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Feasibility of Biodiesel.

FINAL REPORT: SCREENING OF BIODIESEL FROM CURRENTLY UTILIZED PEANUT VARIETIES

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Preparation of Biodiesel from Peanut Oil: Peanut oil from nine cultivars (listed in Figure 1) was extracted using a CeCoCo cold press expeller by Wilson Faircloth's team at the National Peanut Laboratory (Dawson, GA). 100% Peanut oil based Biodiesel was prepared from the oil of these nine peanut cultivars. Small 100mL test batches were prepared to develop a recipe for each oil. Once ratios of reactants and catalyst were determined, 3L batches were made using approximately 3L of oil, 600mL of Methanol and 15g KOH. Reactions were carried out in 4L Erlenmeyer flasks with agitation at 60°C for 1 hour. The reactants were then transferred to 2L separatory funnels which were custom made for the project. The mixture settled for 1 hour and the glycerol byproduct was then drained. The product was washed twice with 300mL of water mist. Washes were allowed to settle for 3 hours and waste water was drained. Alkalinity of the Biodiesel was monitored until the pH reached near 7.0 at which time the product was allowed to settle. At this point many of the varieties exhibited major clouding issues some cultivars took over 7 days to completely clarify. It is assumed that the source of this clouding can either be attributed to gums in the oil that were not removed during the extraction process, or long-chained saturated fatty acids which caused gelling. Ultimately, the problem was solved by heating the final product to 70 °C for 10 minutes which clarified the fuel. The fuel did not cloud again until cooled to 10 °C.

Engine Testing of Peanut Based Biodiesel: Preliminary fuel screening tests were performed on peanut based Biodiesel. Fuels were simultaneously tested in two 6-kW single cylinder direct injection water cooled test engines (Kubota E750). This engine was selected because it is representative of modern on-road engines having similar injection and cooling systems, a relatively high compression ratio of 18:1, and rated rpm of 2500. Injectors were removed before testing and cleaned. The clean injectors were imaged using an Imagingsource DMK21F04 firewire imaging system. The injectors were then replaced and operated on the "torque test" cycle established by Korus et al. (1985). Fuel consumption and power output were monitored throughout the test cycle. At the end of the two-hour test period the injectors were carefully removed and digitally photographed once again.

Peanut based Biodiesel was tested in two concentrations 20% Biodiesel in 80% No. 2 ultra-low sulfur Diesel (B20) and 100% Biodiesel (B100). There was only enough material available to provide B100 using DP-1 extracted oil. DP-1 was tested in both B100 and B20 formulations and all other cultivars were only tested in the B20 formulation. The results of these tests were compared to those obtained by 100% Diesel. Volumetric fuel consumption was found to be significantly higher than diesel fuel with all Biodiesel blends. This was to be expected as the energy content of Biodiesel is lower than petroleum diesel.

Computer vision was used to quantify the amount of carbon deposit on injector tips after the torque test was completed. Injectors were imaged before and after testing and were normalized to a clean, unused injector as a standard. A coking index was developed according to the method of Goodrum, et al. (1996). This index is normalized a ratio of the coking tendencies caused by the fuel of interest and that caused by petroleum diesel fuel. Most varieties had slightly higher coking indices than diesel (1.00). However, two cultivars with low levels of saturated fatty acids had lower coking indices suggesting highly unsaturated oils may perform better than saturated oils. When compared to literature data (Peterson, et al., 1987) peanut based biodiesel exhibited similar performance characteristics to soy based Biodiesel and did not perform as well as canola or safflower based fuels.

Cultivar	Injector Coking Index	Fuel Consumption Index	Cloud Point (°C)
DP1 B20	1.27	7.23	19
GA01R B20	1.69	0.89	19
FR458TX B20	1.35	8.62	19
GA Green B20	1.70	6.24	17
GA02C B20	0.83	12.19	19
AT201 B20	0.57	4.66	19
AP3 B20	1.13	7.43	20
C99R B20	1.13	15.96	18
C-11-239 B20	1.15	16.95	19

Table 1: Fuel Properties of Peanut Based Biodiesel Fuels.

References:

Goodrum, J.W., V.C. Patel, R.W. McClendon. 1996. Diesel injector carbonization by three alternative fuels. *Transactions of the ASAE*. 39(3):817-821.

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Peterson,C.L., R.A. Korus, P.G. Mora, J.P. Madsen. 1987. Fumigation with propane and transesterification effects on injector coking with vegetable oil fuels.