CALIFORNIA STATE SCIENCE FAIR
2012 PROJECT SUMMARY

Name(s)
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Project Number
S0610

Project Title
A Composite Study of Bio-Diesel

Abstract

Objectives/Goals
This project investigates the potential of five plant oils as alternatives to petro-diesel, with the primary objective to investigate the added value, if any, resulting from trans-esterification of these oils into bio-diesel.

Methods/Materials
Avocado, camelina, castor, coconut and palm oils, as well as their methyl-esters were studied for: i) physical properties of viscosity, freeze point, density, and pH; ii) fuel performance; and iii) comparative economics versus petro-diesel. Physical and chemical characteristics were measured using traditional techniques. Fuel performance was tested using a modified diesel generator and placing a constant load on the generator over a timed constant interval run and hen measuring the fuel consumed in grams. Grams consumed over a test period was then converted to an equivalent miles per gallon in terms of percent efficiency relative to the petro-diesel baseline. In addition, aged avocado oil was tested to investigate a potential drawback of bio-fuels, oxidative stability.

Results
Based upon physical and chemical properties, castor, coconut, and palm oils were eliminated as viable alternatives. However, all bio-diesels, including those of eliminated oils, proved viable, though coconut and palm diesels are constrained to serving as warm weather fuels.
In evaluation of energy efficiency relative to petro-diesel, testing indicated a baseline performance of 131 grams diesel consumed, which was converted to a base equivalent of 42.0 mpg. Fuel efficiency of petro-diesel was followed by avocado and its bio-diesel at 38.4 mpg, then camelina and its bio-diesel at 38.3mpg and 38.4 mpg. These were followed by the remaining bio-diesels, with the worst performing fuel tested, castor bio-diesel at 34.3 mpg

Conclusions/Discussion
For four of five fuels, conversion from oil to bio-diesel was an improvement in physical characteristics and performance. Camelina was the exception. Trans-esterification of camelina and avocado proved economically and environmentally unjustified though. Those two oils, as well as all five bio-diesels were found to be superior to petro-diesel in terms of environmental impact, and competitive with petro-diesel in performance measured on cost per mile basis. Furthermore, these can be produced at scale to be a measurable component of the total U.S. energy supply allowing for the potential for a substantial reduction in global CO2 emissions.

Summary Statement
This project investigates the potential of five plant oils as alternatives to petro-diesel, with the primary objective to investigate the added value, if any, resulting from trans-esterification of these oils into bio-diesel.

Help Received
Father converted oils to bio-diesel for use in the project.