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# LAM MAN KEE

Editor PPT

# Biography

- Dr. Lam Man Kee is currently working at the Department of Chemical Engineering, Universiti Teknologi PETRONAS, Malaysia.

- His research interests include biodiesel and bioethanol production technology, microalgae cultivation, catalysis and life cycle assessment.

# Recent Publications


- **Lam, M. K.** & Lee, K. T. (2014). Cultivation of Chlorella vulgaris in a pilot-scale sequential-baffled column photobioreactor for biomass and biodiesel production. *Energy Conversion and Management*, 88, 399-410.

- **Lam, M. K.** & Lee, K. T. (2012). Microalgae biofuels: A critical review of issues, problems and the way forward. *Biotechnology Advances*, 30, 673-690.

- Lam, M. K., Lee, K. T., & Mohamed, A. R. (2009). Sulfated tin oxide as solid superacid catalyst for transesterification of waste cooking oil: An optimization study. *Applied Catalysis B: Environmental*, 93(1-2), 134-139.

# Fuel: Current environmental and social issues

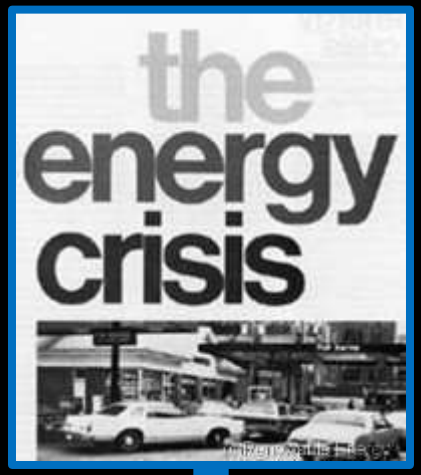
Fossil fuel

Air pollution

Water pollution

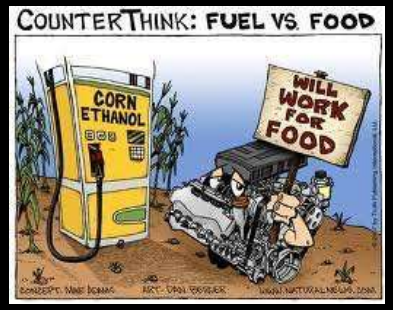
Green house gas effect

Acidification




Renewable fuel

Food vs fuel




High cost

Deforestation

# Biodiesel sources

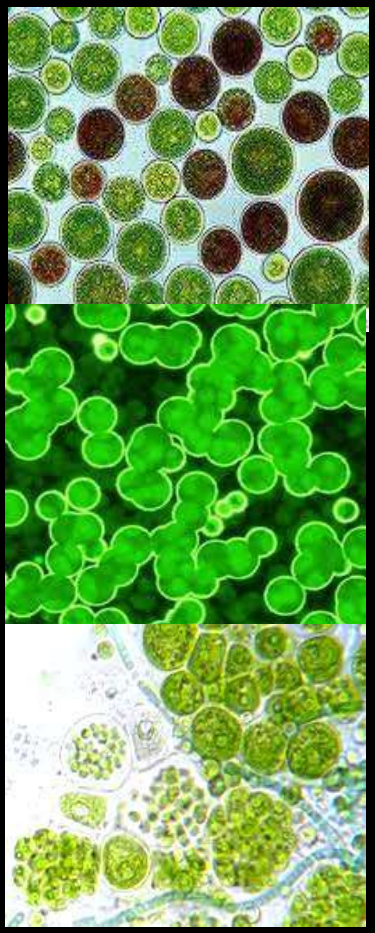
Edible Oil

Biodiesel

Non-Edible Oil


# Microalgae as the third generation of biofuel

Microalgae



-One of the oldest living microorganism on Earth
- More than 30,000 species
- Freshwater & Marine
- Main constituents in the microalgae cell:

**Lipids**

Biodiesel

**Carbohydrate**


Bioethanol

# Advantages of microalgae biofuel

-Does not compete with food supply

-Relatively high lipid productivity compared to terrestrial oil plants

Microalgae -> 54-126 tonne/ha/year
Palm oil -> 3.62 – 10 tonne/ha/year
Jatropha -> 0.14 - 4.13 tonne/ha/year

- High photosynthetic efficiency -> Able to utilize $CO_2$ efficiently

- High growth rate -> 100 times faster than land based plant

# Cultivation of microalgae biofuel

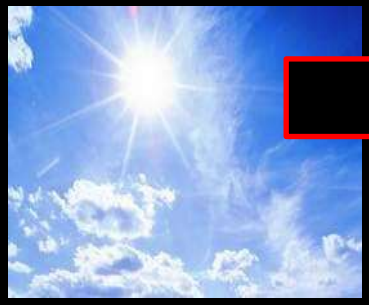
Light

Water


Carbon

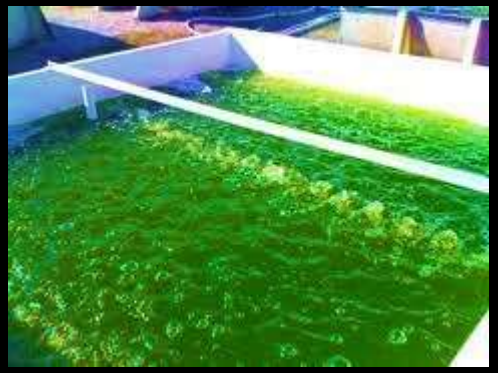
Nutrients

# An ideal microalgae biofuel production flow

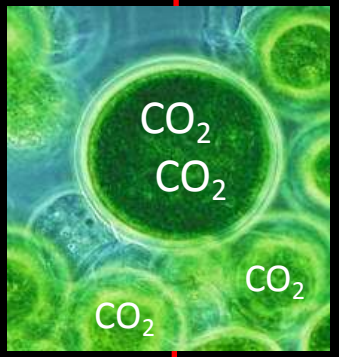


Sunlight

Free and abundantly available



Wastewater as nutrient source




$CO_2$ mitigation

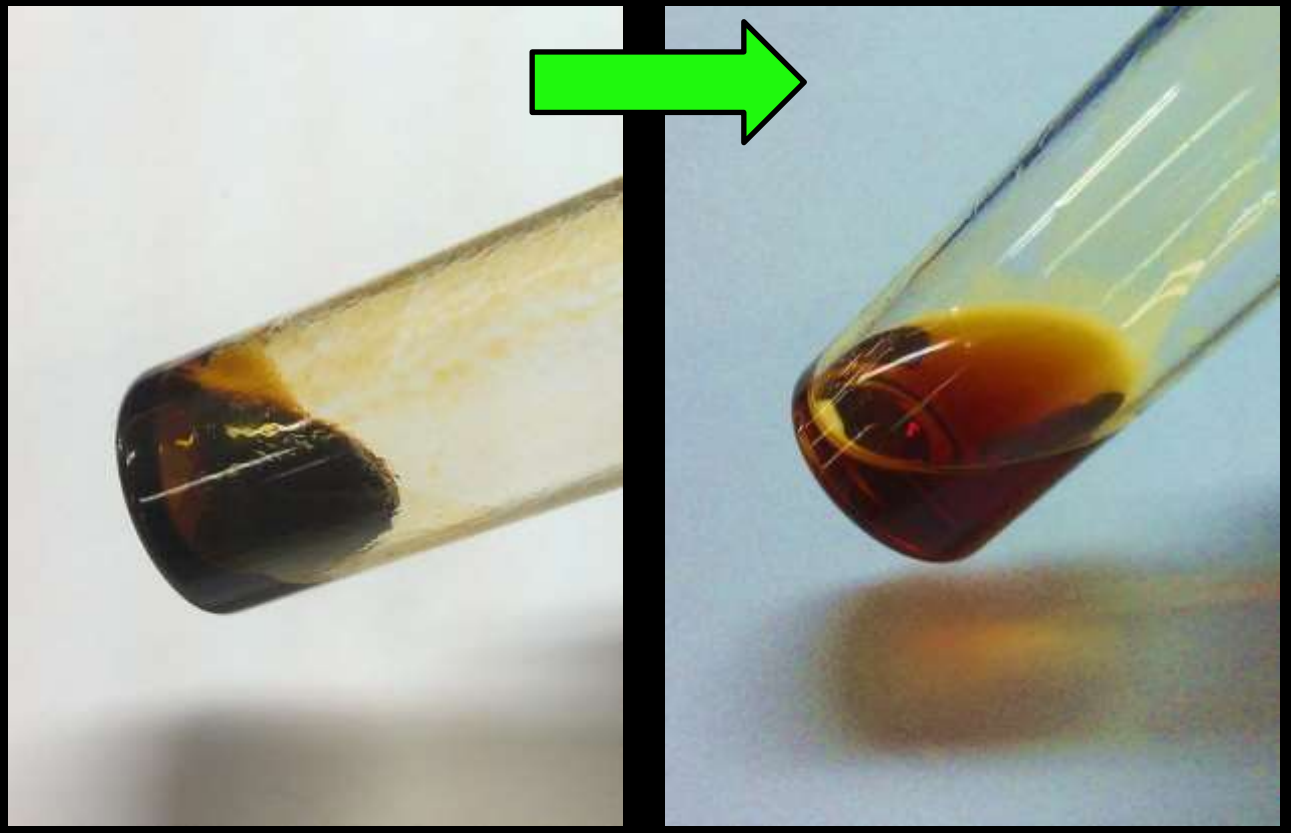
Biofuel production

Alternative carbon source

$CO_2$ from flue gases

# Biodiesel production from microalgae lipid

**Transesterification**

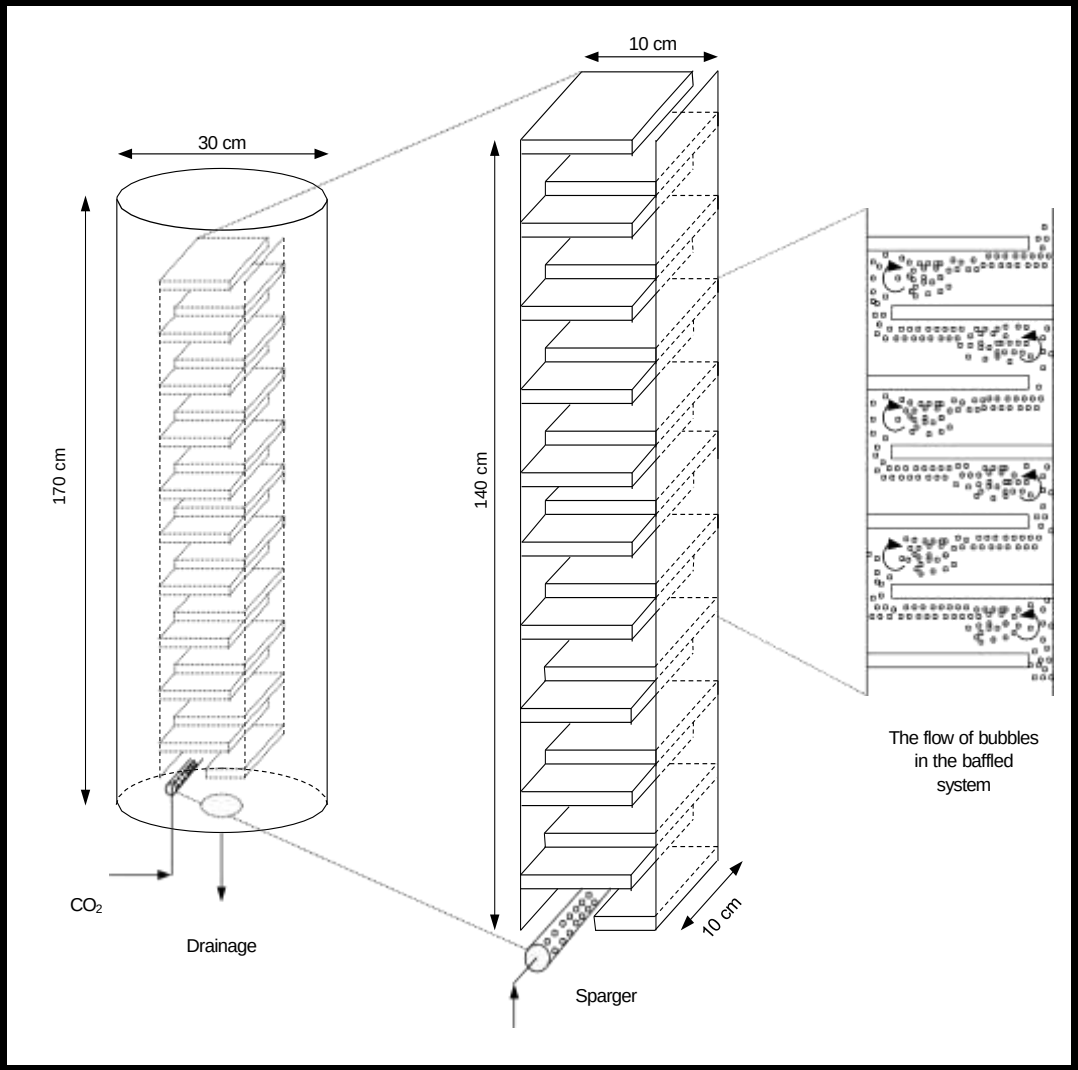


Crude microalgae lipid

Microalgae biodiesel

# Sequential Baffled Photobioreactor (SBP)

100 liter cultivation – Pilot scale



# SBP: Microalgae cultivation under indoor and outdoor environment

Indoor

Outdoor

# Problems with microalgae cultivation for biofuel production

**Availability of nutrients source: Nitrogen & Phosphorus**

- **Chemical nutrients – high cost**
  **not environmentally friendly**
- **Wastewater – inconsistent nutrients concentration**
  **serious contamination**

**Availability of carbon source: $CO_2$**

- **Atmospheric air – low concentration, 0.03 %**
- **Flue gas – toxic compounds:** CO, $NO_x$, $SO_x$
  **high temperature: 65°C-450°C**

# Problems with microalgae cultivation for biofuel production

- Life cycle energy balance – not well understood
- Economic potential - not well understood
- Feasibility of outdoor cultivation



# Related Journals

Chemical Sciences Journal

Chemical Engineering & Process Technology

Signature:

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