

# Sustainable Development of Community Scale Production of Palm Oil for Fuel and Food



By



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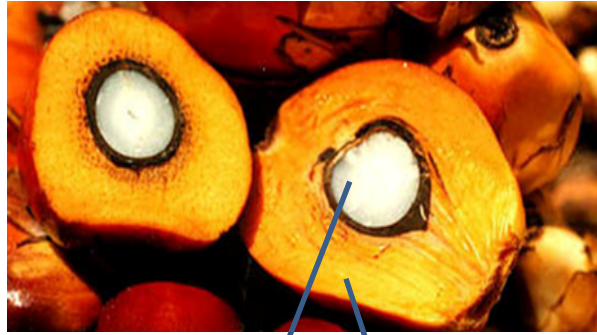
The oil palm tree has become one of the most valuable commercial cash crop in Southeast Asia especially Indonesia, Malaysia and Thailand.





For Thailand 80% of Thai palm oil production is in the hands of small farmers, so the situation in Thailand is quite different from Indonesia and Malaysia, where farming is dominated by large-scale production, so small scale production is suitable for Thailand.





Kernel

Mesocarp



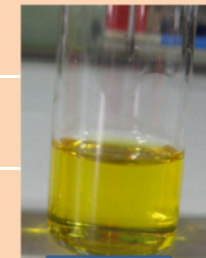
Palm oil obtain form two parts of palm fruit. One is palm oil from palm mesocarp and another one is palm kernel oil from palm kernel. Both oils have different fatty acid compositions.





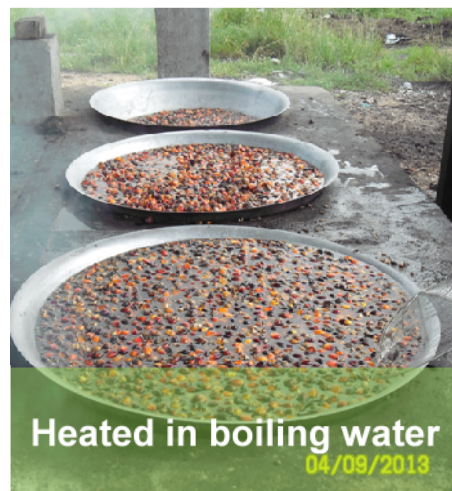
# Fatty acid compositions in palm oil and palm kernel oil

Fatty acid		Amount (%wt)	
		Palm oil	Palm kernel oil
Caprylic	(C8:0)	-	2.8
Capric	(C10:0)	-	3.0
Lauric	(C12:0)	-	48.3
Myristic	(C14:0)	0.9-2.0	17.7
Palmitic	(C16:0)	41.1-43.0	8.2
Stearic	(C18:0)	3.3-7.0	-
Oleic	(C18:1)	39.0-44.1	16.0
Linoleic	(C18:2)	9.0-10.2	-



In small scale palm oil extraction, palm oil from palm mesocarp has free fatty acid (FFA) around 8-10% because palm fruits in this process have to be heated by wood or boiling water before extraction for sterilization.



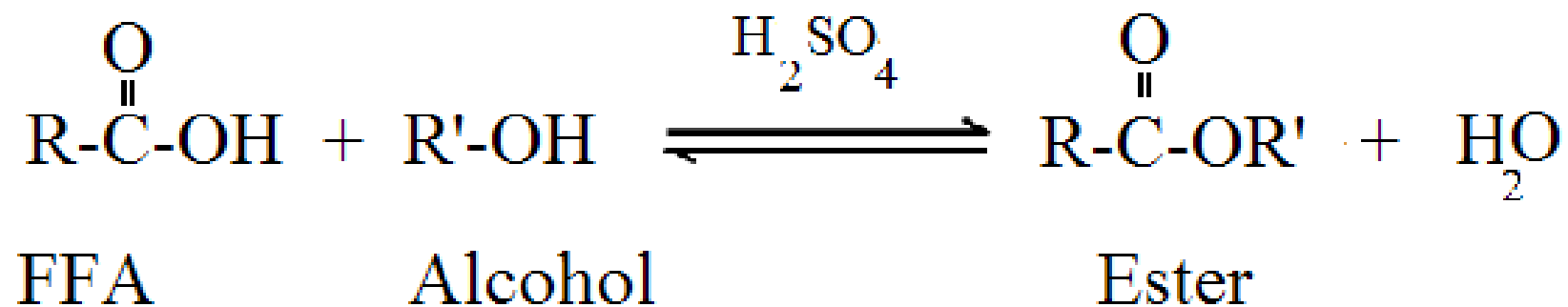


Small scale palm oil extraction process

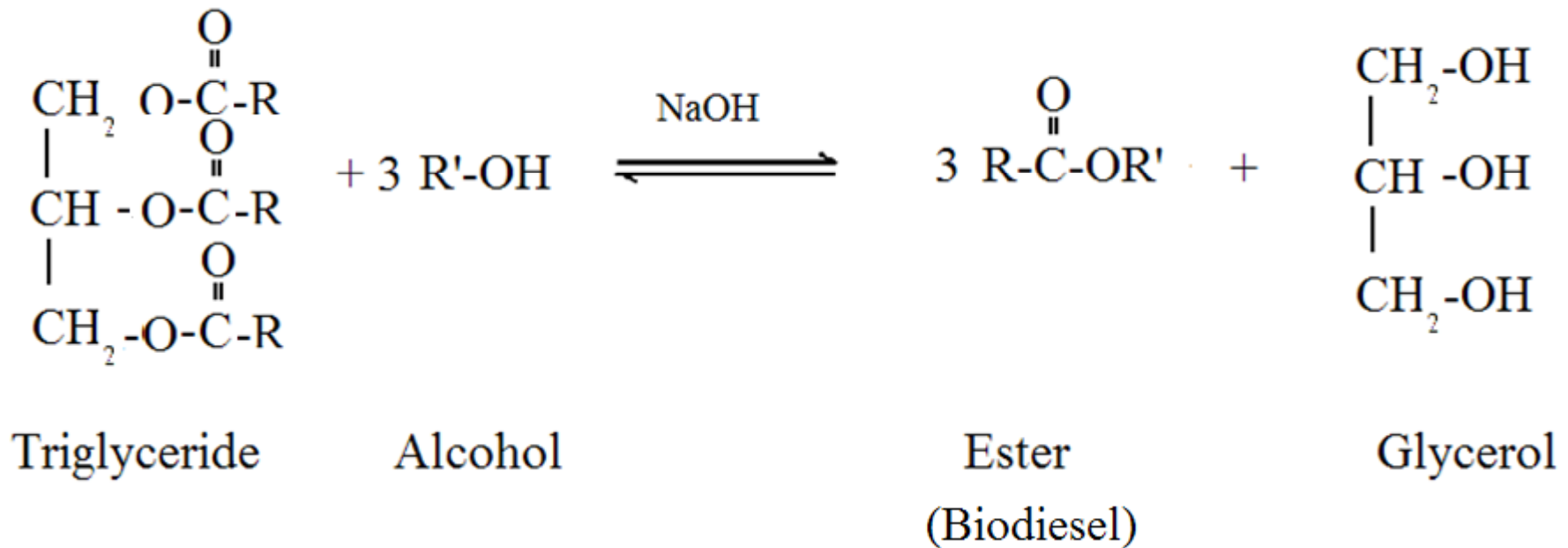


The effective process for the production of biodiesel from high FFA content is two step process (acid esterification followed alkali transesterification)

Acid esterification is employed to reduce both FFA content and gum content in palm oil.



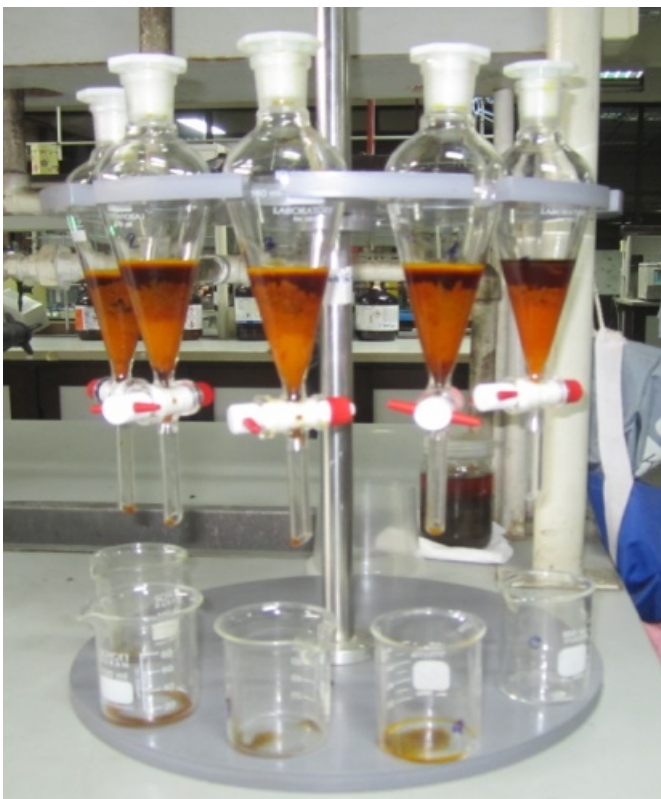
Alkali catalyst transesterification is used to convert triglyceride (palm oil) with low FFA content into biodiesel.



Response surface methodology (RSM) couple with central composite design (CCD) as a tool for optimization in esterification and transesterification process.

The variable effects in both process are studied. These effects are volume of methanol, amount of catalyst and reaction time. Reaction temperature and stirring rate are fixed.





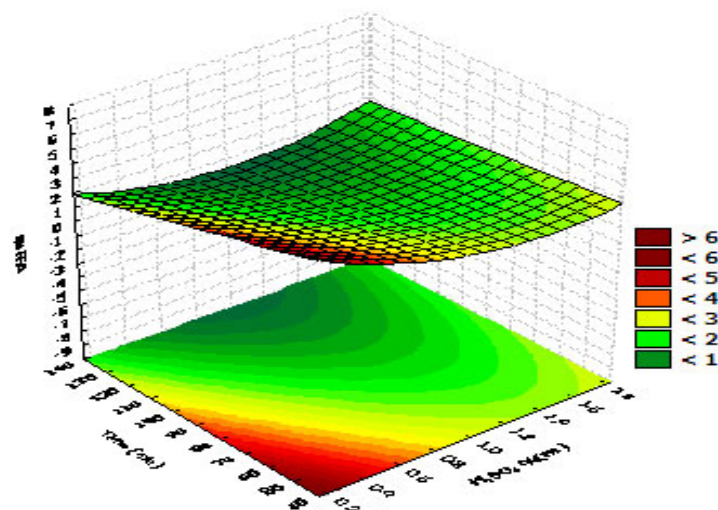
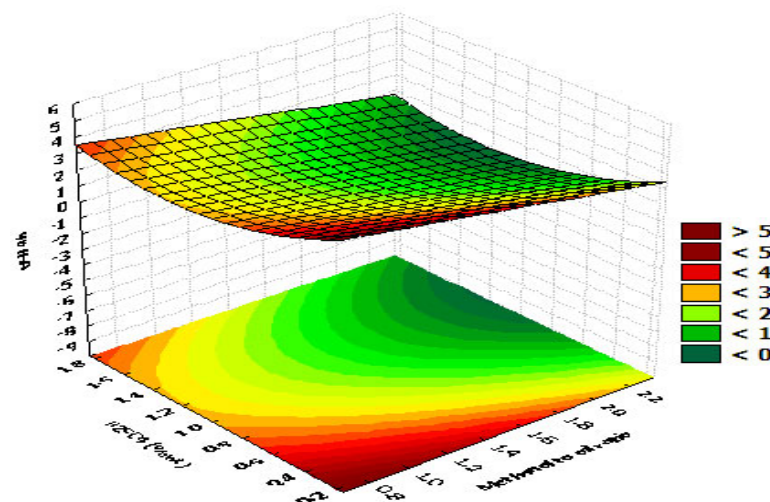
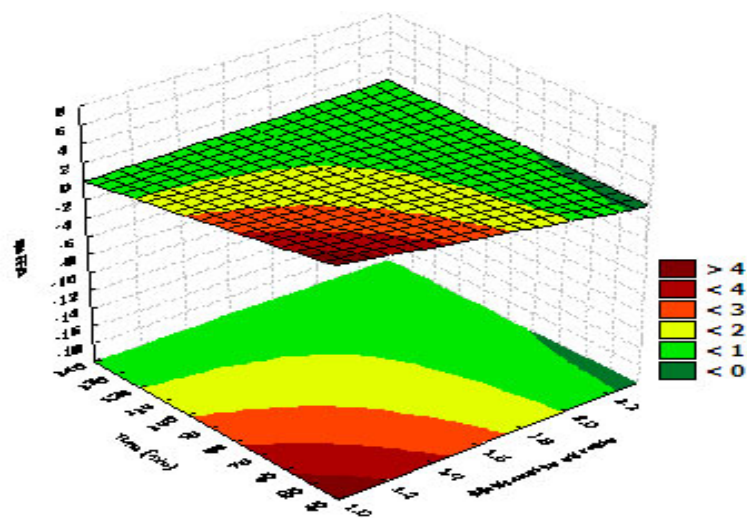
Esterification



Transesterification

Three-dimension response surface plot of FFA and ester content are obtain as picture.

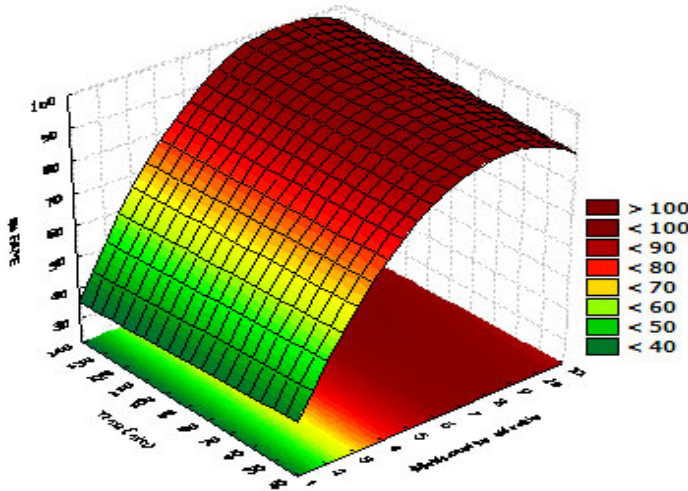
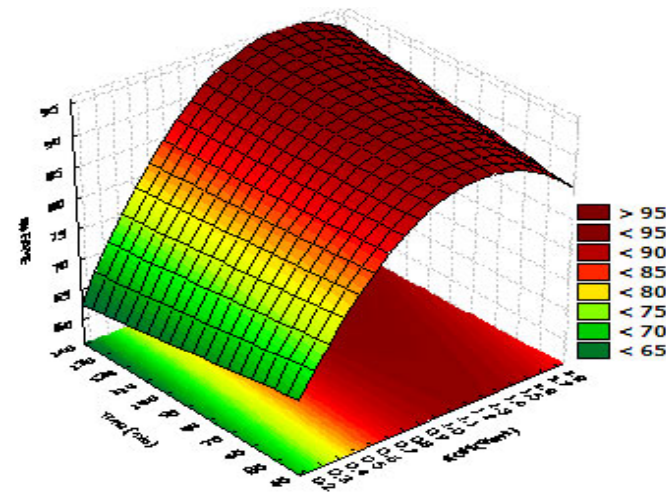
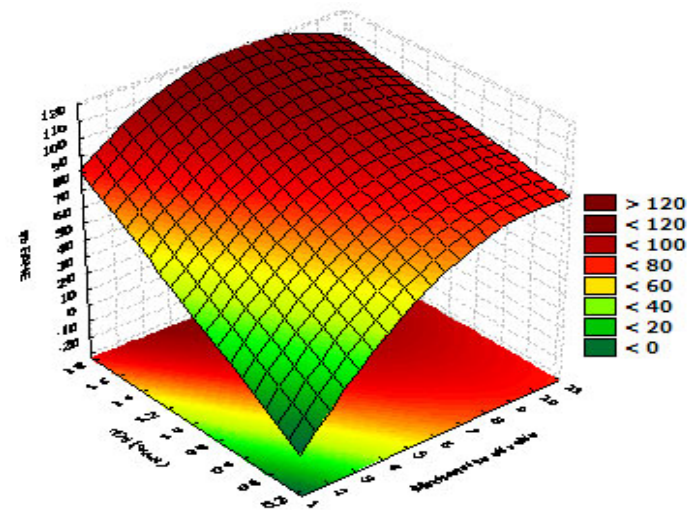
# Esterification



## Optimum condition :

15% (v/v) of methanol, 1.2% (v/v) of  $H_2SO_4$  amount, 30 min of reaction time.

# Transesterification



## Optimum condition :

20% (v/v) of methanol , 0.5% (w/v) of NaOH, 30 min of reaction time.



The results from laboratory scale is extended to community scale with the capacity of 150 Liter/ Batch of production.



150 L of biodiesel reactor  
from community



150 L of biodiesel reactor  
from Kasetsart University

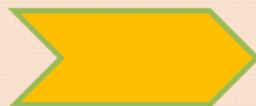
The obtained biodiesel is further determined its quality followed Thai community biodiesel standard.

Properties	Unit	
1. Acid Value	mg KOH/g	$\leq 0.8$
2. Viscosity at 40°C	cSt	1.9 - 8.0
3. Flash point	°C	$\geq 120$
4. Water and Sediment	% vol.	$\leq 0.2$
5. Total Glycerin	% wt.	$\leq 1.5$

The test kits were invented for quality control.



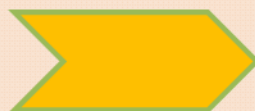
Acid value (ASTM D664)



Test kit



Viscosity (ASTM D445)



Test kit





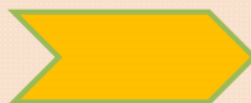
Flash point (ASTM D93)



Test kit



Water and Sediment (EN12662)



Test kit



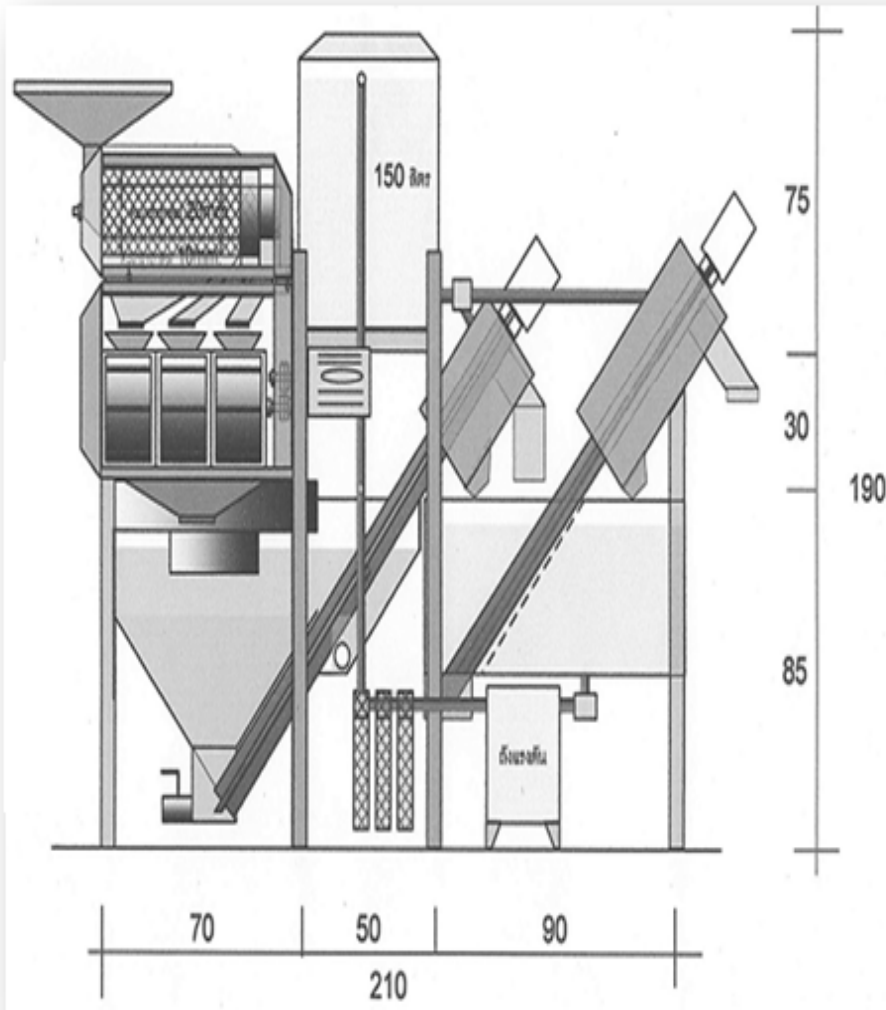
Total glycerin (EN 14105)

### Test kit





The value added products from palm nut. The prototype machine of nut shell cracker was invented by our team for separating nut shell and plant kernel.



Plan of nut shell cracker machine



Nut shell cracker machine

## Products obtained from nut shell cracker



Nut shell used for fuel or activated carbon production



Kernel used for palm kernel oil production



The prototype of solvent extraction machine was invented by our team.



Solvent extraction machine

## Products from solvent extraction machine



Palm kernel oil



Palm kernel meal

## Conclusion

Palm oil biodiesel as a fuel from palm mesocarp and value added products as a food from palm nut can make a sustainability for community scale in Thailand





Thank you very much

