# Production of Bioester Through Solid-Catalyzed Transesterification of *Sterculia Foetida* Oil using an Optimized Protocol

**Wichayasith Intakusol[1] , Pongsakorn Hanpongpun[1], Poolsak Sahakitpichan[2] and Anusorn Vorasingha[1,*]**

*[1]Department of Chemistry, Faculty of Science, Naresuan University, Phitsanulok, 65000 Thailand*
*[2]Chulabhorn Research Institute, Kamphaeng Pet Road, Bang Khen, Bangkok, 10210 Thailand.*
** E-mail: anusornv@nu.ac.th. Tel: +66-55-963-461*

## Abstract

The transesterification reaction of *Sterculia Foetida* oil with methanol using natural fiber acid solid-catalyst was investigated. Various experimental variables, such as the natural oil and methanol molar ratio (1:3, 1:6, and 1:9), temperature (45, 55 and 65 $^{o}$C), rate of stirring (200, 400 and 600 rpm), and solid-catalyst concentration (1.0, 3.0 and 5.0 %) were adopted. Natural oil and methanol molar ratio of 1:6 with solid-catalyst concentration 5.0 %, mixing intensity of 600 rpm, and reaction temperature 65 $^{o}$C offered the best *Sterculia Foetida* oil fatty acid methyl esters (FAMEs) was accomplished by gas chromatography (GC). The bioester were characterized for their physical and main fuel properties including density, specific gravity, kinematic viscosity, high heating value, cetane number, flash point and cloud point. The chemical structure of bioester oil products were studied by nuclear magnetic spectroscopy (NMR) and Mass spectrometry (MS) techniques. The result showed our solid acid catalyst from sulfonate natural fiber could be used as transesterification catalyst.

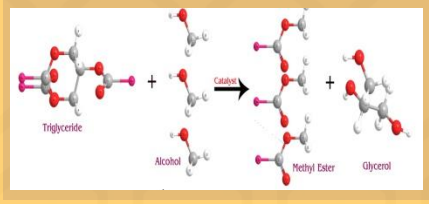
**Keywords** : transesterification, natural oil, *Sterculia Foetida*, viscosity

## Introduction

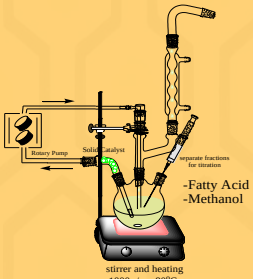
Biodiesel is a nonpetroleum based fuel that consists of alkyl esters derived from either the transesterification of triglycerides or the esterification of free fatty acids with low molecular weight alcohols. The flow and combustion properties of biodiesel are similar to petroleum based diesel and, thus, can be used either as a substitute for diesel fuel or more commonly in fuel blends. As a point of comparison, pure biodiesel (B100) releases approximately 90% of the energy that normal diesel fuel does, and hence, its expected engine performance is nearly the same in terms of engine torque and horsepower. Biodiesel, however, derived from renewable resources, is biodegradable, nontoxic, and has a higher flash point temperature than that of normal diesel. In addition, biodiesel increases lubricity, which prolongs engine life and reduces the frequency of engine part replacement. Another significant advantage of biodiesel is its low emission with oxygen content of 10-14%.

The solid acid catalyzed transesterification process does not enjoy the same popularity in commercial applications as its counterpart, the base catalyzed process. The fact that the heterogeneous solid acid catalyzed reaction is about 400 times slower than the homogeneous base catalyzed reaction has been one of the main reasons. However, solid acid catalyzed transesterifications hold an important advantage with respect to base catalyzed ones. In fact, acid catalysts can simultaneously catalyze both esterification and transesterification.

## Experimental




**Acid Solid Catalyst**



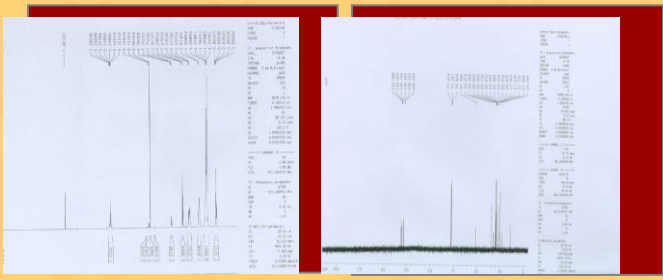

**Solid acid Catalytic Biodiesel Reactor**

**Pinari Seeds**

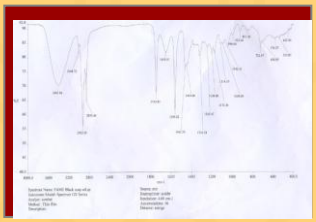
**Biodiesel production**

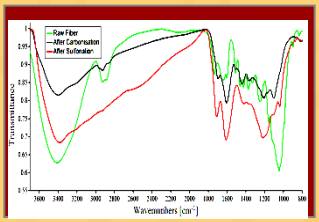
## Results and Discussion

- Increased agitation resulted in a faster rate of biodiesel production.
- Charring produced an average yield of 52%
- Anionic sulfonation resin was synthesized
- Process was performed in a small scale
- Smaller particles have had slower times because of the tars that may have been stuck in the mircopores of the charcoal
- Biodiesel never reached a hundred percent production



$^{1}$H NMR of Bioester Production $^{13}$C NMR of Bioester Production






FTIR Spectrum of the carbon catalyst before and after sulfonation

FTIR of Bioester Production

## Conclusion

The present study introduced a process for biodiesel production through high effective acidic transesterification catalyzed by cellulose sulfonic acid. A range of methanol to oil ratios, acid catalyst concentrations, reaction temperatures and reaction times were established. The research indicated that the oil could be converted to biodiesel directly by one-step cellulose sulfonic acid catalyze process without extreme temperature and pressure conditions. The best process combination was 5%wt catalyst content with 9:1 M ratio of methanol to oil at temperature of 80 $^{o}$C. The methyl ester content reached as high as 98.5%. The present procedure represents a simpleand mild method for bioester production in short reaction time and with high conversion rate, which would offer potential for an industrial process.

## References

1. M. Di Serio, R. Tesser, M. Dimiccoil, F. Cammarota, M. Nastasi and E. Santacesaria, Synthesis of biodiesel via homogeneous Lewis acid catal, Journal of Molecular Catalysis A: Chemical 239, 2005, 111-115.
2. L.C. Meher,D. Vidya Sagar and S.N. Naik, Technical aspects of biodiesel production by Transesterification; a review, Renewable, and Sustainable Enegy Reviews, 10, 2006, 248-268.