Catalytic Transesterification of Waste Engine Oil for Biodiesel Production Using Yeast Enzymes

Chia-Ho, Fan, Chen-Yuan, Ho,

Li-Wen, Chen, Kou-Toung, Chung

Department of Science Education and Application, National Taichung University of Education, West District, Taichung, Taiwan 40306

Background

Traditional biodiesel is primarily derived from plant oils, which limits its sustainability. Waste engine oil offers a potential alternative, as it is abundant and low-cost, making it a viable feedstock for biodiesel production. This study aims to explore the application of yeast enzymes (YT or YT2) and Novo enzyme in the transesterification of waste engine oil to produce biodiesel, with the goal of improving the efficiency and feasibility of this process as a renewable energy source.

Experiment & Method

The materials used in this study included waste engine oil, methanol, water, Novo enzyme, and enzymes produced by YT and YT2 yeast strains. The experimental groups consisted of the Waste Engine Oil Group, the Chain-breaking Treatment Group (which applied ultrasonic fragmentation, microwave heating, and hydrogen peroxide chain scission techniques), and the Short-chain Fatty Acid Addition Group (which involved adding shorter-chain soybean oil and applying chain-breaking treatments). Various enzymes and processing techniques were tested in the transesterification method to evaluate their effectiveness.

Result

Enzyme Catalysis Efficiency: All three enzyme types had limited success in initiating transesterification with the long-chain molecular structure of waste engine oil.

Chain-breaking Techniques: Ultrasonic and microwave techniques were ineffective at breaking chains.

Effect of Short-chain Oil Addition: Mixing soybean oil significantly improved the transesterification rate.

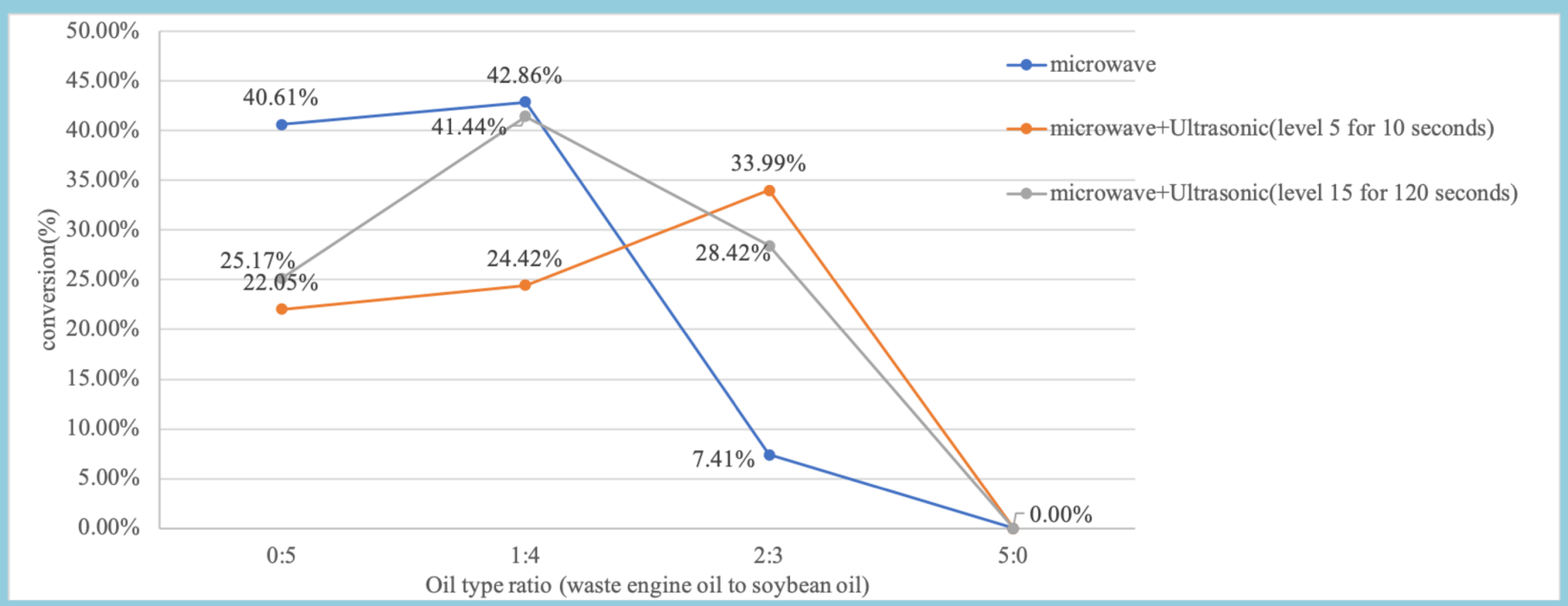

Figure 1. The GC analysis of using different chain-breaking method to catalyze the reaction at different oil type ratio.

Conclusion

The chain-breaking techniques, specifically ultrasonic and microwave energies, were not effective in breaking the chains of waste engine oil. Therefore, future experiments will focus on exploring the use of hydrogen peroxide for chain scission. The addition of short-chain fatty acids, such as soybean oil, significantly increased the transesterification rate, likely due to the direct reaction of soybean oil, rather than from waste oil or a product of re-bonding between waste oil and shorter-chain fatty acids. Gradual methanol addition, as shown in previous studies, proved beneficial for improving the transesterification rate by reducing enzyme deactivation caused by contact obstruction from unreacted waste oil. These findings provide initial insights into the transesterification of waste engine oil and suggest new experimental approaches that could be applied to biodiesel production, offering potential for renewable energy applications.