

## ABSTRACT

### The Optimization of the Base-Catalyzed Transesterification of Mustard Oil (*Brassica Juncea L.*) to Produce Biodiesel for the Analysis of its Fuel Oil Properties

David St. Clair Wesley Dorant

Due to the global energy crisis in the 1970's, and the growing concern for climate change, there was a shift by many countries from the dependence on non-renewable fossil fuels to biodiesels. Interests in the development of edible oils for the production biodiesel continue to receive worldwide attention. Biodiesel is a mixture of mono-alkyl esters of long-chain ( $C_{16}$  -  $C_{18}$ ) fatty acids derived from renewable lipid feedstocks, such as vegetable oils or animal fats. Mustard oil (*Brassica juncea L.*) is another option for mono-alkyl ester (biodiesel) conversion. The potential of mustard oil to add value as a feedstock to satiate global energy demands has not been fully explored. In most parts of the world, it is considered unpalatable due to the high erucic acid content. As the world is faced with escalating food prices, mustard oil as a low cost, non-edible feedstock, is another attractive, sustainable alternative for renewable energy development.

The objective of this optimization study was to evaluate the feasibility of using mustard oil to produce bench-scale biodiesel. Methanolysis was chosen as the most appropriate method for methyl ester conversion. Three reaction parameters affecting biodiesel yield such as catalyst type, catalyst concentration and oil to solvent molar ratio were used to construct a matrix-design of experiments (MDOE). Four catalysts were used in this experimental study: NaOH, NaOCH<sub>3</sub>, KOH and KOCH<sub>3</sub>. The catalyst concentrations were (0.25 – 2.0) wt % of oil and the oil to solvent molar ratios were (1:3 – 1:12). Statistical analysis was incorporated as an integral tool to evaluate the empirical data from the MDOE. The optimum reaction parameters from the MDOE were: 1.5 wt % KOH with an O/S molar ratio of 1:8. The optimized methyl ester yield was 85.05%. A novel approach to dry the methyl ester using microwave energy was also developed. <sup>1</sup>H NMR and GC analysis were used to confirm the presence and identity of the methyl esters.

The fuel properties of *Brassica juncea* (L.) were analyzed using ASTM D 6751. This optimization study concluded it was feasible to produce bench-scale biodiesel from mustard oil. The fuel properties were comparable to no. 2 grade petroleum diesel. In this regard, the study of *Brassica juncea* (L.) as a long-term energy source should be pursued.

Keywords: David St. Clair Wesley Dorant; Mustard oil; non-edible feedstock; optimization; renewable energy development.