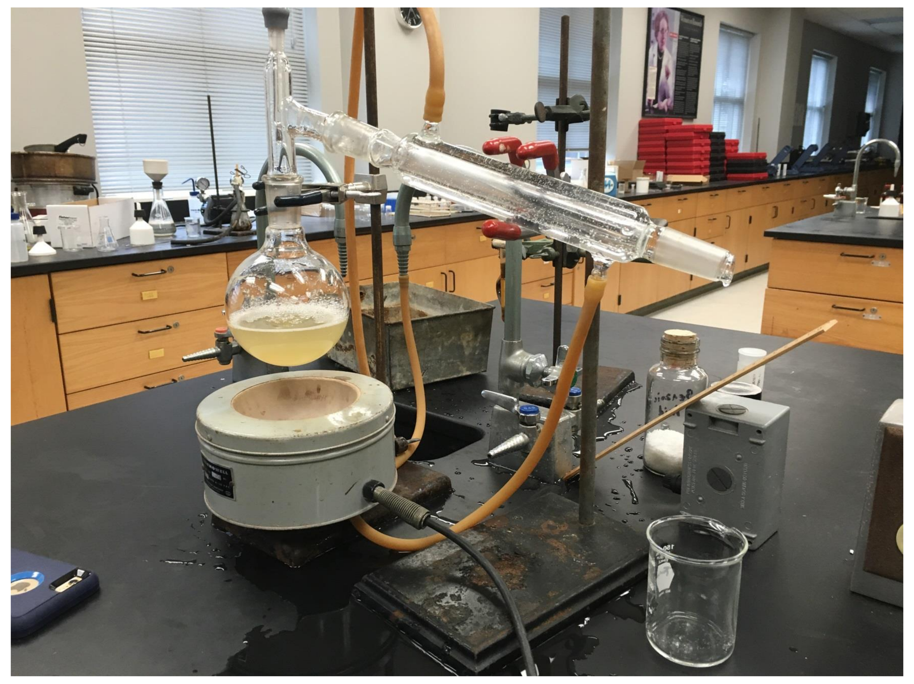


Spirulina

Spirulina is a cyanobacteria that grows in alkaline waters. It strives in pH levels of 8.5-10.5 and flourishes in warm regions of 35-40˚C. *Spirulina* are tiny green filaments that are coiled in spirals. They are similar to Gram-positive bacteria and can be broken down by digestive enzymes. Their carbohydrate content is between 15-25% and their lipid content is about 7%.

Spirulina to Ethanol

To ferment our algae, we transferred 200 mL of *Spirulina* into a 500 mL round bottom flask, added 3.5 g of dried baker's yeast, and added 0.35 g of Na_2HPO_4.
We then filtered the fermented algae, began the simple distillation, and performed a fractional distillation.
Once we received our sample from the fractional distillation we calculated the density.



Five different trials were done, each using a different method to help break the cell wall and using either uncultured or cultured *Spirulina*. Freezing and sonication were used to help break the cell wall.

Results

In all five trials, we calculated densities between 0.98-1.01 g/mL. One error that may have impacted our results was that the sample distilled between 90-100˚C instead of between 77-80˚C.

Selenastrum

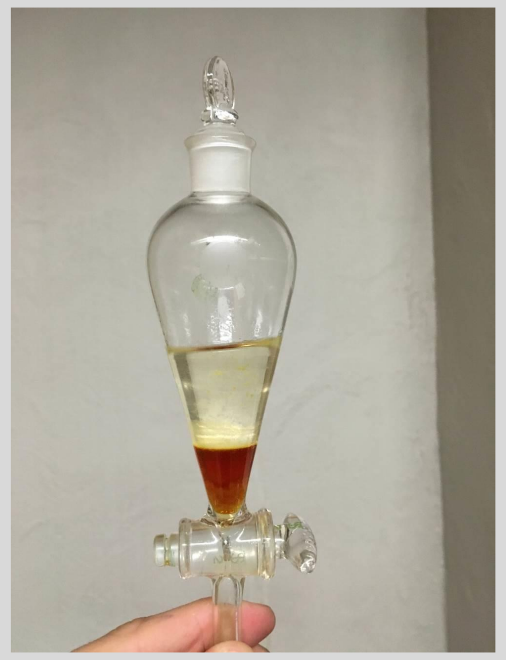
Selenastrum is a green microalgae found in freshwater systems that is rich in lipid content and has a very tough cell wall.

Selenastrum to Biodiesel

To begin, a diesel control was produced from canola oil. In this experiment, 6.6 mL of methanol was heated with 0.5 g of KOH and mixed with the oil to allow the reaction to proceed. The free floating lipids in the oil quickly and easily converted into diesel. A wash test confirmed pure biodiesel. Turpentine was implemented into the experiment by adding warm quantities of it to filtered *Selenastrum* microalgal paste and heated further. The KOH and methanol mixture was then added and placed over heat for the full reaction to occur.

Diesel control

Biodiesel



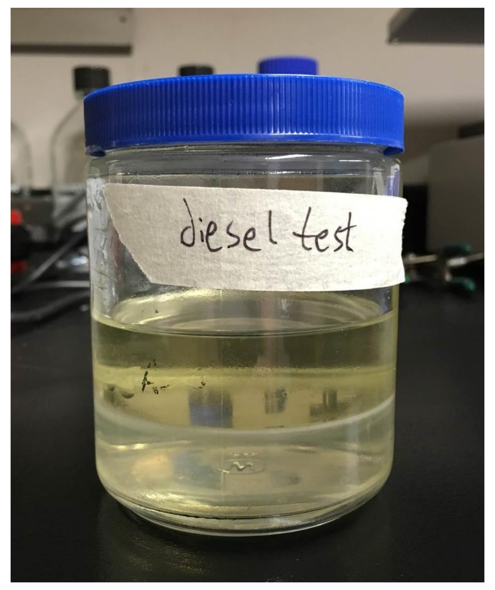
Conclusions

Ethanol

The density of ethanol is 0.789 g/mL, and it distills between 77-80˚C. Our algae distilled between 90-100˚C, and our density was between 0.98-1.01 g/mL. From our results, ethanol was not produced; however, further testing is needed. We believe it may have to do with *Spirulina's* low carbohydrate content. Further research should be conducted to see if other concentrations or requirements of the fermentation and distillations would be beneficial.

Biodiesel

Biodiesel was produced when using *Selenastrum* , but results were inconclusive when using *Spirulina*. We believe this is because *Selenastrum* has a much higher lipid content than *Spirulina*. Without the terpene, no biodiesel was successfully made. Further research should be conducted to discover other ways to break the cell wall of this microalgae as turpentine is a very flammable chemical.



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