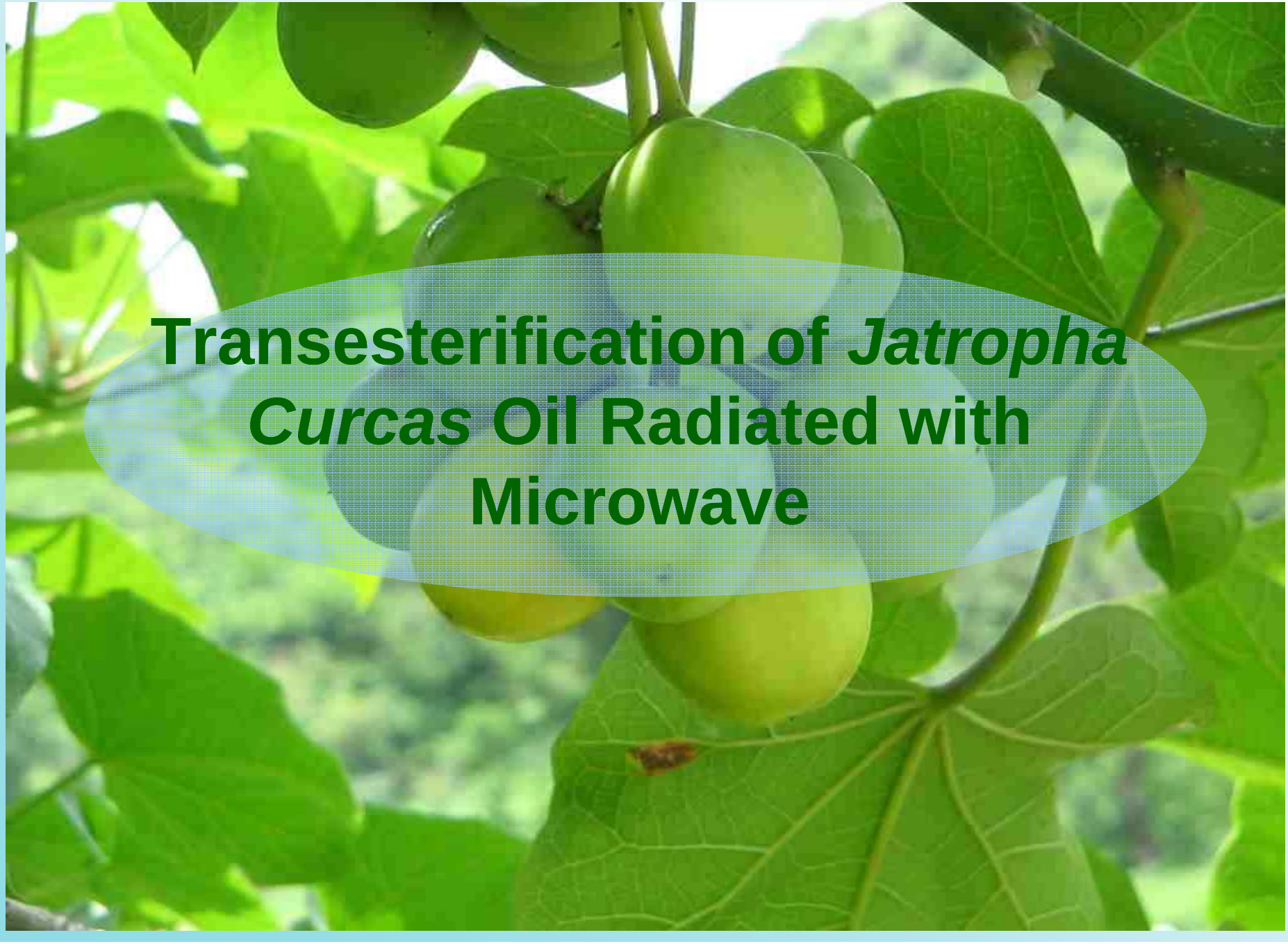


Transesterification of *Jatropha Curcas* Oil Radiated with Microwave

•PRESENTATION OUTLINES

- •Introduction
- •Methodology
- •Results and Discussion
- •Conclusion

•BACKGROUND

- ❖ World is now facing twin energy-related threats:
  - i) depletion of fossil fuel
  - ii) environmental harm caused by consuming too much of fossil fuel
- ❖ Biodiesel can be an alternative fuel
- ❖ Rudolf Diesel fueled his diesel engine invented in 1898 by peanut oil
- ❖ Vegetable oil (biodiesel) was used until 1920s
- ❖ Disadvantages of vegetable oils as diesel fuel:
  - i) Higher viscosity
  - ii) Lower volatility
  - iii) causing injection coking and carbon deposits

•Dr. Rudolf Diesel

Unrefined Jatropha oil can be used in certain types of diesel engines, such as Lister-type engines; Commonly used in developing countries to run small-scale flourmills or electric generators.

BACKGROUND

- Methods of reducing vegetable oils viscosity
  - i) Transesterification
  - ii) Pyrolysis (Thermal cracking)
  - iii) Microemulsions
  - iv) Blending
  - v) Dilution

- Transesterication methods
  - i) Microwave method
  - ii) Ultrasonic method
  - iii) Supercritical method
  - iv) Batch process method




•JATROPHA CURCAS

- Drought resistant shrub or tree (1-7 m)
- Native to Central America and has grown in many climatic zones with rainfall intensity 250 – 1200 mm/year especially in tropical (Malaysia, Brazil, Indonesia) and subtropical areas, including Africa, India, and North America.
- Resistant to a high degree of aridity, low fertility, and low moisture demand.
- Well adapted in every texture of soils; gravelly, sandy and saline, ph 5 – 6.5
- Maximum productivity in 5 years
- Can live up to 50 years

•Local Names

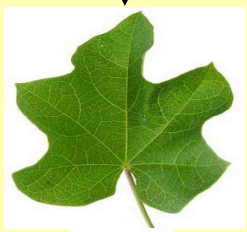
• Central America	• Barbados nut
• Africa and Asia	• Physic nut
• India	• Ratanjut
• Bangladesh	• Sadamandar/Erenda/Jamalgota
• Mali	• Pourghere
• Zambia	• Bemba
• South Africa	• Venda/Swahili
• Malaysia/Indonesia	• Pokok jarak
• Tanzania	• Makanean

Parts of *Jatropha Curcas* Plant

Jatropha tree

root

stem



leaf

flowers

fruits

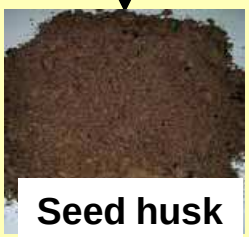
kernels

seeds

Fruit husk

oil

Seed cake



Seed husk

FLOWERS

Female:male flowers range from 13:1 to 29:1 which give more number of seeds

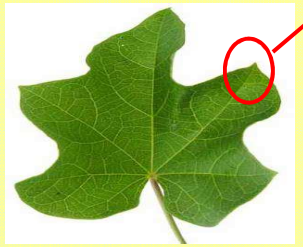
FRUITS

fruits are produced in winter or in good moisture and sufficiently high temperature

SEEDS

- the seeds become mature when fruits changes from green to yellow-brown
- contain 30-50% oil that can be processed to produce fuel

LEAF



- Has 4 – 6 lobes
- 10 – 15 cm in length and width

MULTIPLE USES OF *JATROPHA CURCAS*

Jatropha Curcas

Leaves
- Feedstock for silkworm
- Anti inflammatory
- dye
- Toothache

Flowers
- Bee food

Latex
- Wound healing
- Pesticide
- Mollusk control
- Stop bleeding

Bark
- Rich in tannin
- Dark blue dye
- Fish poisoning

Seeds

Seed cake
- Fertilizer
- Biogas
- Adsorbent

Oil
- Fuel
- Soap
- Lubricant
- Insecticide
- Cosmetic
- Varnish
- Candle illuminant
- Polyol
- Plastics
- Alkyd resin
- Thermal stabilizer

Seed husk
- Adsorbent
- Directly combustible by product
- Gasification feedstock

Root
- Medicinal purposes (anti helminthic, pneumonia syphilis)

Fruit husk
- Combustible
- Green manure
- Biogas production
- Contain tannin

Tree
- Soil erosion controller
- Firewood
- hedge plant
- Plant protector
- Reclaim wasteland

Multiple Cropping System

•Jatropha Composition

1000 kg jatropha fruits

→ **350 kg fruit husks**

650 kg seeds

→ **228 kg seed husks**

422 kg kernels

245 kg oil
24.5% from total fruits
58% from kernels

177 kg seed cake

•Oil Extraction

Mechanical

- Common use whole seeds
- Increasing oil yield by cooked seed

Chemical

- Only use kernel as feed
- Most common use n-hexane to result highest yield

SEED YIELD

- Seed should be harvested at maturity
- Depending on :
  - site characteristics
  - genetics
  - plant age
  - management
- One ha of plantation will give 1.6 - 3 metric tons of oil

•Fatty Acid Composition of Several Oils

Fatty Acid	Carbon Atoms/ Double Bond	Jatropha Oil	Soybean Oil	Palm Oil
Lauric	$C_{12/}0$	-	-	0.2
Myristic	$C_{14/}0$	0.1	0.1	1.1
Palmitic	$C_{16}/0$	14.2	11.0	44.0
Palmitoleic	$C_{16}/1$	0.7	-	-
Stearic	$C_{18}/0$	7.0	4.0	4.5
Oleic	$C_{18}/1$	44.7	23.4	39.2
Linoleic	$C_{18}/2$	32.8	53.2	10.1
Linolenic	$C_{18}/3$	0.2	7.8	0.4
Arachidic	$C_{20}/0$	0.2	-	-
Behenic	$C_{22}/0$	-	0.1	-

Physical and Thermal Properties of Vegetable oils

Properties	Jatropha	Soybean	Palm
Cetane number	**46.3**	37.9	42
Cloud point (°C)	**2**	-3.9	31.0
Flash point (°C)	**235**	254	267
Pour Point (°C)	**-3**	-12.2	-
Carbon residu (% wt)	**0.38**	0.27	-
Heating Value (MJ/kg)	**39.63**	39.6	-
Oil content from kernel (%)	**58**	18.35	44.6

•MICROWAVE TRANSESTERIFICATION

❖ Conventional heating of tranesterification process (batch, continuous and supercritical methanol) consumes more energy and takes long preheat and reaction time (optimally ~ 1hr). What is the suitable transesterification method to overcome these problem?

❖ How to reduce the cost of production of biodiesel?

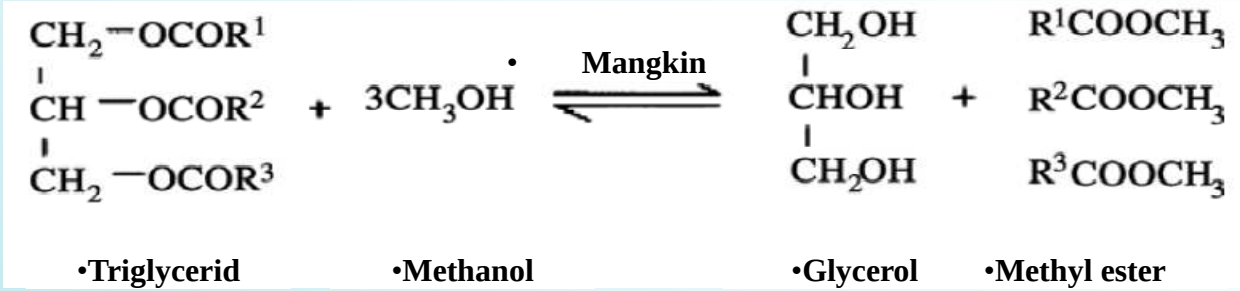
❖ Microwave irradiation as an alternative energy stimulant – reaction time↓, energy ↓, production cost ↓.




•TYPES OF TRANESTERIFICATION

•Catalytic Transesterification

- •Alkali (Homogeneous)
- •Acid (Homogeneous)
- •Alkali and Acid (Heterogeneous)



•Triglycerid •Methanol •Glycerol •Methyl ester

•Supercritical Alcohol Transesterification

- •Non-Catalytic Supercritical Alcohol
- •Catalytic Supercritical Alcohol

•Biocatalytic Transesterification

•*Pseudomonas fluorescens*, *Pseudomonas cepacia*, *Rizhomucor miehei*, *Rhizopus oryzae*, *Candida rugosa*, *Thermomyces lanuginosus*, and *Candida antarctica*.

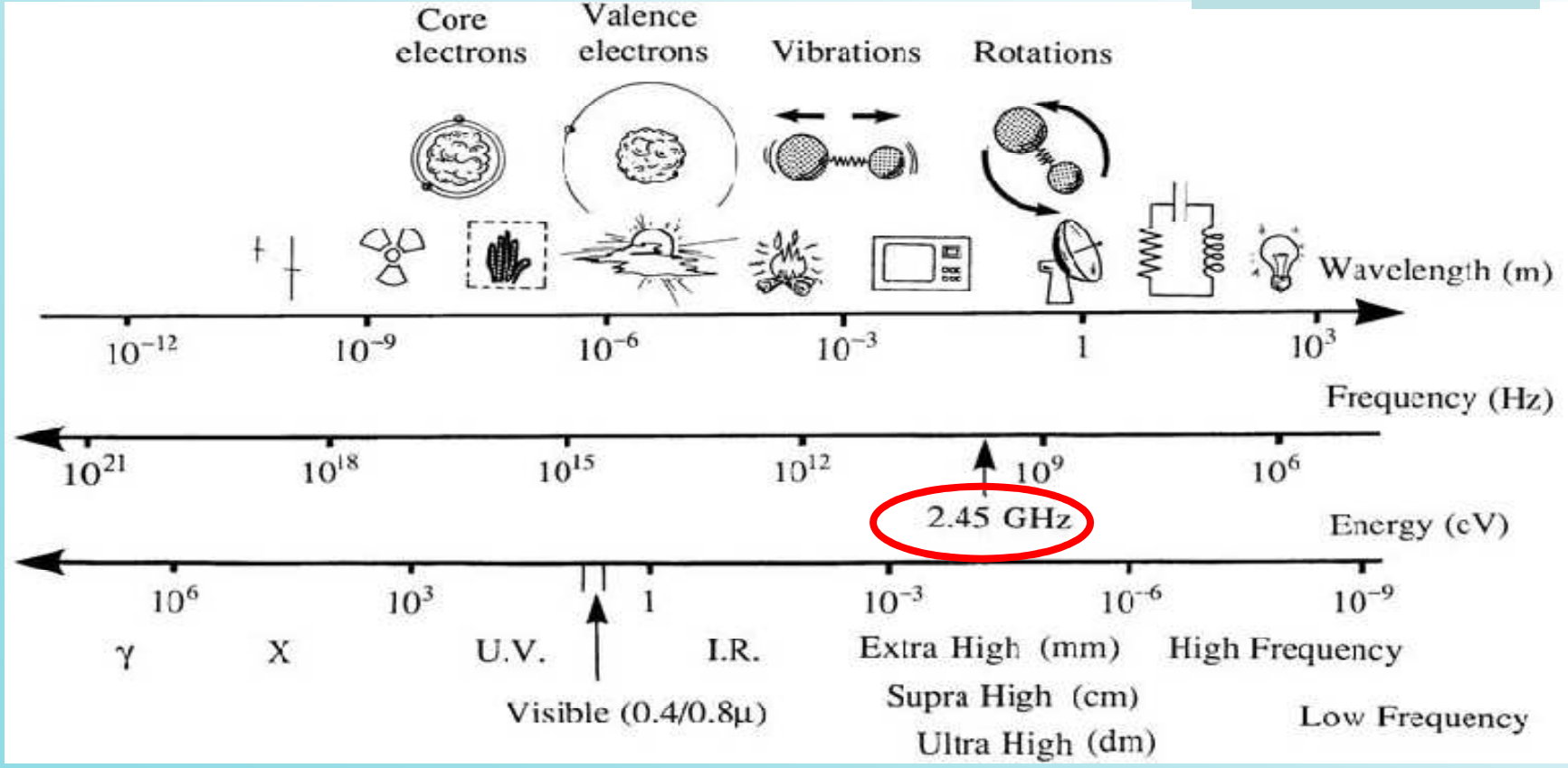
•Microwave

•ELECTROMAGNETIC SPECTRUM OF MICROWAVES

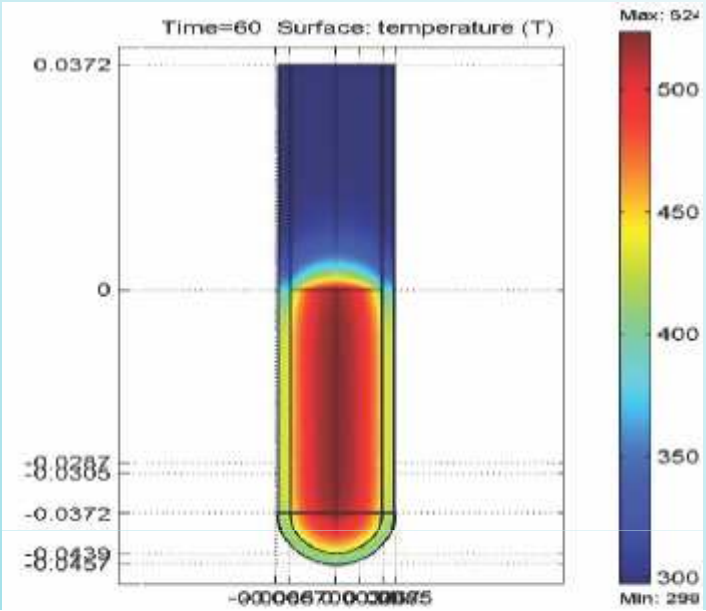
• Microwave frequencies occupy the electromagnetic spectrum between **radio frequencies** and **infrared radiation**

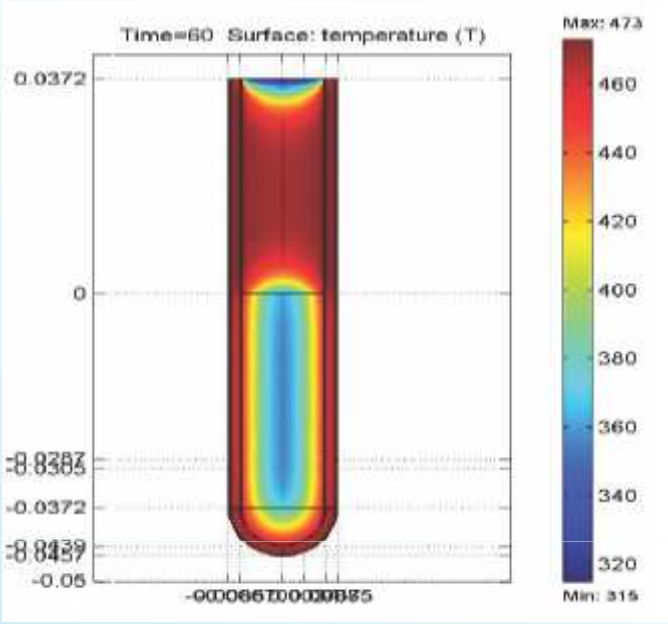
• Microwave Frequencies : **300GHz** to **300MHz** which corresponds to the wavelengths of **1mm** to **1m** respectively.

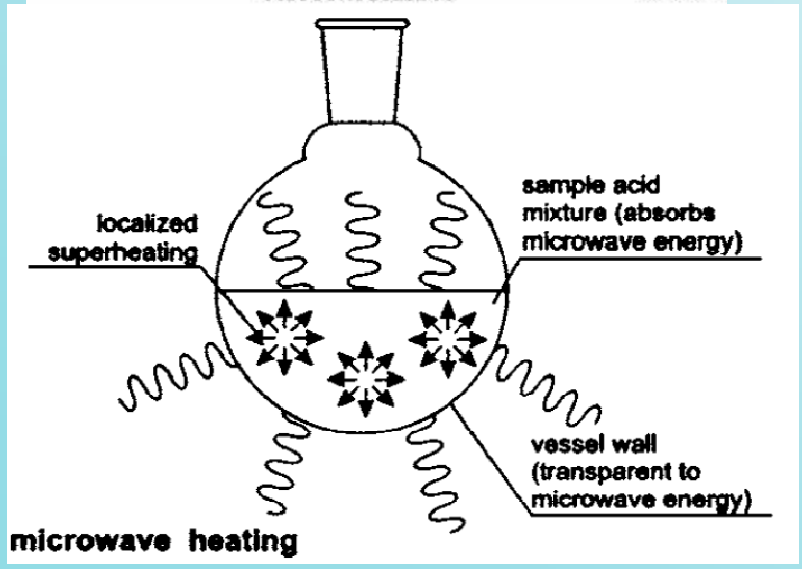
•2.45 GHz → 12.2 cm

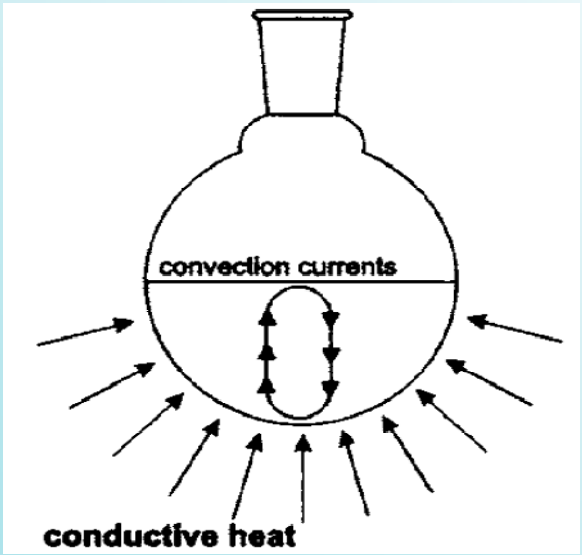


•ADVANTANGES
•OF MICROWAVE HEATING OVER THERMAL HEATING









•Microwave Heating

•Thermal Heating

•Methodology

•Conventional

Dry and De-Shelled the *Jatropha curcas* fruit at 102℃ For 35 Minutes

The crushed *Jatropha curcas* fruit, deffated in soxhlet extractor for four hours using hexane as a solvent in 60 ℃

The extracted oil were then transferred into a the rotary evaporator to recover hexane from oil mixture at 80°

Transesterification with homogenous catalyst in 1-3 hours

Separation of biodiesel from the reaction mixture using centrifuged at 6500 rpm for 15 minutes and the top methyl ester phase was separated from glycerol phase

•Asissted by Microwave

Dry and De-Shelled the *Jatropha curcas* fruit at 102℃ For 35 Minutes

The crushed *Jatropha curcas* fruit, deffated in soxhlet extractor for four hours using hexane as a solvent in 60 ℃

The extracted oil were then transferred into a the rotary evaporator to recover hexane from oil mixture at 80°

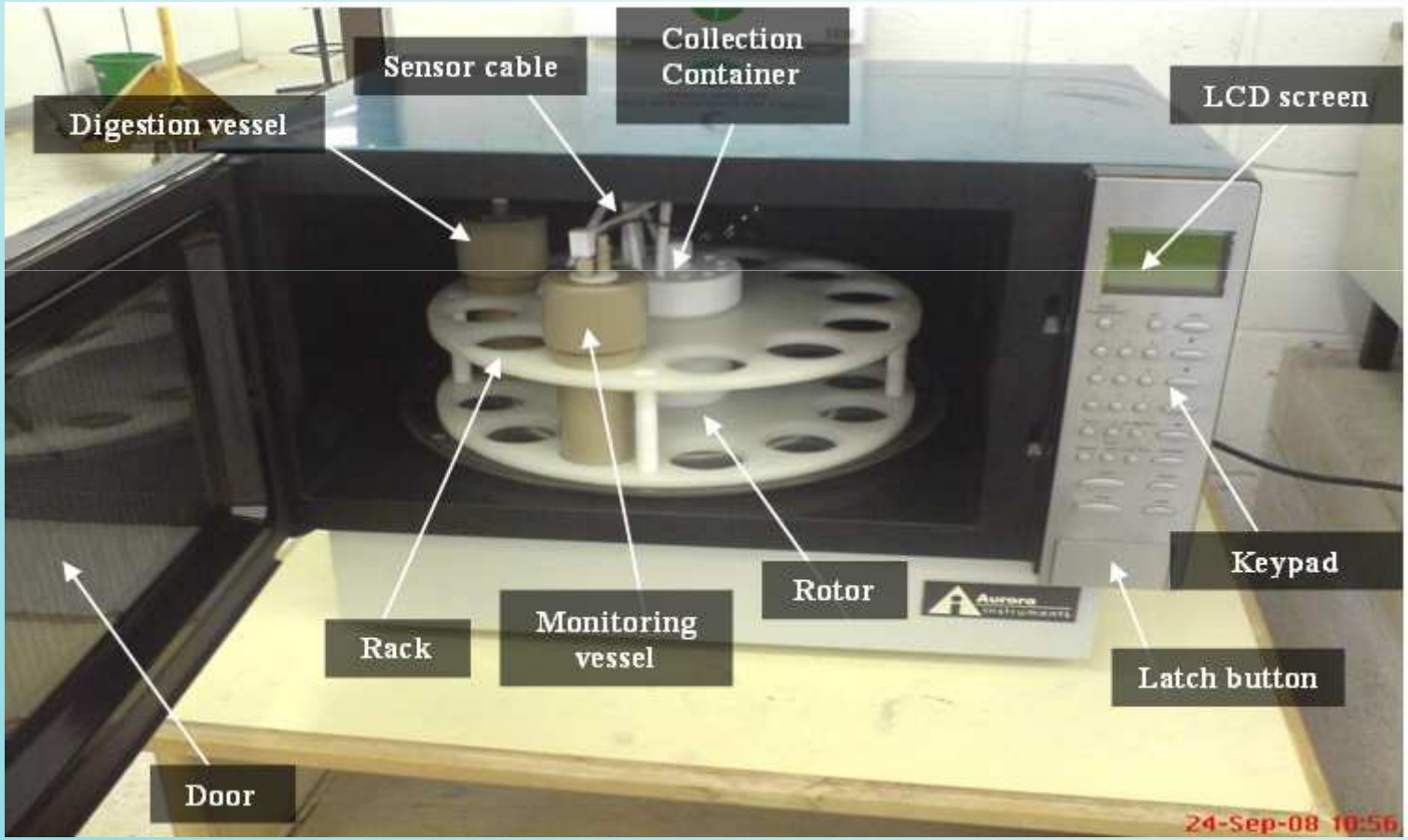
Transesterification assisted by microwave heating irradiation with homogenous catalyst in 3,5,7 and 9 minutes

Separation of biodiesel from the reaction mixture using centrifuged at 6500 rpm for 15 minutes and the top methyl ester phase was separated from glycerol phase

•MATERIALS AND METHODS

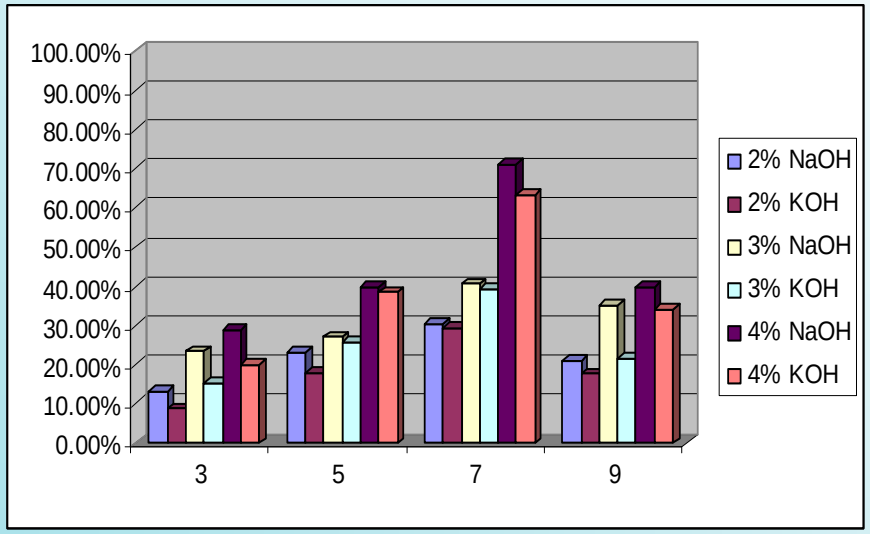
•**Microwave Apparatus**

- **Model: MW 650 (MW Discovery Ltd., Canada)**
- **Exit Power: 1250 watts**
- **Microwave Frequency: 2.45GHz**

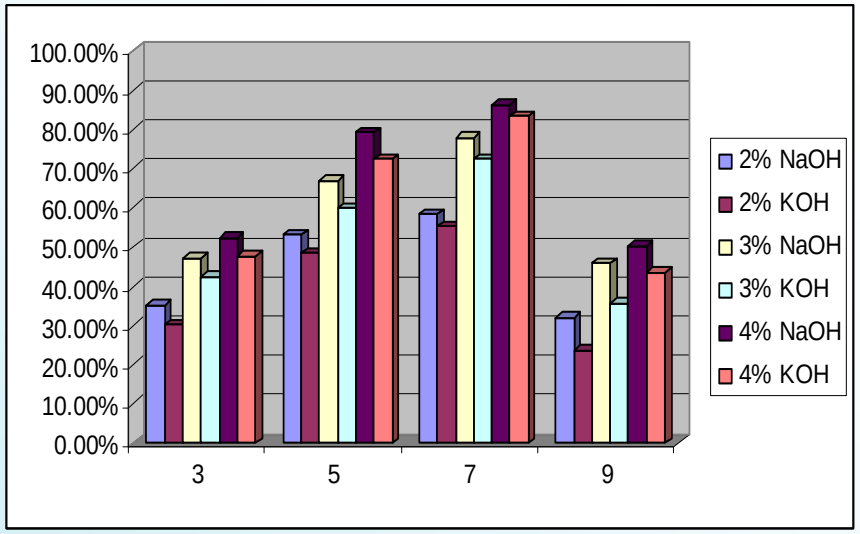


•Microwave heating system used for transesterification reaction

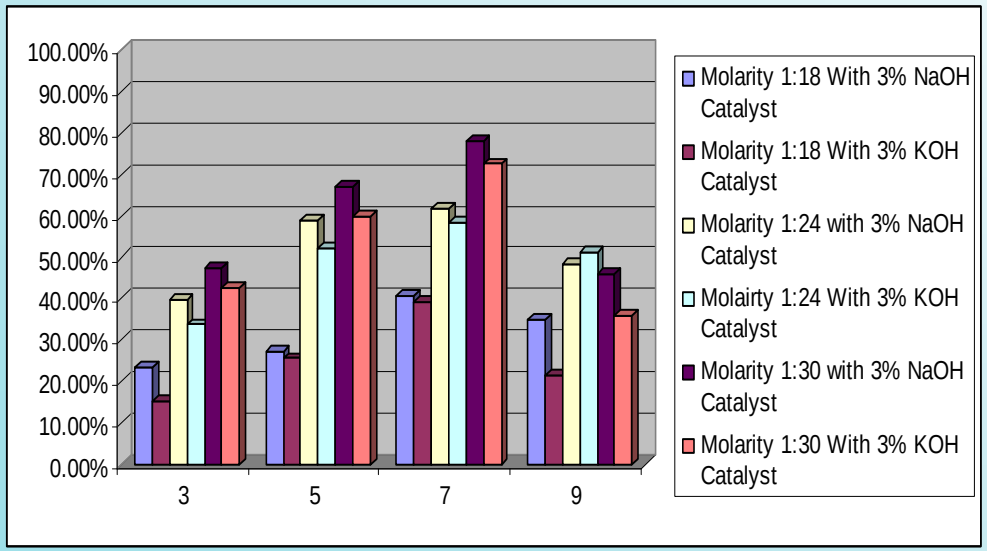
•Preliminary Results



Biodiesel Production at oil to methanol 1:18



Biodiesel Production at oil to methanol 1:30



Biodiesel production at different reaction time

Summary

Jatropha can produce more oil per ha compare to common alternatives (soybeans, cotton seed, rapeseed, sunflower, groundnuts)

If investigation of its genetic diversity and its yield potential had been covered by adequate scientific research, jatropha could be a very potential crops for energy and other uses

Microwaves energy can be one of the alternative method to convert jatropha crude oil to biodiesel

The maximum biodiesel production is with 86.3% at 7 minutes compare 1-3 hours with conventional menthod reaction time in excess of methanol.

Members in Jatropha Research Group

Assoc. Prof. Dr Zahira Yaakob , Group Leader, Product Development

Assoc. Prof. Dr. Siti Rozaimah Sheik Abdullah, Polymer, Waste water and detoxification

Assoc. Prof. Dr. Siti Kartom Kamarudin, Process Design and Optimisation

Assoc. Prof. Dr. Jaharah Abd Ghani, Expeller and Harvester Design

Assoc. Prof. Dr. Mohd Sobri Takriff, Product Developmet

Dr. Manal Ismail, Transesetrification and direct hydrogeantion

Cont. Members in Jatropha Research Group

Dr. Nurina Anuar, Plant Propagation, soil suitability

Dr. Masturah Markom, Miroalgae for fuel

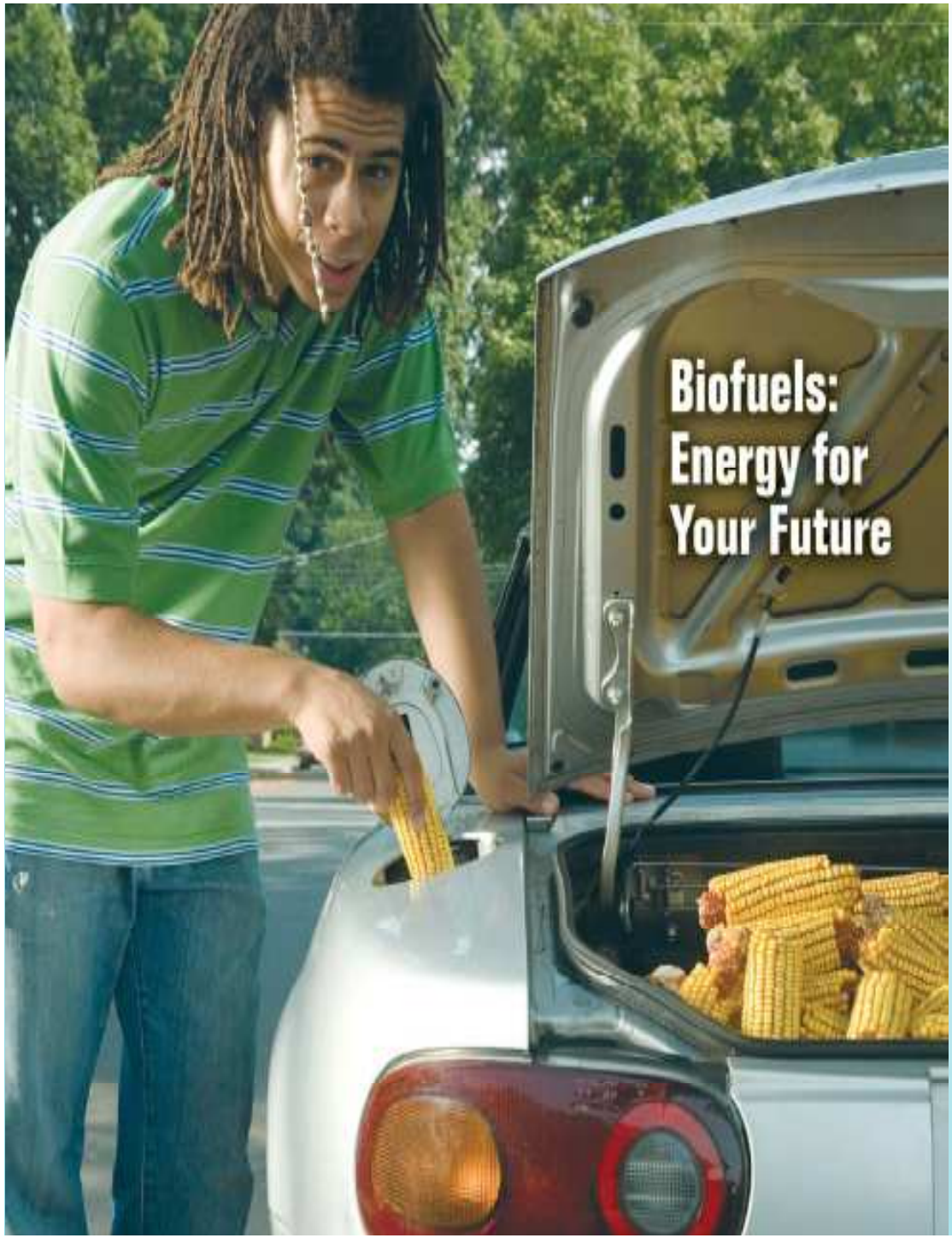
Dr. Jamaliah Jahim, Biomass Conversion

Prof. Dr. Yusoff Ali, Engine testing

Mr Norhisham Tan Kofli, Medicinal use, ethanol production

Acknowledgement

- I would like to thank National University of Malaysia (UKM) and Ministry of Science, Technology and Innovation for the financial Support to carry out this research
- Also many thanks to all the researchers and students
- We would like to welcome any interested parties to collaborate on the R& D



- ***OBRIGADO***
- ***TERIMA KASIH***
- ***THANK YOU***