Extracting Oils and Fermenting Carbohydrates from the Same Seed Source to Maximize Biofuel Yields

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Abstract
The need for a renewable and clean form of energy to power our transportation is growing as the negative effects of using fossil fuels continues to increase. One solution is the use of biofuels derived from seed sources like corn, primarily used for ethanol, and soybeans, primarily used for biodiesel. Typically, only one type of biofuel would be extracted from a seed, but this experiment attempts and successfully extracts both the oils and ferments alcohol from the same seeds. The experiment not only tested corn and soybeans, but it also tested acorns due to the fact that it is not a food stock. The results are that the acorns provided the highest weight percent of both oil and ethanol with 30.0% extracted out of its flour. The extraction and

transferred to a 1L round bottom flask and then allowed to cool to 70°C. While cooling, the pH of the water was tested with litmus paper to check that the pH was in the range of 5.5-6.0 for optimal conditions for the bacterial alpha amylase (BA 100 from Mile Hi Distilling). If the solution was too basic, 1M citric acid was added dropwise. If the solution was too acidic, 1M sodium carbonate was added dropwise. Once the sample was ready, 2.2% (w/w) of the alpha-amylase to oil extracted flour was added to the solution, mixed, and placed in a 70°C water bath for an hour. The mash solution was removed from the bath to cool to 57°C and the pH was then adjusted to about 4.5. At 57°C, 2.2% (w/w) of glucoamylase (GA 100 from Mile Hi Distilling) to flour was added to the solution, mixed, and placed into a 57°C water bath for 1 hour. The mash was allowed to 35°C out of the bath. The nutrient content for the yeast was boosted by adding 0.2mL of a Pasteur salt solution per gram of flour and 0.34% (w/w) of urea to flour.

Once the solution reached 35°C, 0.66% (w/w) of Ethanol Red® yeast (from Phibro Ethanol Performance Group) to oil extracted flour was added to mash and sat at that temperature for 20 minutes. After hydration of the yeast, the flask was sealed with parafilm that had holes to prevent a pressure build up and the mash solution was placed in a 33°C incubator for at least 7 days to ferment. After fermentation, the mash solution was decanted and strained via a 1 gallon paint strainer (Blue Hawk from Lowe's®) into a clean round bottom flask. Boiling stones were added to the filtered mash solution and hooked up to a 300mm vigreux column and still head/water condenser combo. The filtered mash was distilled and 5mL fractions were collected until the still head reached a temperature of 99°C or greater. Each fraction was later analyzed for ethanol content using a Perkin Elmer Clarus 500 GCFID. The internal size standard used was 0.40mL of 2-propanol was used for a 1.00mL of fraction in the vial for analysis. The ethanol to 2-propanol peak areas were compared to a calibration curve that consisted of 1.00%, 4.00%, 10.0%, 40.0%, and 100.0% ethanol. All of the samples tested in procedural and instrumental testing were done in triplicate.

Table 2 Perkin Elmer Claurus 500 GCFID parameters

Parameters	Settings
Column	Zobrax ZB-1 phase 30M-0.32mm i.d.-1.0εm
Injection Volume	0.5εL
Oven	45°C for 4min isothermal
Carrier Gas Pressure	He @ 10.0 psi
Injector Temp	250°C
Split Control	50:1
Detector Temp	280°C
Detector Gases	H_2 : 45.0 mL/min He: 450.0 mL/min
Events	@ 0.00min split 50:1 @ 1.75min split 1:1

Results and Discussion

Table 3

This experiment could be further optimized to improve the yields of biofuel, especially for ethanol. The oil extraction method with the soxhlet extractor and hexanes is fairly standard, but a different solvent would help improve its environmental impact. During the mash boiling, some of the flour burned on the bottom of the flask and could have affected the ethanol yield. There are several other factors that can be used to improve the yield of ethanol such as using more types of enzymes and improvements in temperature control though out the process

Conclusion

The experiment was overall a success that it was possible to extract oil and ferment alcohol with the same seed. The seeds in the experiment yielded fuel in their relative concentrations as expected, except for the soybean

Toect00(o)16ipota th]TJ -10(o)162(i6p)--1(u-0.001 Tc 0.185 T36[(i)-6.289 [(T)-13lt(f)11(i)-12(s)-10(h(o)-4(a)-15(n)5(ot)-4(a)-15)