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Project Title
Comparison of Alternative Sources for Efficient Biofuel Production: Effect of Type of Biofuel Source on Energy Density

Abstract

Objectives/Goals
Within two generations, 90% of the world's oil reserves are expected to be depleted. A renewable source of energy is needed for the world to sustain itself. Biofuels, an environmentally friendly alternative, are carbon neutral fuels derived from organic matter. The objective of this experiment was to determine which source oil generated the highest quality biodiesel out of microalgae, macro algae (kelp), and a plant-based biodiesel source (soybeans). It was hypothesized that micro algae oil would yield the highest energy density due to its high lipid content, followed by kelp oil, then soybean oil.

Methods/Materials
The significant materials used in the experiment were soybean oil, kelp oil, micro algae oil, dandelion oil, sodium hydroxide, methanol, and a ring stand to test energy density. Oil was transesterified to convert oil to biodiesel, reacting with methanol and the catalyst sodium hydroxide. To test fuel quality, biodiesel was used to heat water over a constant period of time. Temperature increase was measured using a thermometer.

Results
On average, the microalgae biodiesel raised the temperature by 29.83 ºC. Soybean biodiesel raised the temperature by 24.83 ºC. Kelp biodiesel raised the temperature by 22.5 ºC. Through repeated trials, it was determined that micro algae biodiesel had the highest energy density, followed by soybean biodiesel, then kelp biodiesel. This was due to the characteristics of each biodiesel's source oil.

Conclusions/Discussion
Although lipid content impacted the final energy density, allowing microalgae to exceed soybean, the source oil's chemical structure impacted the energy density more. Since triglyceride oil molecules yielded more biodiesel than diglyceride or monoglyceride oil molecules and microalgae and soybean oil were triglycerides while kelp oil was a diglyceride, microalgae and soybean both exceeded kelp's fuel quality. In further experimentation, the invasive species dandelion was found a promising biodiesel source. Today, waste soybean oil accounts for nearly 50% of America's biodiesel usage. In the future, open ocean farming of microalgae could yield 7x the oil that is converted into high quality biodiesel to reduce the effect on global warming.

Summary Statement
By burning different biodiesel to test energy density, I found that biodiesel such as microalgae with a triglyceride source oil chemical structure has high energy density, making it a promising alternative fuel.

Help Received
I researched and performed the transesterification of oil and testing of energy density. I received supervision during the chemical reaction process and burning of biodiesel; I received help from my science teacher in understanding the chemical structure of oil.