Micro-scale Potential Viability of Bio-fuel from New York Ponds

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New York lakes have an abundance of algae that has been known to clog up several homes that are located near water banks. The homeowners constantly unclog the algae from their pipes and simply throw it away without knowing the advantages that algae have to create a more environmentally and economically friendly world. Recently research has been involved in obtaining the algae found on the surfaces of these open water bodies and near homes to create algae bio-fuels. Collecting algae and delivering it to labs where oil can be extracted and tested can be profitable for the growing bio-fuel market. This study focuses on the ability of successfully extracting usable amounts of bio-fuel from algae found in a New York pond and compares it to the bio-fuel extracted from other regions.

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Introduction

Algae are photosynthetic organisms that are found on the surfaces of open freshwater bodies of water and wastewater, and can also be found on certain areas of land. Mostly green in color and slimy, they are very prolific in producing more oxygen compared to many other plants in the world. Algae can be distinguished into two groups; the uni-cellular form being microalgae and the multi-cellular form being macro-algae. Not only do these algae provide us with oxygen and food for certain animals, algae can be cultivated under controlled climate conditions to produce byproducts such as fat, oils, sugars, and bioactive compounds. Perhaps the most interesting use of algae is its ability to secrete oils at a much higher and more productive rate than corn and soy. More than 50% of algae's bodyweight consists of lipids. Studies show that soy produces about 50 gallons per acre of oil per year; canola, about 150 gallons; and palm, 650 gallons. Algae can potentially generate around 10,000 gallons of oil per acre per year (Haag, 2009). Bio-fuel from algae has the potential to be an economically viable, low emission transportation fuel. Algae can be grown at a rapid pace requiring only sunlight, water, and carbon dioxide to grow while doubling its volume overnight.

Recent studies have tested several strains of algae, including both macro and micro algae. Some of the most common strains of algae used include Oedogonium and Spirogyra, both of which are macro-algae as well as several species of Chlorella which are micro-algae. Macro-algae can be defined as being seaweed and larger in size as compared to micro-algae which are very small, resembling organisms which can be seen with the aid of a microscope. These studies have tested the ability of macro and micro-algae to produce useful oil that may be comparable to that of regular petroleum. In the study called "Biodiesel fuel production from algae as a renewable energy", a group of scientists performed an experiment to find the proper transesterification amounts of biodiesel production and the physical properties that came out of the biodiesel (Houssain, 2008). They used the species Oedogonium and Spirogyra to compare their amounts of the biodiesel produced. The results showed that after oil extraction, the biomass was higher in Spirogyra than in Oedogonium. Their results reinforced the notion that different species of algae can produce different amounts of biodiesel and that some are more efficient at excreting certain amounts than others (Am. J. Biochem & Biotech, 2008).

Similarly, studies have been performed to test the feasibility of transesterification to reduce the viscosity levels in the resulting bio-fuel. Viscosity results when the bio-fuel turns out to be very thick and causing an inability to sufficiently burn out during use. Certain studies have viewed the transesterification process to be the key element in reducing viscosity problems.

Transesterification is the chemical reaction of an alcohol of one ester, with the presence of the second alcohol, in order to create an ester of the second alcohol using the original ester. Essentially, transesterification targets a triglyceride molecule from a fatty acid to neutralize the acids which will separate the glycerin to produce an alcohol ester. Many studies mixed methanol with sodium hydroxide to create sodium meth-oxide (Oilgae.com, 2007). Experiments have been undertaken to test whether regular soaking periods in potassium hydroxide will secrete more oil and reduce viscosity during the extracting periods. Studies showed that subjecting the algae to regular soaking intervals in the potassium hydroxide solution and then expressing the oils, produces more oils to be secreted (Vijayaraghavan, 2009). This study resulted in the development that certain timings during soaking intervals produce more oil than others.

New York Lakes have a massive quantity of algae that may be quite profitable to harvest, collect and convert to bio-fuel. This study focuses on the ability to successfully extract usable amounts of bio-fuel from algae in a New York pond.

Materials and Methodology

Collection of Algae – Algae was collected in a near Mountain View, Valley Cottage, NY. A net was needed to scoop out the algae, and the algae was placed in a plastic container. The algae was then brought into the Rockland Community College (RCC) greenhouse where an A-5 nutrient solution was added to keep the algae fresh.

Algae drying period- After about 3 days, the algae was strained of water and the A-5 chemicals and dabbed with a paper towel to dry out some more excess water. The algae was then weighed and the mass came out to be 50 grams. This algae was then placed back into the plastic container and was then separated into small flattened chunks and spread throughout the container which was then placed in an incubator at 80 degrees Celsius for four intervals of 20 minutes. The algae was checked after each 20 minute interval to see the amount of water evaporation until dry. After 80 minutes, the algae was taken out and placed back in the greenhouse to further undergo the drying process for about five days.

Grinding the algae – The dried algae was ground in a blender and then placed back in the 80 degree incubator for 20 minutes to sufficiently dry once again.

Soaking Period – The dried and ground algae was then soaked with 35mL of hexane (solvent) and ether solution and left for 3 days to settle.

Oil Extraction - Algae that was soaked in hexane solution was then subjugated to the expression process to squeeze out lipids using an expresser and a separating funnel. This process separated the triglycerides from the algal biomass, which was in the solvent.

Evaporation - The extracted oil was then placed in a vacuum to release the hexane and ether solutions with the use of the rotary evaporator. The mass was measured before and after the extraction.

Mixing of the Catalyst and Ethanol (Transesterification) - The catalyst, 4.0 mL of KOH (potassium hydroxide), was then mixed with the dried algal mass by the use of a vortex mixer for about 15 minutes. The extracted triglycerides from the hexane extraction process were then treated with 30 ml of ethanol and potassium hydroxide as the catalyst. The reaction was then stopped by the addition of water.

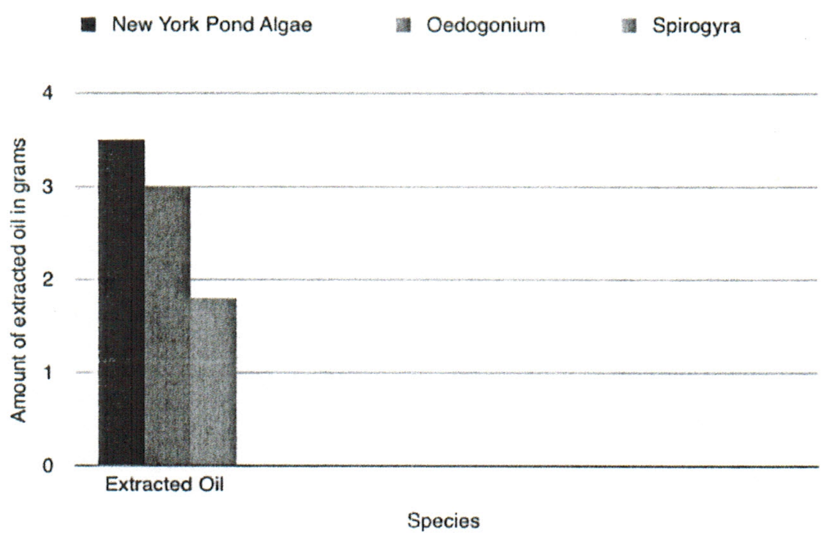
Shake and Settle Period - The flask containing the solution after the transesterification process was then shaken for about 1 hour in an electric shaker. The solution was then left to settle for 2 days so that the biodiesel and the sediment layers could settle and separate.

Separation of the Bio-fuel - The bio-fuel was then separated from the sediments by using a flask separator.

Washing - The bio-fuel was then washed with water until it was clean using a water bath over the lab table sink.

Drying - The bio-fuel was then kept under a fan to dry for about 10 hours.

Figure 1. Compares the amount of oil extracted from algae in this study compared with the amount extracted in the study by (Houssain, 2008). The amount of oil extracted by the algae in this experiment is similar to the amount of oil extracted from the macro-algae species Oedogonium. While the oil extracted from this experiment was 3.5 grams, as stated in figure 1, (Houssain, 2008) extracted 3.0 grams.



Fresh weight before incubator	After incubator (Dry Weight)	Extracted oil
50 grams	15.8 grams	3.5 grams

Figure 2. Shows the measured values in grams of the dried algae before and after being places in the incubator as well as the final weight of the extracted oil.

Discussion

Overall, the algae bio-fuel extracted in this experiment is comparable to the oil extracted from the species Oedogonium and Spirogyra in the study by (Houssain, 2008). Further research would have to be done to determine the exact species of algae that was collected from the New York pond. Knowing the species of algae that were used could give further insight as to which of species of algae produce efficient amounts of bio-fuel as opposed to others. In this study, the algae, after the grinding process, was soaked in hexane only once, due to time constraints. Perhaps another study could soak the algae several times after each expression process in order to determine the most effective method of oil extraction. This process could potentially help in finding out which timings of the soaking periods are more effective at excreting the most oil.

Another study could also be carried out by harvesting algae from several different ponds in New York to test the viability of algae in different regions throughout the state to figure out whether regions affect algal bio-fuel or whether these regions have different species of algae. Additionally such a methodology would determine which species in which ponds or lakes, produce the greatest amount of bio-fuel. If this study could be done, a greater mass of algae would need to be harvested in order to maximize the efficiency of the results.

Economically, algae are seen as the most effective alternate source for bio-fuel production. Algae have the factor of sustainability that allows it to be able to reproduce through the use of proper balance of carbon dioxide, water, and sunlight. This advantage gives algae the ability to reproduce at higher rates than corn and soy.

Bio-fuel companies have invested in photobioreactors which resemble green houses allowing scientists to control the amount of light, water, and carbon dioxide algae receives in a closed environment where no gases or other potential contaminants are leaked out or into the photobioreacors.

Algae not only has environmental benefits, but societal ones as well. More jobs can be created in the fields of algal growth, such as cultivating algae farms. More researchers and scientists will have opportunities to extract bio-fuel and learn more about effective methods to obtain viable amounts. The ability to create a local sustainable energy source for little money would be very prosperous for not only the community but for the protection of our planet as well. Algal growth would help clean our air from by talking carbon dioxide as a nutrient for growth. Algae farms could be built near factories where pollution is high therefore absorbing the carbon dioxide emissions for its growth as well as cleaning the air.

Conclusion

The results from this study proved that oil extracted from algae in New York ponds can be comparable to oil extracted from various regions. While this is a micro-scale study, results showed a viable amount of oil was extracted from a small mass of algae. This ultimately concludes that many species of algae, regardless of region can be used to extract usable amounts of bio-fuel that could potentially replace if not be side by side with regular petroleum in the future.

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