UNIVERSITI PUTRA MALAYSIA
BERILMU BERBAKTI

RESEARCH REPORT 2017

http://www.research.upm.edu.my/EB-EB book2017-Vol 9

ENVIRONMENTAL BIOTECHNOLOGY RESEARCH GROUP

FACULTY OF BIOTECHNOLOGY AND BIOMOLECULAR SCIENCES

EB GROUP 2017

COLLABORATORS

NATIONAL

FGV
FELDA
TDM PLANTATION SDN. BHD.
MPSJ MAJLIS PERBANDARAN SUBANG JAYA
UPJ
IndahWater

INTERNATIONAL

Kyutech
National Institute of Advanced Industrial Science and Technology AIST
九州大学 KYUSHU UNIVERSITY
CJ
MITSUBISHI MITSUBISHI MATERIALS
MITSUBISHI HEAVY INDUSTRIES ASIA PACIFIC PTE. LTD. Our Technologies, Your Tomorrow
KOREA UNIVERSITY

EB GROUP MEMBERS

- 9 Principal researchers
- 15 PhD students
- 22 Master students
- 10 Research Assistants

RESEARCH INTEREST

- OIL PALM BIOMASS
- SAGO BIOMASS
- LANDFILL LEACHATE
- KITCHEN WASTE
- MUNICIPAL SOLID WASTE
- AGRICULTURAL WASTE

→ VALUE ADDED PRODUCTS

3P's


PROFIT


PEOPLE


PLANET

CONTENTS

EB RESEARCHERS

CONTENTS

PhD STUDENTS

PhD STUDENTS

MASTER STUDENTS

MASTER STUDENTS

CONTENTS

BIOREFINERY COMPLEX @ UPM

BIOMASS & BIOREFINERY LABORATORY

- Biomass & Biorefinery Laboratory (BBL) located near to University Agricultural Park (TPU) and UPM golf course, was operated since January 2014.
- The whole area of BBL covers 1075 m^2.

PILOT PLANT

- Biochar, biocompost, biodiesel and biogas pilot plants are developed based on our research for 20 years in environmental biotechnology.
- Majorly equipped with solid biomass processing machines such as biocompost machinery, steam blasting and biodiesel reactor.

GENERAL FACILITIES

- Postgraduate students room
- Researcher rooms
- Meeting room
- Seminar room
- Washroom and prayer room

LABORATORY

- The laboratory comprises of chemical room, culture room, bioreactor system, analysis room and cold room.
- These rooms are fully equipped with instruments for biomass pretreatment, fermentation process, bioalcohol detection and wastewater characterisation.

CAPACITY

- The laboratory can accommodate about 30 students.
- A maximum occupancy of the seminar room is 80 people at a time.

EB LABORATORY AT BIOTECH 3

We have three labs at BioTech 3: EB Lab 1 (general lab), EB Lab 2 (molecular biotechnology lab) and Biomolecular Sciences

The general laboratory is equipped with:

- Gas-chromatography with Flame Ionization Detector (GC-FID)
- Gel permeation chromatography (GPC) with UV and RI detectors
- High performance liquid chromatography (HPLC)
- Thermogravimetric Analyzer (TGA)
- Freeze dryer

The laboratory focuses on research related to biopolymers and biomaterials. While, the Molecular section mainly focus on the molecular biotechnology research.

The molecular laboratory is equipped with:

- PCR and RT-PCR thermal cycler
- Denaturing Gradient Gel Electrophoresis (DGGE)
- Flow cytometer
- NanoDrop spectrophotometer
- Gel Documentation Systems

General laboratory

Molecular laboratory

Preparation room

In The Name of ALLAH, Most Gracious, Most Merciful.

AlhamduLillah, praise to ALLAH for His generous favours and blessings on us all. As the Leader of Environmental Biotechnology Research Group (EB) at Universiti Putra Malaysia, I am glad to share with you our research report for 2017.

PROFESSOR DR. MOHD ALI HASSAN

MESSAGE FROM THE EB GROUP LEADER

- We have two sub-groups; comprising of EB1 - Biomass and Biorefinery, and EB2 – Bioenergy and Biobased Chemicals.

- We have 9 academic staff members, 1 post-doctorate researcher and 11 associate researchers.

- Our current student enrolment are 15 PhD, 22 MS and 17 undergraduate students. In addition we also have 3 students on the PhD Dual-Degree program with Kyushu Institute of Technology, Japan.

- In 2017, 2 PhD students and 6 MS students graduated from our laboratory.

- We continue to operate the Biorefinery@UPM Complex, comprising of the Biomass Technology Laboratory and the Pilot Plant for Biocompost, Biochar, Biodiesel and Biogas under the Serdang Biomass Town project, in collaboration with The Ministry of Housing and Local Government (KPKT, Malaysia), The Ministry of Agriculture, Forestry and Fisheries (MAFF, Japan), Malaysia Agricultural Research and Development Institute (MARDI) and The Subang Jaya Municipal Council (MPSJ).

- We managed to secure the JICA-JST SATREPS International Grant for the period 2013-2017, with a matching grant from The Ministry of Education Malaysia (2014-2018), to set up an integrated zero-emission showcase pilot plant at Keningau Palm Oil Mill in Sabah. Under the JICA-JST SATREPS project, we continue to strengthen the academic and research collaboration with Professor Yoshihito Shirai and co-workers from Kyushu Institute of Technology, Dr. Satoshi Hirata and co-workers from Advanced Institute of Science and Technology (AIST) Japan, Professor Dr. Kenji Sakai and co-workers from Kyushu University and Professor Dr. Charles Vairappan and co-workers from Universiti Malaysia Sabah.

- We conduct collaborative research projects with the industry, namely Indah Water Konsortium (IWK) on sewage sludge pellets, and with CJ BioMalaysia Sdn. Bhd on sludge and spent activated carbon. We also conduct a consultancy project with Mitsubishi Heavy Industry Asia Pacific on fuel pellets from oil palm biomass and municipal solid waste management. Recently we have Kemanan Palm Oil Mill under TDM Berhad as our industry partner on the biocomposting project.

- In terms of output, we successfully published 24 research papers in 2017, with 11 in Quartile 1 (Q1) and 6 in Quartile 2 (Q2), with a total of 75.2 Impact Factors.

I appreciate the hard work from all EB members in maintaining our high-performance culture. May ALLAH give us the strength to continue the good work and contribute to the development of university, the ummah and the nation.

Thank you. Wassalam.

Professor Dr. Mohd Ali Hassan

EB GROUP


OIL PALM TREE


FROND


TRUNK

Pressing

POME final discharge treated with bioadsorbent

Methane for electricity generation


FRESH FRUIT


RIVER WATER


ELECTRICITY

PALM OIL MILL


CRUDE PALM OIL


KERNEL

MAIN PRODUCTS


POME


EMPTY FRUIT BUNCH

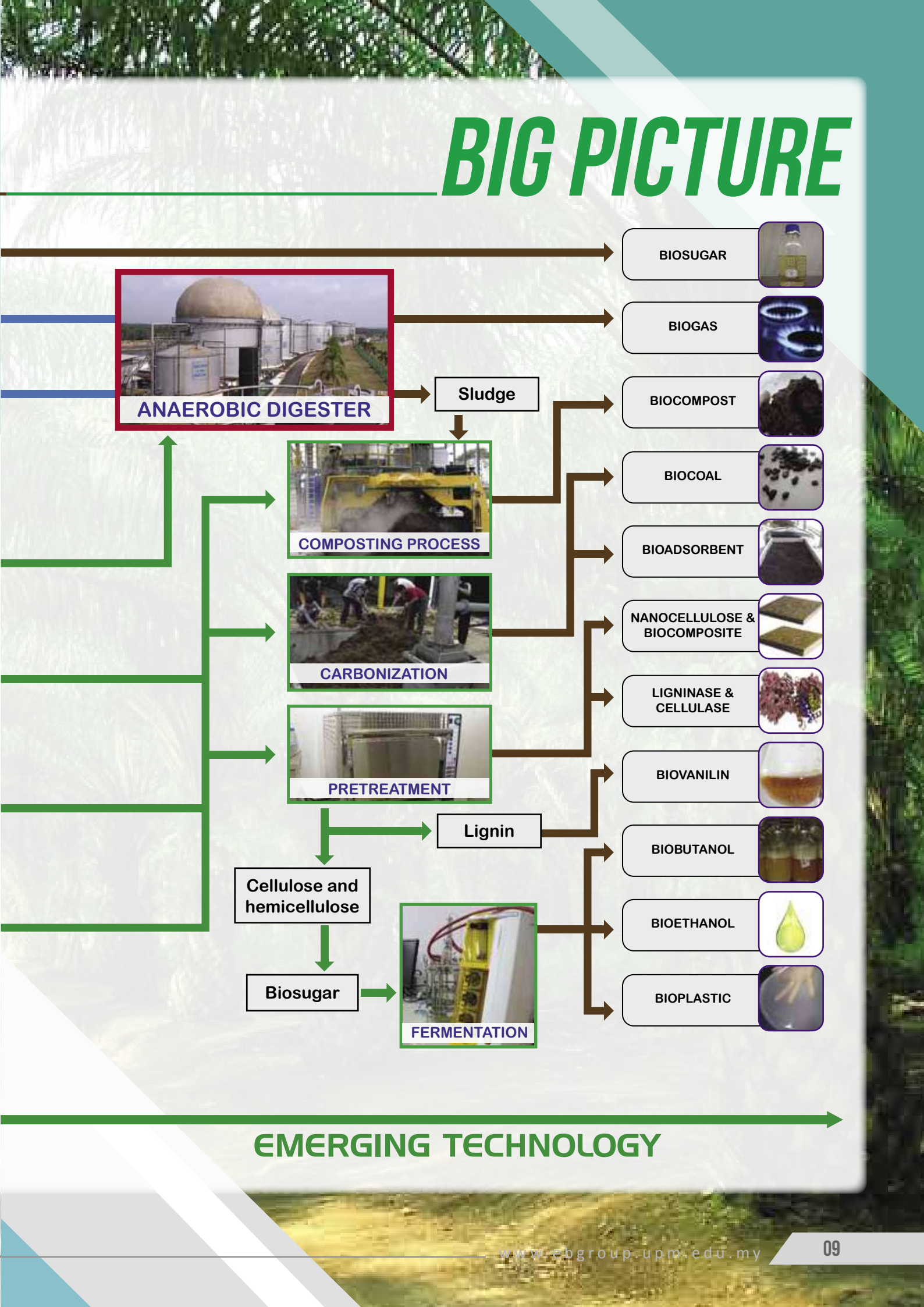

MESOCARP FIBRE


SHELL

OIL PALM BIOMASS

TRADITIONAL TECHNOLOGY

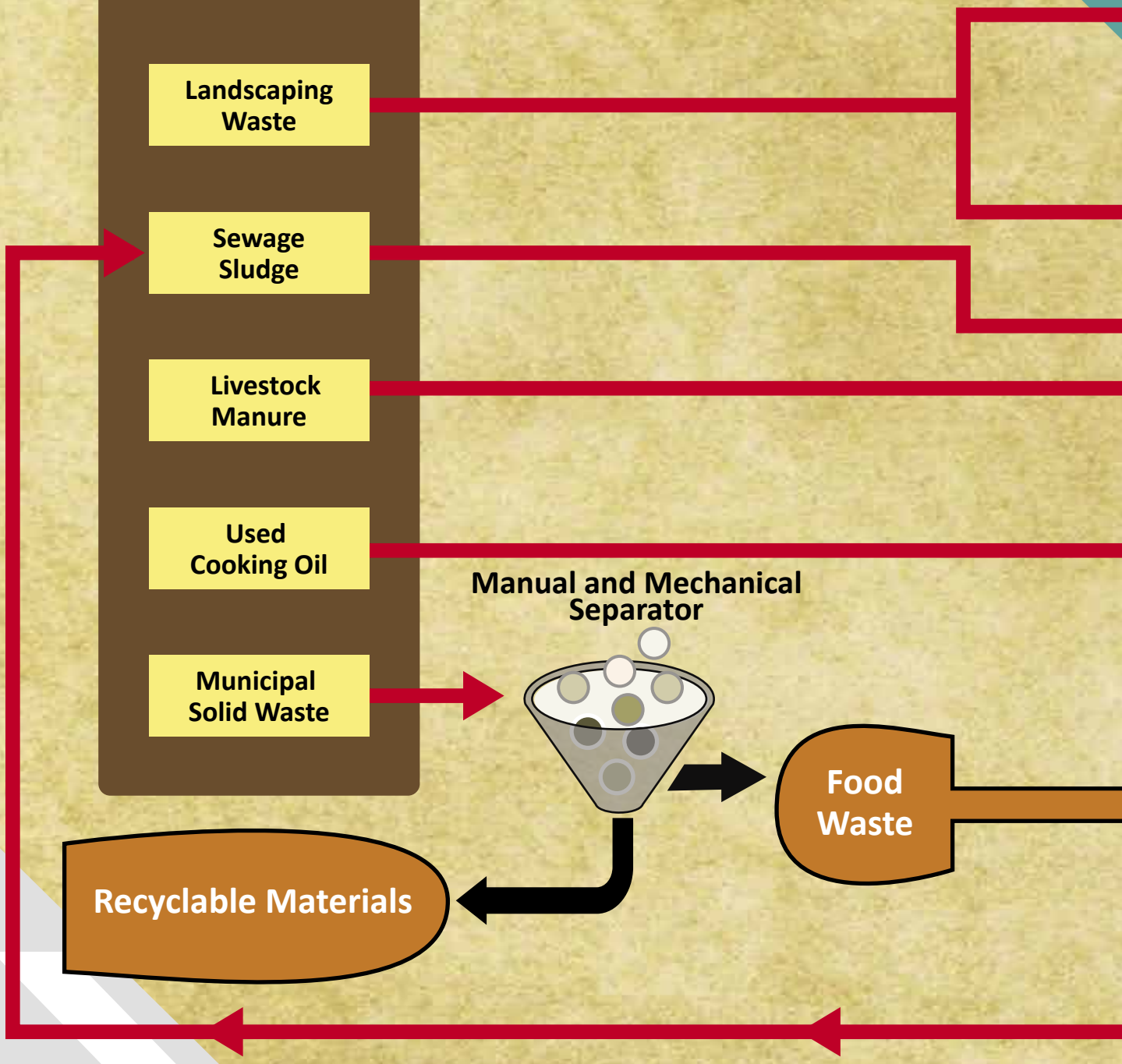
BIG PICTURE



EMERGING TECHNOLOGY

SERDANG BIOMASS TOWN

WASTE COLLECTION FROM:
| UNIVERSITI PUTRA MALAYSIA (UPM) |
| SRI SERDANG TOWN |
| MARDI |



BIOREFINERY COMPLEX AT UNIVERSITI PUTRA MALAYSIA

Carbonization Process

BIOCHAR

Composting Process

BIOCOMPOST

Biodiesel Production

BIODIESEL

Biogas Production

BIOGAS

Sludge

PROMOTION ON GREEN ECONOMY WITH PALM OIL INDUSTRY FOR BIODIVERSITY CONSERVATION IN MALAYSIA


OIL PALM TREE

RAW MATERIALS

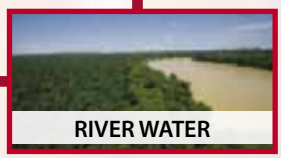

FRESH FRUIT BUNCH


CRUDE PALM OIL


KERNEL

TRADITIONAL PRODUCTS


PALM OIL MILL


RIVER WATER


HOLDING POND


ELECTRICITY

Turbine

Boiler


SHELL


MESOCARP FIBER


EMPTY FRUIT BUNCH


EXCESS STEAM


POME

Dust and Smoke

Mulching and Dumping

Heat

POME final discharge
BOD 50ppm
COD 600ppm

Water &
Air Pollution

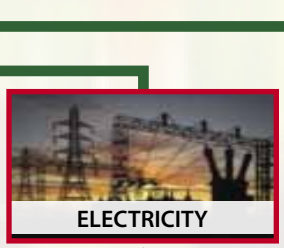

AEROBIC TREATMENT


METHANE

ANAEROBIC TREATMENT

Crisis in Biodiversity

BUSINESS AS USUAL


ELECTRICITY


RECYCLED WATER

Methane

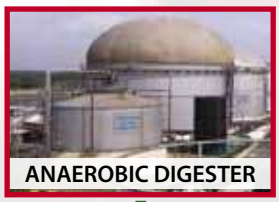
New Turbine

New Boiler


CARBONIZATION


PRETREATMENT


COMPOSTING PROCESS


ANAEROBIC DIGESTER

Sludge

POME final discharge treated with biochar


BIOADSORBENT


BIOCHAR


BIOSUGAR


NANOCELLULOSE & BIOCOMPOSITE


BIOCOMPOST

High Income from New Green Industry

Biodiversity Conservation

No Dust & Smoke
No POME

NEW BUSINESS MODEL

EB Group Success Story

SATREPS
Science and Technology Research Partnership for Sustainable Development Program

Promotion of Green Economy with Palm Oil Industry for Biodiversity Conservation in Malaysia

PROJECT LEADERS

Prof. Dr. Yoshihito Shirai

Kyutech 九州大学 AIST

Prof. Dr. Mohd Ali Hassan

UPM

Prof. Dr. Charles Santhanaraju Vairappan

Budget= MYR 4 million

27 Publications

Applied Science, Technology and Engineering, National Sciences and National Herritage

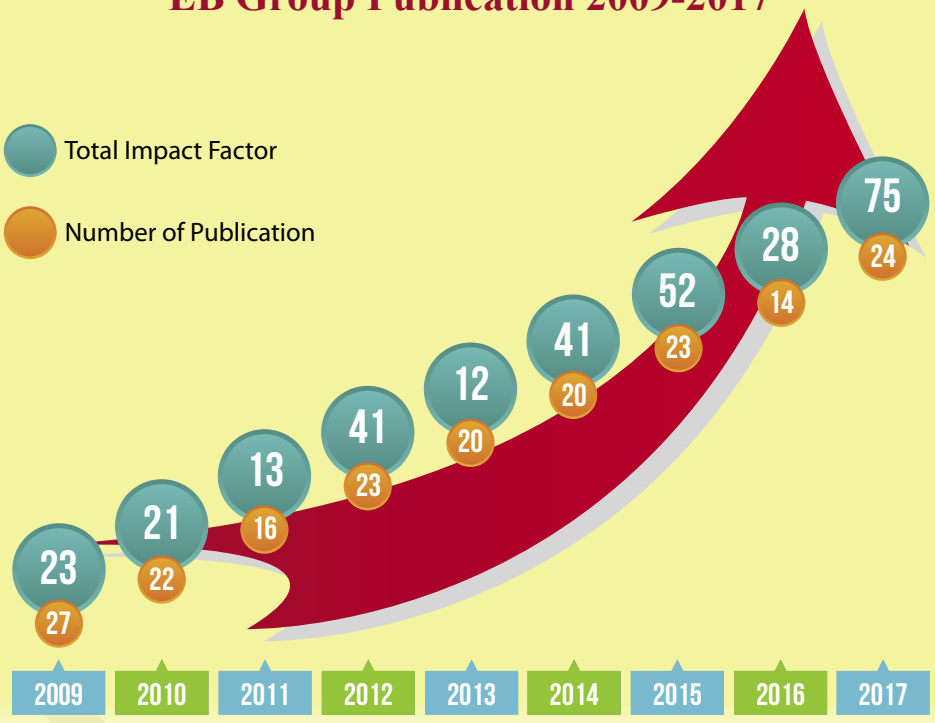
48 months (Sept 2014 - Aug 2018)

10 students graduated; 3 PhDs and 7 Masters

9 on-going students; 3 PhDs and 4 masters 3 PhDs dual degree program Kyutech-UPM

Keningau, Sabah, Malaysia

EB Group Publication 2009-2017



EB GROUP RESEARCHER

Professor Dr Mohd Ali Hassan

Specialization:
Bioprocess Engineering and Environmental Biotechnology

Current research interest:
Treatment and utilization of biomass for the production of bio-based products, bioremediation and reduction of greenhouse gases.

***h*-index:** 31

Citation: 3223

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Academic Qualification:

(a) PhD (Environmental Biotechnology), University of Okayama, Japan (1997)

(b) MPhil. (Chemical Engineering), University of Birmingham, U.K. (1990)

(c) MSc. (Food Engineering), University of Leeds, U.K. (1982)

(d) BSc. (Honours) (Chemical Engineering), University of Leeds, U.K. (1980)

(e) 'A' Levels (Math., Chem., Physics), Oxford College Further Edu., U.K. (1977)

(f) Post-graduate Diploma (Islamic Studies), University Kebangsaan Malaysia (1985)

Selected Publications:

1. Abdullah, S.S.S., Shirai, Y., Ali, A.A.M., Mustapha, M., Hassan, M.A., 2016. Case study: Preliminary assessment of integrated palm biomass biorefinery for bioethanol production utilizing non-food sugars from oil palm frond petiole. Energy Convers. Manag. 108, 233–242.

2. Ahmad Farid, M.A., Hassan, M.A., Taufiq-Yap, Y.H., Ibrahim, M.L., Othman, M.R., Ali, A.A.M., Shirai, Y., 2017a. Production of methyl esters from waste cooking oil using a heterogeneous biomass-based catalyst. Renew. Energy 114, 638–643.

3. Ahmad Farid, M.A., Hassan, M.A., Taufiq-Yap, Y.H., Shirai, Y., Hasan, M.Y., Zakaria, M.R., 2017b. Waterless purification using oil palm biomass-derived bioadsorbent improved the quality of biodiesel from waste cooking oil. J. Clean. Prod. 165, 262–272.

4. Dzulkurnain, Z., Hassan, M.A., Zakaria, M.R., Wahab, P.E.M., Hasan, M.Y., Shirai, Y., 2017. Co-composting of Municipal Sewage Sludge and Landscaping Waste: A Pilot Scale Study. Waste and Biomass Valorization 8, 695–705.

5. Ibrahim, I., Hassan, M.A., Abd-Aziz, S., Shirai, Y., Andou, Y., Othman, M.R., Ali, A.A.M., Zakaria, M.R., 2017. Reduction of residual pollutants from biologically treated palm oil mill effluent final discharge by steam activated bioadsorbent from oil palm biomass. J. Clean. Prod. 141, 122–127.

EB GROUP RESEARCHER

Professor Dr Suraini Abd-Aziz

Specialization:
Biochemical Engineering/Enzyme Technology

Current research interest:
Utilization of lignocellulosic biomass for bioenergy and biobased chemicals.

***h*-index:** 23

Citation: 1482

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Academic Qualification:

(a) PhD (Biochemical Engineering), University of Wales, Swansea, United Kingdom (1997)

(b) MSc. (Biochemical Engineering), University of Wales, Swansea, United Kingdom (1994)

(c) BSc. (Hons) (Clinical Biochemistry), Universiti Kebangsaan Malaysia (1992)

Selected Publications:

1. Abu Samah, R., Zainol, N., Lai Yee, P. and Abd-Aziz., S. 2017. Fixed-bed adsorption of aqueous vanillin onto resin H103. IIUM Engineering Journal. 18(2): 94-104.

2. Ariff, I.N.M., Bahrin, E.K., Ramli, N., Abd-Aziz, S., 2017. Direct Use of Spent Mushroom Substrate from Pleurotus pulmonarius as a Readily Delignified Feedstock for Cellulase Production. Waste and Biomass Valorization.

3. Ibrahim, M.F., Ramli, N., Bahrin, E.K., Abd-Aziz, S., 2017. Cellulosic biobutanol by Clostridia: Challenges and improvements. Renew. Sustain. Energy Rev. 79, 1241–1254.

4. Mohamad, N., Phang, L., Abd-Aziz, S., 2017. Optimization of metallo-keratinase production by Pseudomonas sp. LM19 as a potential enzyme for feather waste conversion. Biocatal. Biotransformation 35, 41–50.

5. Zainal, N.H., Aziz, A.A., Idris, J., Mamat, R., Hassan, M.A., Bahrin, E.K., Abd-Aziz, S., 2017. Microwave-assisted pre-carbonisation of palm kernel shell produced charcoal with high heating value and low gaseous emission. J. Clean. Prod. 142, 2945–2949.

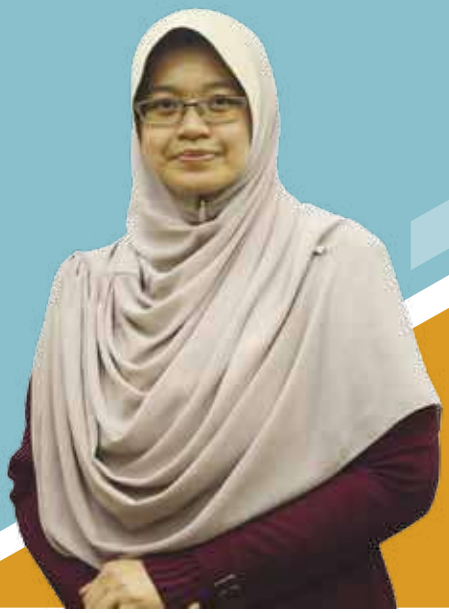
Book Chapter

Abd-Aziz, S, Ibrahim, M.F and Jenol, M.A.. (2017). Biological Pretreatment of Lignocellulosic Biomass for Volatile Fatty Acid Production (Part IV). IN: Emerging Areas in Bioengineering: Advanced Biotechnology (Vol 7). Edited by Ho Nam Chang. Series edited by Sang Yup Lee, Jens Nielsen and Gregory Stephanopoulos.

ISBN: 978-3-527-34088-0; 880 pages; December 2017. Wiley, 2017. Page 191-202.

EB GROUP RESEARCHER

Associate Professor Dr Hidayah Ariffin



Specialization:
Bioprocess Engineering and Biomaterials.

Current research interest:
- Nanocellulose and Nanocomposites.
- Utilization of plant biomass for the production of bio-based chemicals, biopolymers and biocomposites.

***h*-index:** 14

Citation: 581

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Academic Qualification:
(a) PhD (Environmental Engineering) Kyushu Institute of Technology, Japan (2009)

(b) MSc. (Bioprocess Engineering) Universiti Putra Malaysia (2006)

(c) Bachelor of Engineering (Process and Food) Universiti Putra Malaysia (2004)

Selected Publications:

1. Ahamad Nordin, N.I.A., Ariffin, H., Hassan, M.A., Shirai, Y., Ando, Y., Ibrahim, N.A., Wan Yunus, W.M.Z., 2017. Superheated Steam Treatment of Oil Palm Mesocarp Fiber Improved the Properties of Fiber-Polypropylene Biocomposite. BioResources 12, 68–81.

2. Kian, L.K., Jawaid, M., Ariffin, H., Alothman, O.Y., 2017. Isolation and characterization of microcrystalline cellulose from roselle fibers. Int. J. Biol. Macromol. 103, 931–940.

3. Mohd Warid, M.N., Ariffin, H., Hassan, M.A., Shirai, Y., 2016. Optimization of Superheated Steam Treatment to Improve Surface Modification of Oil Palm Biomass Fiber. BioResources 11, 5780–5796.

4. Rajaratanam, D.D., Ariffin, H., Hassan, M.A., Kawasaki, Y., Nishida, H., 2017. Effects of (R)-3-hydroxyhexanoate units on thermal hydrolysis of poly((R)-3-hydroxybutyrate-co-(R)-3-hydroxyhexanoate)s. Polym. Degrad. Stab. 137, 58–66.

5. Yasim-Anuar, T.A.T., Ariffin, H., Norrrahim, M.N.F., Hassan, M.A., 2017. Factors Affecting Spinnability of Oil Palm Mesocarp Fiber Cellulose Solution for the Production of Microfiber. BioResources 12, 715–734.

EB GROUP RESEARCHER

Dr Mohd Rafein Zakaria

Specialization:
Environmental biotechnology, Biomass valorization, Hydrothermal pretreatment, Polyhydroxyalkanoates

Current research interest:
Biomass valorization in biorefinery concept

***h*-index:** 11

Citation: 291

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Academic Qualification:

(a) PhD (Environmental Biotechnology), Universiti Putra Malaysia (2012)

(b) M.Sc. (Environmental Biotechnology), Universiti Putra Malaysia (2008)

(c) B.Sc. (Hons) Biotechnology, Universiti Putra Malaysia (2003)

Selected Publications:

1. Ahmad Farid, M.A., Hassan, M.A., Taufiq-Yap, Y.H., Shirai, Y., Hasan, M.Y., Zakaria, M.R., 2017. Waterless purification using oil palm biomass-derived bioadsorbent improved the quality of biodiesel from waste cooking oil. J. Clean. Prod. 165, 262–272.

2. Dzulkurnain, Z., Hassan, M.A., Zakaria, M.R., Wahab, P.E.M., Hasan, M.Y., Shirai, Y., 2017. Co-composting of Municipal Sewage Sludge and Landscaping Waste: A Pilot Scale Study. Waste and Biomass Valorization 8, 695–705.

3. Taifor, A.F., Zakaria, M.R., Mohd Yusoff, M.Z., Toshinari, M., Hassan, M.A., Shirai, Y., 2017. Elucidating substrate utilization in biohydrogen production from palm oil mill effluent by Escherichia coli. Int. J. Hydrogen Energy 42, 5812–5819.

4. Zakaria, M.R., Norrrahim, M.N.F., Hirata, S., Hassan, M.A., 2015. Hydrothermal and wet disk milling pretreatment for high conversion of biosugars from oil palm mesocarp fiber. Bioresour. Technol. 181, 263–269.

5. Zakaria, M.R., Hirata, S., Fujimoto, S., Ibrahim, I., Hassan, M.A., 2016. Soluble inhibitors generated during hydrothermal pretreatment of oil palm mesocarp fiber suppressed the catalytic activity of Acremonium cellulase. Bioresour. Technol. 200, 541–547.

EB GROUP RESEARCHER

Dr Norhayati Ramli

Specialization:
Microbial Biotechnology,
Environmental Microbiology

Current research interest:
Diversity and ecology of microbial community in waste and wastewater;
Strain improvement and utilization of biomass for the production of enzymes and biobased products

***h*-index:** 2

Citation: 15

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Academic Qualification:

(a) PhD (Microbial Biotechnology), Universiti Putra Malaysia (2012)

(b) B.Sc. (Biotechnology), Universiti Putra Malaysia (2008)

Selected Publications:

1. Sharuddin, S.S., Ramli, N., Hassan, M.A., Mustapha, N.A., Amran, A., Mohd-Nor, D., Sakai, K., Tashiro, Y., Shirai, Y., Maeda, T., 2017. Bacterial community shift revealed Chromatiaceae and Alcaligenaceae as potential bioindicators in the receiving river due to palm oil mill effluent final discharge. Ecol. Indic. 82, 526–529.

2. Sharuddin, S.S., Ramli, N., Mohd-Nor, D., Hassan, M.A., Maeda, T., Shirai, Y., Sakai, K., Tashiro, Y., 2018. Shift of low to high nucleic acid bacteria as a potential bioindicator for the screening of anthropogenic effects in a receiving river due to palm oil mill effluent final discharge. Ecol. Indic. 85, 79–84.

3. Zainudin, M.H.M., Ramli, N., Hassan, M.A., Shirai, Y., Tashiro, K., Sakai, K., Tashiro, Y., 2017. Bacterial community shift for monitoring the co-composting of oil palm empty fruit bunch and palm oil mill effluent anaerobic sludge. J. Ind. Microbiol. Biotechnol. 44, 869–877.

4. Chin, C.F.S., Furuya, Y., Zainudin, M.H.M., Ramli, N., Hassan, M.A., Tashiro, Y., Sakai, K., 2017. Novel multifunctional plant growth-promoting bacteria in co-compost of palm oil industry waste. J. Biosci. Bioeng. 124, 506–513.

5. Mustapha, N.A., Sharuddin, S.S., Zainudin, M.H.M., Ramli, N., Shirai, Y., Maeda, T., 2017. Inhibition of methane production by the palm oil industrial waste phospholine gum in a mimic enteric fermentation. J. Clean. Prod. 165, 621–629.

EB GROUP RESEARCHER

Dr Mohd Zulkhairi Mohd Yusoff

Specialization:
Environmental biotechnology, Bioprocess technology and Molecular biotechnology

Current research interest:
Biomass utilization, biohydrogen production, bioenergy, biocomposting, microbial fuel cells, molecular biotechnology applications, metabolic engineering *E coli*

***h*-index:** 7

Citation: 190

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Academic Qualification:

(a) PhD (Environmental Biotechnology), Kyushu Institute of Technology, Japan (2013)

(b) M.Sc. (Environmental Biotechnology), Universiti Putra Malaysia (2010)

(c) B.Sc. (Biotechnology), Universiti Putra Malaysia (2006)

Selected Publications:

1. Akita, H., Kimura, Z., Mohd Yusoff, M.Z., Nakashima, N., Hoshino, T., 2016. Isolation and characterization of Burkholderia sp. strain CCA53 exhibiting ligninolytic potential. Springerplus 5, 596.

2. Akita, H., Kimura, Z., Yusoff, M.Z.M., Nakashima, N., Hoshino, T., 2017. Identification and characterization of Burkholderia multivorans CCA53. BMC Res. Notes 10, 249.

3. Mohd Yusoff, M.Z., Akita, H., Hassan, M.A., Fujimoto, S., Yoshida, M., Nakashima, N., Hoshino, T., 2017. Production of acetoin from hydrothermally pretreated oil mesocarp fiber using metabolically engineered Escherichia coli in a bioreactor system. Bioresour. Technol. 245, 1040–1048.

4. Tuan Nguyen, M., Maeda, T., Zulkhairi Mohd Yusoff, M., Ogawa, H.I., 2014. Effect of azithromycin on enhancement of methane production from waste activated sludge. J Ind Microbiol Biotechnol 41, 1051–1059

5. Mohd Yusoff, M.Z., Hu, A., Feng, C., Maeda, T., Shirai, Y., Hassan, A., Yu, C.-P., 2013. Influence of pretreated activated sludge for electricity generation in microbial fuel cell application. Bioresour. Technol. 145, 90–96.

EB GROUP RESEARCHER

Dr Mohamad Faizal Ibrahim

Specialization:
Bioprocessing technology, Fermentation Technology, Enzyme Technology

Current research interest:
Biomass utilisation and conversion into biofuels, biocatalyst, and bio-based chemicals through biotechnology approaches

***h*-index:** 7

Citation: 138

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Academic Qualification:

(a) PhD (Environmental Biotechnology), Universiti Putra Malaysia (2013)

(b) B.Sc. (Biotechnology), Universiti Putra Malaysia (2009)

(c) Diploma in Science, Universiti Teknologi MARA (2006)

Selected Publications:

1. Ibrahim, M.F., Abd-Aziz, S., Yusoff, M.E.M., Phang, L.Y., Hassan, M.A., 2015. Simultaneous enzymatic saccharification and ABE fermentation using pretreated oil palm empty fruit bunch as substrate to produce butanol and hydrogen as biofuel. Renew. Energy 77, 447–455.

2. Ibrahim, M.F., Ramli, N., Bahrin, E.K., Abd-Aziz, S., 2017. Cellulosic biobutanol by Clostridia: Challenges and improvements. Renew. Sustain. Energy Rev. 79, 1241–1254.

3. Ibrahim, M.F., Razak, M.N.A., Phang, L.Y., Hassan, M.A., Abd-Aziz, S., 2013. Crude cellulase from oil palm empty fruit bunch by Trichoderma asperellum UPM1 and Aspergillus fumigatus UPM2 for fermentable sugars production. Appl. Biochem. Biotechnol. 170, 1320–1335.

4. Jenol, M.A., Ibrahim, M.F., Lai Yee, P., Md Salleh, M., Abd-Aziz, S., 2013. Sago Biomass as a Sustainable Source for Biohydrogen Production by Clostridium butyricum A1. BioResources 9, 1007–1026.

5. Masran, R., Zanirun, Z., Bahrin, E.K., Ibrahim, M.F., Lai Yee, P., Abd-Aziz, S., 2016. Harnessing the potential of ligninolytic enzymes for lignocellulosic biomass pretreatment. Appl. Microbiol. Biotechnol. 100, 5231–5246.

EB GROUP RESEARCHER

Dr Ezyana Kamal Bahrin

Specialization:
Biomass and Bioenergy

Current research interest:
Lignocellulosic biomass, Enzyme Technology, Biomass and Bioenergy

***h*-index:** 6

Citation: 85

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Academic Qualification:

(a) PhD (Industrial Biotechnology), Universiti Putra Malaysia (2013)

(b) B.Sc. (Biotechnology), Universiti Putra Malaysia (2007)

Selected Publications:

1. Abdullah, S.S.S., Shirai, Y., Bahrin, E.K., Hassan, M.A., 2015. Fresh oil palm frond juice as a renewable, non-food, non-cellulosic and complete medium for direct bioethanol production. Ind. Crops Prod. 63, 357–361.

2. Masran, R., Zanirun, Z., Bahrin, E.K., Ibrahim, M.F., Lai Yee, P., Abd-Aziz, S., 2016. Harnessing the potential of ligninolytic enzymes for lignocellulosic biomass pretreatment. Appl. Microbiol. Biotechnol. 100, 5231–5246.

3. Zainal, N.H., Aziz, A.A., Idris, J., Mamat, R., Hassan, M.A., Bahrin, E.K., Abd-Aziz, S., 2017. Microwave-assisted pre-carbonisation of palm kernel shell produced charcoal with high heating value and low gaseous emission. J. Clean. Prod. 142, 2945–2949.

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***h*-index:** 3

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1. Roslan, A.M., Zahari, M.A.K.M., Hassan, M.A., Shirai, Y., 2014. Investigation of Oil Palm Frond Properties for Use as Biomaterials and Biofuels. Trop. Agric. Dev. 58, 26–29.

2. Zahari, M.A.K.M., Abdullah, S.S.S., Roslan, A.M., Ariffin, H., Shirai, Y., Hassan, M.A., 2014. Efficient utilization of oil palm frond for bio-based products and biorefinery. J. Clean. Prod. 65, 252–260.

3. Abdul-Mutalib, N.A., Amin Nordin, S., Osman, M., Roslan, A.M., Ishida, N., Sakai, K., Tashiro, Y., Tashiro, K., Maeda, T., Shirai, 2016. The prevalence of foodborne pathogenic bacteria on cutting boards and their ecological correlation with background biota. AIMS Microbiology. 2(2), 138-151.

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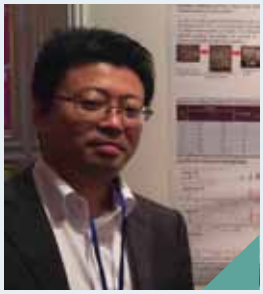

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PUBLICATIONS

2017 EB GROUP PUBLICATION STATUS

TOTAL NUMBER OF PUBLISHED JOURNAL
24

- Q1 **11**
- Q2 **6**
- Q3 **4**
- Q4 **2**
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28

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Renewable and Sustainable Energy Reviews

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Cellulosic biobutanol by Clostridia: Challenges and improvements

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Lignocellulosic biomass
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ABSTRACT

The gradual shift of transportation fuels from oil based fuels to alternative fuel resources and worldwide demand for energy has been the impetus for research to produce alcohol biofuels from renewable resources which focus on utilizing simple sugars from lignocellulosic biomass, the largest known renewable carbohydrate source as an alternative. Currently, the usage of bioethanol and biodiesel do not cover an increasing demand for biofuels. Hence, there is an extensive need for advanced biofuels with superior fuel properties. Biobutanol is regarded to be an excellent biofuel compared to bioethanol in terms of energy density and hygroscopicity, could be produced through acetone-butanol-ethanol (ABE) fermentation process. Even though the ABE fermentation is one of the oldest large-scale fermentation processes, biobutanol yield by anaerobic fermentation remains sub-optimal. For sustainable industrial scale of biobutanol production, a number of obstacles need to be addressed including choice of feedstock, low product yield, product toxicity to strain, multiple end-products and downstream processing of alcohol mixtures plus the metabolic engineering for improvement of fermentation process and products. Studies on the kinetic and physiological models for fermentation using lignocellulosic biomass provide useful information for process optimization. Simultaneous saccharification and fermentation (SSF) with *in-situ* product removal techniques have been developed to improve production economics due to the lower biobutanol yield in the fermentation broth. The present review is attempting to provide an overall outlook on the discoveries and strategies that are being developed for biobutanol production from lignocellulosic biomass.

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Microwave-assisted pre-carbonisation of palm kernel shell produced charcoal with high heating value and low gaseous emission

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Microwave-assisted carbonisation
Higher heating value
Palm kernel shell
Charcoal
Waste utilisation

ABSTRACT

Production of charcoal with a high higher heating value (HHV) while maintaining low gaseous emission requires high energy input and complicated methods. This paper presents a study of the production of charcoal with high HHV and low gaseous emission from palm kernel shell (PKS) within a microwave-assisted pre-carbonisation system. The maximum temperature was 300 °C, and three magnetrons were employed to assist with the pre-carbonisation process. The magnetrons were programmed to automatically shut down when the temperature reached 250 °C. Carbonisation took place when the PKS was combusted and the resulting heat was used to sustain the carbonisation. The gaseous emission was passed through a condensation unit and a scrubber system connected to the microwave reactor. Untreated PKS biomass with particle size of 6–15 mm was used in this study. A high HHV of 27.63 MJ/kg was obtained. The concentrations for the particulate matter with a size of 10 μm and below (PM_{10}), CO, NO_2, SO_2 and HCl were below the standard limits set by the Malaysian Ambient Air Quality Standards (2014). Therefore, the microwave-assisted pre-carbonisation technology proposed in this study produced charcoal with high HHV and low gaseous emission which can be used as co-combustion for renewable energy generation.

(Q1) IMPACT FACTOR 5.715

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Journal of Cleaner Production

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Short communication

Reduction of residual pollutants from biologically treated palm oil mill effluent final discharge by steam activated bioadsorbent from oil palm biomass

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ABSTRACT

Treatment of wastewater using bioadsorbent has gained interest as one of the tertiary treatment methods. Bioadsorbents from peat, coconut shell, fruit stones and oil palm biomass have been produced but the bioadsorbent ability in removing pollutants from biologically treated palm oil mill effluent final discharge is scarcely reported. This research attempts to treat biologically treated palm oil mill effluent final discharge using steam activated oil palm mesocarp fiber bioadsorbent without the use of chemicals as activating agents. Oil palm mesocarp fiber was carbonised at 400 °C for 30 min and later activated using steam at same temperature for another 30 min. The Brunauer-Emmett-Teller (BET) surface area of the bioadsorbent was found to be 494 m^2/g. Bioadsorbent produced was then used to treat biologically treated palm oil mill final discharge by mixing both bioadsorbent and the wastewater into a conical flask and shaken at 150 rpm for 24 h. At 10 g/L dosage, the bioadsorbent reduced the chemical oxygen demand and suspended solid of biologically treated palm oil mill effluent final discharge from 395 mg/L and 317 mg/L down to 103 mg/L and 14 mg/L, respectively. Consecutive treatments at 10 g/L dosage resulted in higher removal of the chemical oxygen demand and suspended solids up to 122 mg/L and 7 mg/L, respectively, which meets the river water quality, making the final wastewater suitable as recycled water for the zero-emission system in the palm oil mill.

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Inhibition of methane production by the palm oil industrial waste phospholine gum in a mimic enteric fermentation

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Phospholine gum
By-product of palm oil industry
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ABSTRACT

The potential utilization of phospholine gum, a by-product of the palm oil industry was evaluated using waste sewage sludge (WSS) as a substrate as well as a microbial source to mimic methane production by enteric fermentation. Ruminant animals release enteric methane through their digestive process. The enteric methane is one of the greenhouse gases that can contribute to global warming and should be prevented. In this study, methane production was remarkably inhibited by adding phospholine gum to WSS, even at a low concentration. Phospholine gum reduced the activity of methanogens and *Lactobacillus* sp. and *Megasphaera* sp. which are known as important ruminal microorganisms were detected as bacterial species induced by the addition of phospholine gum to WSS. Also, the addition of phospholine gum triggered an increase in protein concentrations as well as protease activities and stimulated to produce protease and cellulase by which phospholine gum may be degraded. Furthermore, a significant amount of propionate was produced in the presence of phospholine gum. Thus, phospholine gum inhibits methane production without inhibiting the stages of hydrolysis and acidogenesis/acetogenesis. Finally, methane fermentation using the rumen derived from a goat was also inhibited by phospholine gum. Therefore, these results indicate that the phospholine gum has great potential to inhibit methane production as a feed additive for ruminant animals.

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Waterless purification using oil palm biomass-derived bioadsorbent improved the quality of biodiesel from waste cooking oil

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ABSTRACT

The utilization of adsorbents produced from biomass for tertiary treatment of industrial wastes has gained much interest compared to the conventional methods such as flocculation and coagulation. In the present study, a bioadsorbent produced from pressed-shredded oil palm empty fruit bunch was used to remove impurities from crude biodiesel derived from waste cooking oil. The purification process was performed using 1 to 5 wt% bioadsorbent loadings under continuous stirring at 500 rpm for 1 h. After purification using 5 wt% of bioadsorbent loading, 89.7% of residual methanol, 81.7% of water, 36.7% of free fatty acid and 98.6% of potassium were successfully removed. This met the European Biodiesel Standard (EN14214). In comparison to commercial adsorbents and the water washing method, purification using the oil palm empty fruit bunch derived bioadsorbent resulted in higher removal of free fatty acids, potassium, water impurities and a smaller loss of fatty acid methyl esters. It was found that the use of the bioadsorbent improved the biodiesel quality besides its benefits of ease of operations and avoidance of waste water production.

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Bioresource Technology

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Production of acetoin from hydrothermally pretreated oil mesocarp fiber using metabolically engineered *Escherichia coli* in a bioreactor system

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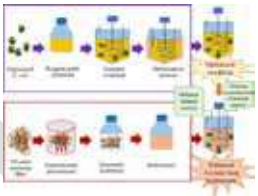

(Q1) IMPACT FACTOR **4.357**

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Renewable Energy

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Production of methyl esters from waste cooking oil using a heterogeneous biomass-based catalyst

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ABSTRACT

Fatty acid methyl esters (FAME) production from waste cooking oil was successfully carried out using a newly developed heterogeneous biomass-based catalyst. Activated carbon produced from oil palm biomass was calcined with potassium phosphate tri-basics (K_3PO_4) in order to synthesize a high catalytic heterogeneous catalyst. As it is characterized with substantial surface area of 680 m^2/g and basicity amount of 11.21 mmol/g, 98% of FAME yield was achieved under optimum reaction parameters of 5 wt% catalyst loading, 12:1 methanol to oil molar ratio at 60 °C for 4 h. The catalyst was shown to be reusable, with more than 76% FAME yield after 5 consecutive cycles.

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Short Communication

Bacterial community shift revealed *Chromatiaceae* and *Alcaligenaceae* as potential bioindicators in the receiving river due to palm oil mill effluent final discharge

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ABSTRACT

A thorough outlook on the effect of palm oil mill effluent (POME) final discharge towards bacterial community dynamics in the receiving river is provided in this study by using a high-throughput MiSeq. The shift of bacterial composition could be used to determine the potential bacterial indicators to indicate contamination caused by POME. This study showed that the POME final discharge did not only alter the natural physicochemical properties of the river water but also caused the reduction of bacterial diversity in the receiving river. The *Chromatiaceae* and *Alcaligenaceae* which were not detected in the upstream but were detected in the downstream part of the river are proposed as the indicator bacteria to indicate the river water contamination caused by POME final discharge. The emergence of either one or both bacteria in the downstream part of the river were shown to be carried over by the effluent. Therefore, an accurate pollution monitoring approach using bacterial indicator is expected to complement the conventional POME pollution assessment method which is currently dependent on the physicochemical properties of the final discharge. This is the first study that reported on the potential indicator bacteria for the assessment of river water contamination caused by POME final discharge.

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Assoc. Prof. Dr. Hidayah Ariffin
Group Researcher

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Isolation and characterization of microcrystalline cellulose from roselle fibers

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ABSTRACT

In this study, microcrystalline cellulose (MCC) was extracted from roselle fiber through acid hydrolysis treatment and its properties were compared with those of commercially available MCC. The physicochemical and morphological characteristics, elemental composition, size distribution, crystallinity and thermal properties of the obtained MCC were analyzed in this work. Fourier transform infrared spectroscopy (FTIR) analysis provided clear evidence that the characteristic peak of lignin was absent in the spectrum of the MCC prepared from roselle fiber. Rough surface and slight aggregation of MCC were observed by scanning electron microscopy (SEM). Energy dispersive X-ray (EDX) analysis showed that pure MCC with small quantities of residues and impurities was obtained, with a similar elemental composition to that of commercial MCC. A mean diameter of approximately 44.28 μm was measured for MCC by using a particle size analyzer (PSA). X-ray diffraction (XRD) showed the crystallinity increased from 63% in roselle pulp to 78% in roselle MCC, the latter having a slightly higher crystallinity than that of commercial MCC (74%). TGA and DSC results indicated that the roselle MCC had better thermal stability than the roselle pulp, whereas it had poorer thermal stability in comparison with commercial MCC. Thus, the isolated MCC from roselle fibers will be going to use as reinforcing element in green composites and may be a precursor for future roselle derived nanocellulose, and thus a promising subject in nanocomposite research.

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Azam Fikri Taifor
Master Student

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Elucidating substrate utilization in biohydrogen production from palm oil mill effluent by *Escherichia coli*

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Palm oil mill effluent
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Formic acid

ABSTRACT

The present work aims to elucidate substrate utilization from palm oil mill effluent (POME) for biohydrogen production. The experiment was performed in 150 mL serum bottles and the cultures were supplemented with autoclaved-pretreated POME or 0.05 M individual technical grade substrates to investigate the potential use of POME and substrates in preference towards biohydrogen production. The cultures were incubated at 37 °C for 24 h with mild agitation. The maximum hydrogen yield (MHY) obtained was 0.66 mol H_2/mol total monomeric sugars and productivity of 3551 μmol/10^{10} cfu were obtained from engineered *Escherichia coli*. The POME oligomeric sugars were not metabolized further, which render insignificant conversion of carbohydrates into hydrogen from POME. The yield of hydrogen production increased by 3.5 folds by engineered *E. coli* BW25113 compared to wild type *E. coli* BW25113. The preference of the substrates for biohydrogen production is in the following order; glucose > fructose > formic acid.

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Effects of (*R*)-3-hydroxyhexanoate units on thermal hydrolysis of poly((*R*)-3-hydroxybutyrate-co-(*R*)-3-hydroxyhexanoate)s

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ABSTRACT

In order to clarify effects of (*R*)-3-hydroxyhexanoate (HHx) unit on the hydrothermal degradation of poly((*R*)-3-hydroxybutyrate-*co*-(*R*)-3-hydroxyhexanoate) (PHBHHx), two PHBHHxs: P(HB-*co*-6%-HHx) and P(HB-*co*-11%-HHx), and poly((*R*)-3-hydroxybutyrate) (PHB) as a reference were treated by superheated steam at 130–190 °C. Interestingly, despite having contents of the HHx unit nearby, contrastive degradation property: the contradictory scission behavior of HB-HHx sequence was confirmed. From analysis of chain-end structures, it was confirmed that HHx unit basically suppressed the hydrolysis of HB-HHx sequence and the formation of crotonoyl chain-end groups rapidly increased at higher temperatures, suggesting the shift to thermal degradation from hydrolysis as a main reaction. On thermal degradation, the contrary upper and lower E_a values: 138 ± 1.9 and 121 ± 1.8 kJ mol^{-1} for P(HB-*co*-6%-HHx) and P(HB-*co*-11%-HHx), respectively, compared to E_a value: 126 ± 5.3 kJ mol^{-1} of PHB were obtained. The HHx unit basically acts as suppressing factor of the thermal degradation from T_{d50} and T_{d50}-T_m values; however, the increase in flexibility of polymer sequence must promote the thermal chain cleavage. Thus, the complex hydrothermal degradation behaviors were considered to be combined results of the suppression effects by hydrophobicity and steric hindrance of propyl group in HHx unit and the promotive effects of lower crystallinity and easier steam diffusion into more flexible amorphous region of PHBHHx.

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Research paper

Evaluation of biomass energy potential towards achieving sustainability in biomass energy utilization in Sabah, Malaysia

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ABSTRACT

The potential of biomass energy in Sabah, Malaysia was analyzed by data which was established from literature, statistic data and available documents for estimating the potential of biomass energy derived from oil palm, coconut shell, rice, livestock and forest. Nowadays, the issue of solid biomass residues including effluent from the palm oil milling process has become a big concern for the industry and the public in Sabah, because oil palm residues provide a huge potential of biomass energy in Sabah. This paper showed that biomass energy potential in Sabah was around 267,179,818 GJ/year in total, which was derived from oil palm EFB, shell, OPF (oil palm frond), OPT (oil palm trunk), coconut shell, rice, livestock and forest. Potential of biomass energy from oil palm, coconut shell, rice, livestock and forest was 263,635,079 GJ/year, 95,713 GJ/year, 710,028 GJ/year, 750,696 GJ/year and 1,988,301 GJ/year, respectively. Most biomass energy came from oil palm, which was around 98.7% of total potential. If this total energy potential is applied at a power plant with efficiency ratio of 25% and 8000 h per year of operation, this has potential of 2,288 MW, which is equivalent to around 3.8 times of total supply of electricity in 2010 in Sabah. This paper also suggests that relevant policy and innovative technology be developed based on the result to effectively utilize biomass.

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Dr. Norhayati Ramli
Group Researcher

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ENVIRONMENTAL MICROBIOLOGY - ORIGINAL PAPER

SIMB Society for Industrial Microbiology and Biotechnology

Bacterial community shift for monitoring the co-composting of oil palm empty fruit bunch and palm oil mill effluent anaerobic sludge

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Abstract A recently developed rapid co-composting of oil palm empty fruit bunch (OPEFB) and palm oil mill effluent (POME) anaerobic sludge is beginning to attract attention from the palm oil industry in managing the disposal of these wastes. However, a deeper understanding of microbial diversity is required for the sustainable practice of the co-compositing process. In this study, an in-depth assessment of bacterial community succession at different stages of the pilot scale co-composting of OPEFB-POME anaerobic sludge was performed using 454-pyrosequencing, which was then correlated with the changes of physicochemical properties including temperature, oxygen level and moisture content. Approximately 58,122 of 16S rRNA gene amplicons with more than 500 operational taxonomy units (OTUs) were obtained. Alpha diversity and principal component analysis (PCoA) indicated that bacterial diversity and distributions were most influenced by the physicochemical properties of the co-composting stages, which showed remarkable shifts of dominant species throughout the process. Species related to *Devosia yakushimensis* and *Desemzia incerta* are shown to emerge as dominant bacteria in the thermophilic stage, while *Planococcus rifietoensis* correlated best with the later stage of co-composting. This study proved the bacterial community shifts in the co-composting stages corresponded with the changes of the physicochemical properties, and may, therefore, be useful in monitoring the progress of co-composting and compost maturity.

Keywords Co-composting · Bacterial community structure · Oil palm empty fruit bunch · Palm oil mill effluent anaerobic sludge · Pyrosequencing

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Novel multifunctional plant growth–promoting bacteria in co-compost of palm oil industry waste

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Previously, a unique co-compost produced by composting empty fruit bunch with anaerobic sludge from palm oil mill effluent, which contributed to establishing a zero-emission industry in Malaysia. Little was known about the bacterial functions during the composting process and fertilization capacity of this co-compost. We isolated 100 strains from the co-compost on 7 types of enumeration media and screened 25 strains using *in vitro* tests for 12 traits, grouping them according to three functions: plant growth promoting (fixation of nitrogen; solubilization of phosphorus, potassium, and silicate; production of 3-indoleacetic acid, ammonia, and siderophore), biocontrolling (production of chitinase and anti-*Ganoderma* activity), and composting (degradation of lignin, xylan, and cellulose). Using 16S rRNA gene sequence analysis, 25 strains with strong or multi-functional traits were found belong to the genera *Bacillus*, *Paenibacillus*, *Citrobacter*, *Enterobacter*, and *Kosakonia*. Furthermore, several strains of *Citrobacter sedlakii* exhibited a plant growth-stimulation *in vivo* komatsuna plant cultivation test. In addition, we isolated several multifunctional strains; *Bacillus tequilensis* CE4 (biocontrolling and composting), *Enterobacter cloacae* subsp. *dissolvens* B3 (plant growth promoting and biocontrolling), and *C. sedlakii* CESi7 (plant growth promoting and composting). Some bacteria in the co-compost play significant roles during the composting process and plant cultivation after fertilization, and some multifunctional strains have potential for use in accelerating the biodegradation of lignocellulosic biomass, protecting against *Ganoderma boninense* infection, and increasing the yield of palm oil.

[**Key words:** Co-compost; *Citrobacter sedlakii*; *Enterobacter cloacae* subsp. *dissolvens*; *Bacillus tequilensis*; Plant growth promoting]

(Q2) IMPACT FACTOR **1.860**

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Assoc. Prof. Dr. Hidayah Ariffin
Group Researcher

Journal of Applied Polymer Science

Dynamically controlled fibrillation under combination of ionic liquid with mechanical grinding

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ABSTRACT: Combination of mortar grinder mill (MG) and ionic liquid (IL) treatment was employed in order to fibrillate fibers from oil palm mesocarp fiber (OPMF) in one-step. The structural changes of OPMF before and after the treatment were examined by Thermogravimetric analysis (TGA), Fourier transformed infrared (FT-IR) spectra, Wide-angle X-ray diffraction (WAXD), Dynamic light scattering (DLS) and Scanning electron microscopy (SEM). Compared with the only use of 1-butyl-3-methylimidazolium tetrafluoroborate (BMIM[BF_4]), combination of MG and IL helped to remove hemicellulose and lignin components partially from OPMF, and also fibrillated OPMF fibers at average particle diameter of 127 nm. Afterwards, the fibrillated fibers were utilized as reinforcement material for the purpose of enhancement of mechanical properties of poly(ε-caprolactone)(PCL). The addition of OPMF treated with the combined method led to a 64% increase in tensile strength in comparison with that of untreated OPMF. These results indicate that the combined method enables effective fibrillation. © 2016 Wiley Periodicals, Inc. J. Appl. Polym. Sci. **2017**, *134*, 44469.

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(Q3) IMPACT FACTOR **1.527**

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Dr. Norhayati Ramli
Group Researcher

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Improvement of hydrogen yield of ethanol-producing *Escherichia coli* recombinants in acidic conditions

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ABSTRACT

Background: An effective single culture with high glycerol consumption and hydrogen and ethanol coproduction yield is still in demand. A locally isolated glycerol-consuming *Escherichia coli* SS1 was found to produce lower hydrogen levels under optimized ethanol production conditions. Molecular approach was proposed to improve the hydrogen yield of *E. coli* SS1 while maintaining the ethanol yield, particularly in acidic conditions. Therefore, the effect of an additional copy of the native hydrogenase gene *hycE* and recombinant clostridial hydrogenase gene *hydA* on hydrogen production by *E. coli* SS1 at low pH was investigated.
Results: Recombinant *E. coli* with an additional copy of *hycE* or clostridial *hydA* was used for fermentation using 10 g/L (108.7 mmol/L) of glycerol with an initial pH of 5.8. The recombinant *E. coli* with *hycE* and recombinant *E. coli* with *hydA* showed 41% and 20% higher hydrogen yield than wild-type SS1 (0.46 ± 0.01 mol/mol glycerol), respectively. The ethanol yield of recombinant *E. coli* with *hycE* (0.50 ± 0.02 mol/mol glycerol) was approximately 30% lower than that of wild-type SS1, whereas the ethanol yield of recombinant *E. coli* with *hydA* (0.68 ± 0.09 mol/mol glycerol) was comparable to that of wild-type SS1.
Conclusions: Insertion of either *hycE* or *hydA* can improve the hydrogen yield with an initial pH of 5.8. The recombinant *E. coli* with *hydA* could retain ethanol yield despite high hydrogen production, suggesting that clostridial *hydA* has an advantage over the *hycE* gene in hydrogen and ethanol coproduction under acidic conditions. This study could serve as a useful guidance for the future development of an effective strain coproducing hydrogen and ethanol.

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Dr. Norhayati Ramli
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Research article

Co-production of hydrogen and ethanol by *Escherichia coli* SS1 and its recombinant

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ABSTRACT

Background: The development of a potential single culture that can co-produce hydrogen and ethanol is beneficial for industrial application. Strain improvement via molecular approach was proposed on hydrogen and ethanol co-producing bacterium, *Escherichia coli* SS1. Thus, the effect of additional copy of native hydrogenase gene *hybC* on hydrogen and ethanol co-production by *E. coli* SS1 was investigated.
Results: Both *E. coli* SS1 and the recombinant *hybC* were subjected to fermentation using 10 g/L of glycerol at initial pH 7.5. Recombinant *hybC* had about 2-fold higher cell growth, 5.2-fold higher glycerol consumption rate and 3-fold higher ethanol productivity in comparison to wild-type SS1. Nevertheless, wild-type SS1 reported hydrogen yield of 0.57 mol/mol glycerol and ethanol yield of 0.88 mol/mol glycerol, which were 4- and 1.4-fold higher in comparison to recombinant *hybC*. Glucose fermentation was also conducted for comparison study. The performance of wild-type SS1 and recombinant *hybC* showed relatively similar results during glucose fermentation. Additional copy of *hybC* gene could manipulate the glycerol metabolic pathway of *E. coli* SS1 under slightly alkaline condition.
Conclusions: HybC could improve glycerol consumption rate and ethanol productivity of *E. coli* despite lower hydrogen and ethanol yields. Higher glycerol consumption rate of recombinant *hybC* could be an advantage for bioconversion of glycerol into biofuels. This study could serve as a useful guidance for dissecting the role of hydrogenase in glycerol metabolism and future development of effective strain for biofuels production.

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Assoc. Prof. Dr. Hidayah Ariffin
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Synthesis and comparative study of thermal, electrochemical, and cytotoxicity properties of graphene flake and sheet

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Abstract Two types of graphene, namely few-layer flake and multilayer sheet, were produced by chemical vapor deposition on nickel catalyst at high temperature (1050 °C) using different reaction times and cooling rates and their properties characterized and compared. The number of layers, morphology, structure, graphitization, composition, and surface area were studied using scanning electron microscopy, transmission electron microscopy, electron-dispersive X-ray analysis, Raman spectroscopy, and Brunauer–Emmett–Teller (BET) surface area measurements, respectively. Further properties of these nanomaterials, including their thermal stability, electrochemical properties, and cytotoxicity, were also comprehensively investigated.

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Master Student

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ORIGINAL PAPER

Co-composting of Municipal Sewage Sludge and Landscaping Waste: A Pilot Scale Study

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Abstract Compost with nutrient-rich organic matter can be produced from renewable biomass materials such as municipal sewage sludge, landscaping waste and others. In this study, co-composting of municipal sewage sludge and landscaping waste as a soil amendment using 10 m^3 pilot scale bioreactor system was tested. The temperature, oxygen level, moisture content and pH were monitored throughout the composting process. Proximate and ultimate analyses of the compost were determined for nutrient availability. The matured compost produced has nitrogen, phosphorus and potassium content of 3.01, 0.27 and 0.68 %, respectively, which made it suitable for the growth of ornamental plants. The Solvita® compost maturity kit gave an index result of 7, which indicated that the product was matured. Pathogenicity test of the compost confirmed that coliforms and *Escherichia coli* were eliminated within 15 days of composting at the thermophilic stage, making the compost safe to be used in the natural environment.

Keywords Bioreactor composting · Compost · Biofertiliser · Municipal sewage sludge · Landscaping waste

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Tengku Arisyah Tengku Yasim Anuar
PhD Student

PEER-REVIEWED ARTICLE *bioresources.com*

Factors Affecting Spinnability of Oil Palm Mesocarp Fiber Cellulose Solution for the Production of Microfiber

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Cellulose microfiber (MF) formation by electrospinning is affected by several factors. In this paper, fabrication of MF from oil palm mesocarp fiber (OPMF), a biomass residue abundantly available at the palm oil mill, was conducted by electrospinning. The effect of OPMF-cellulose solution properties on the spinnability of the solution was determined. Extracted cellulose from OPMF was dissolved in four different formulations of ionic liquids: (i) ([EMIM]Cl), (ii) ([EMIM][Cl):DMF, (iii) ([EMIM]Cl):([C_{10}MIM][Cl]), and (iv) ([EMIM]Cl):([C_{10}MIM][Cl]):DMF at cellulose concentrations of 1% to 9% (w/v). Scanning electron microscopy (SEM) analysis showed that MF formed had diameter sizes ranging from 200 to 500 nm. MF was formed only at 6% (w/v) cellulose concentration, when DMF was mixed in the solution. The results showed that cellulose concentration and viscosity played major roles in the spinnability of cellulose solution, in which too high viscosity of the cellulose solution caused failure of the electrospinning process and eventually affected the formation of MF. The characteristics of MF obtained herein suggest the potential of OPMF cellulose as a starting material for the production of MF.

Keywords: Oil palm mesocarp fibers; Microfibrillated cellulose; Spinnability; Electrospinning; Ionic liquids

(Q2) IMPACT FACTOR **1.321**

PUBLISHED

Nor Ida Amalina Ahamad Nordin
PhD Student

PEER-REVIEWED ARTICLE *bioresources.com*

Superheated Steam Treatment of Oil Palm Mesocarp Fiber Improved the Properties of Fiber-Polypropylene Biocomposite

Noor Ida Amalina Ahamad Nordin,[a,b] Hidayah Ariffin,[a,c,*] Mohd Ali Hassan,[a] Yoshihito Shirai,[d] Yoshito Ando,[d] Nor Azowa Ibrahim,[e] and Wan Md Zin Wan Yunus [f]

The effect of fiber surface modification by superheated steam (SHS) treatment and fiber content (30 to 50 wt.%) was evaluated relative to the mechanical, morphology, thermal, and water absorption properties of oil palm mesocarp fiber (OPMF)/polypropylene (PP) biocomposites. SHS treatment of OPMF was conducted between 190 and 230 °C for 1 h, then the SHS-treated fiber was subjected to melt-blending with PP for biocomposite production. The biocomposite prepared from SHS-OPMF treated at 210 °C with 30 wt.% fiber loading resulted in SHS-OPMF/PP biocomposites with a tensile strength of 20.5 MPa, 25% higher than untreated-OPMF/PP biocomposites. A significant reduction of water absorption by 31% and an improved thermal stability by 8% at $T_{5\%degradation}$ were also recorded. Scanning electron microscopy images of fractured SHS-OPMF/PP biocomposites exhibited less fiber pull-out, indicating that SHS treatment improved interfacial adhesion between fiber and PP. The results demonstrated SHS treatment is an effective surface modification method for biocomposite production.

Keywords: Superheated steam treatment; Surface modification; Fiber-matrix bond; Biocomposite; Mechanical properties

(Q4) IMPACT FACTOR **0.836**

PUBLISHED

Prof. Dr. Suraini Abd-Aziz
Group Researcher

Biocatalysis and Biotransformation, 2017; 35(1):41–50

Taylor & Francis
Taylor & Francis Group

RESEARCH ARTICLE

Optimization of metallo-keratinase production by *Pseudomonas* sp. LM19 as a potential enzyme for feather waste conversion

NURLIYANA MOHAMAD, LAI-YEE PHANG & SURAINI ABD-AZIZ

Department of Bioprocess Technology, Faculty of Biotechnology and Biomolecular Sciences, Universiti Putra Malaysia, UPM Serdang, Selangor, Malaysia

Abstract
Locally isolated bacterium *Pseudomonas* sp. LM19, a metallo-keratinase producer was used to hydrolyze the highly rigid keratin recalcitrant in this study. The production of crude keratinase by *Pseudomonas* sp. LM19 is influenced by both physical and nutritional parameters. The highest keratinase activity of 127 U/ml (2.15-fold) was observed in feather meal medium supplemented with fructose and peptone at a C/N ratio of 40. The optimum pH and temperature for keratinase production were found to be pH 8 and 30 °C, using 1% (w/v) feather as substrate. The degradation rate of the feathers was increased 2.4-fold at optimized physical and nutritional conditions. Feather degradation by *Pseudomonas* sp. LM19 led to the production of free amino acids such as arginine, glycine, leucine, and serine. The information on the production of keratinase by *Pseudomonas* sp. LM19 obtained from this study warrants further research for possible commercial application.

Keywords: Pseudomonas; *keratinase*; *chicken feathers*; *submerged cultivation*; *amino acids*; *enzymatic hydrolysis*

(Q4) IMPACT FACTOR **0.437**

PUBLISHED

Dr. Norhayati Ramli
Group Researcher

Chiang Mai J. Sci. 2017; 44(3) : 768-773
http://epg.science.cmu.ac.th/ejournal/
Short Communication

Co-production of Hydrogen and Ethanol of *Escherichia coli* SS1 Isolate

Chiu-Shyan Soo [a], Wai-Sum Yap [b], Wei-Min Hon [c], Norhayati Ramli [a], Umi Kalsom Md Shah [a] and Lai-Yee Phang* [a]
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[b] Faculty of Applied Sciences, UCSI University, 56000 Cheras, Kuala Lumpur, Malaysia.
[c] Chancellery, KDU University College, Utropolis Glenmarie, 40150 Shah Alam, Selangor, Malaysia.
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Received: 3 December 2015
Accepted: 6 October 2016

ABSTRACT

Simultaneous production of hydrogen and ethanol from waste materials has potential for the development of a more cost-effective biofuels generation process. This study aimed to conduct glycerol fermentation using *Escherichia coli* SS1 to establish its hydrogen and ethanol co-production profile. Anaerobic fermentation was performed at 37°C with different concentrations of glycerol as a substrate. *E. coli* SS1 had exponential growth within 24 h (OD_{600} of 1.6), and hydrogen and ethanol were produced in abundance within 48 h of fermentation. Fermentation using 10 g/l of glycerol achieved the highest yield, 0.57 mol of hydrogen and 0.88 mol of ethanol per mol of glycerol. The highest hydrogen productivity (1.85 mmol/l/h) and ethanol productivity (3.13 mmol/l/h) were obtained at 45 g/l of glycerol. This report provides the complete data set for hydrogen and ethanol co-production yield and productivity by the wild-type *E. coli* SS1 and serves as a useful reference for other researchers working on the co-production of hydrogen and ethanol.

Keywords: hydrogen, ethanol, co-production, *Escherichia coli*, glycerol

CITED

Dr. Mohd Zulkhairi Mohd Yusoff
Group Researcher

Akita *et al. BMC Res Notes (2017) 10:249*
DOI 10.1186/s13104-017-2565-1

BMC Research Notes

RESEARCH NOTE Open Access

Identification and characterization of *Burkholderia multivorans* CCA53

Hironaga Akita[1*], Zen-ichiro Kimura[2], Mohd Zulkhairi Mohd Yusoff[1,3], Nobutaka Nakashima[4,5] and Tamotsu Hoshino[1,4]

Abstract

Objective: A lignin-degrading bacterium, *Burkholderia* sp. CCA53, was previously isolated from leaf soil. The purpose of this study was to determine phenotypic and biochemical features of *Burkholderia* sp. CCA53.

Results: Multilocus sequence typing (MLST) analysis based on fragments of the *atpD*, *gltD*, *gyrB*, *lepA*, *recA* and *trpB* gene sequences was performed to identify *Burkholderia* sp. CCA53. The MLST analysis revealed that *Burkholderia* sp. CCA53 was tightly clustered with *B. multivorans* ATCC BAA-247^T. The quinone and cellular fatty acid profiles, carbon source utilization, growth temperature and pH were consistent with the characteristics of *B. multivorans* species. *Burkholderia* sp. CCA53 was therefore identified as *B. multivorans* CCA53.

Keywords: *Burkholderia multivorans*, MLST analysis, Lignin-degrading bacterium, Second-generation biofuel

(Q1) IMPACT FACTOR 3.898

IN-PRESS

Siti Suhailah Sharuddin
Master Student

Contents lists available at ScienceDirect

Ecological Indicators

journal homepage: www.elsevier.com/locate/ecolind

Short Communication

Shift of low to high nucleic acid bacteria as a potential bioindicator for the screening of anthropogenic effects in a receiving river due to palm oil mill effluent final discharge

Siti Suhailah Sharuddin[a], Norhayati Ramli[a,*], Diana Mohd-Nor[a,b], Mohd Ali Hassan[a], Toshinari Maeda[b], Yoshihito Shirai[b], Kenji Sakai[c], Yukihiro Tashiro[c]

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[b] Department of Biological Functions Engineering, Graduate School of Life Science and Systems Engineering, Kyushu Institute of Technology, Japan
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ARTICLE INFO

Keywords:
Bacterial community
Palm oil mill effluent
Wastewater effluent
High nucleic acid bacteria
Low nucleic acid bacteria
Flow cytometry

ABSTRACT

The microbiological effects of palm oil mill effluent (POME) final discharge upon a receiving river were assessed in this study by using the nucleic acid double staining assay based on flow cytometry. The functional status of the bacterial community at the single-cell level was determined with regards to their abundance, viability and nucleic acid content to monitor the effects of POME final discharge on the affected river. The effluent resulted in the increment of the total cell concentration (TCC) and viable cells which were correlated with the increment of biological oxygen demand (BOD_5) and total organic carbon (TOC) concentrations in the receiving river. The shift of low nucleic acid (LNA) to high nucleic acid (HNA) bacterial cells in the affected river suggested the transformation of dormant to active cells due to the POME final discharge. This is the first study to report on the shift of LNA/HNA ratios which may serves as a potential bioindicator in the screening of the anthropogenic effects due to POME final discharge in river water with originally high LNA proportions. Monitoring the effluent discharge at low impact level using flow cytometry is a rapid and sensitive approach when compared to the current physicochemical assessment method. This approach allows for the screening of river water contamination caused by POME final discharge prior to a full assessment using the recently proposed specific bacterial indicators.

(Q3) IMPACT FACTOR 1.337

IN-PRESS

Iffah Nabilah Mohd-Ariff
Master Student

Waste Biomass Valor
DOI 10.1007/s12649-017-0106-8

CrossMark

SHORT COMMUNICATION

Direct Use of Spent Mushroom Substrate from *Pleurotus pulmonarius* as a Readily Delignified Feedstock for Cellulase Production

Iffah Nabilah Mohd Ariff[1] · Ezyana Kamal Bahrin[1] · Norhayati Ramli[1] · Suraini Abd-Aziz[1]

Received: 10 March 2017 / Accepted: 6 October 2017

Abstract The feasibility of spent mushroom substrate (SMS) as an alternative fermentation feedstock for cellulase production has been demonstrated in this work. Utilization of SMS as a substrate has been attempted widely due to its high cellulose content and readily available in smaller particle size. On top of that, the availability of delignified SMS by the action of *Pleurotus pulmonarius* during mushroom cultivation offers another benefit to its use whereby no chemical pretreatment would be required prior to fermentation. The recovery of crude laccase and manganese peroxidase from delignified SMS were found to be 3 and 1.4 U/g, respectively. Further to this, the cellulase production from SMS by *Trichoderma asperellum* UPM 1 under solid state fermentation was optimized by applying central composite design, resulted in increment of 1.4-fold in CMCase (171.21 U/g) and 1.5-fold in β-glucosidase (6.83 U/g), with the optimum temperature of 27.5 °C, initial moisture content 81% and initial pH of fermentation 4.5. Therefore, this study showed that the direct utilization of SMS is feasible for promising cellulase production by *T. asperellum* UPM 1.

(Q3) IMPACT FACTOR 1.337

IN-PRESS

Prof. Dr. Suraini Abd-Aziz
Group Researcher

Waste Biomass Valor
DOI 10.1007/s12649-017-9838-8

CrossMark

ORIGINAL PAPER

Effects of Surfactant on the Enzymatic Degradation of Oil Palm Empty Fruit Bunch (OPEFB)

Noratiqah Kamsani[1] · Madihah Md. Salleh[1,2] · Siti Aisyah Basri[1] · Shaza Eva Mohamad[3] · Suraini Abd Aziz[4] · Kamarulzaman Kamaruddin[5]

Received: 22 January 2016 / Accepted: 23 January 2017

Abstract Various pretreatments have been employed to pretreat oil palm empty fruit bunch (OPEFB) to improve sugars production via enzymatic degradation reaction. However, less attention has been paid to investigate the effects of surfactant addition in the OPEFB degradation process. Therefore, the effects of surfactants on degradation of pretreated OPEFB by *Aspergillus niger* EFB1 crude cellulase were studied. Tween 80 was the most effective surfactant tested. When 0.25% (v/v) Tween 80 was added, the production of reducing sugar increased 63% (from 0.49 to 0.8 g/L). This was the optimum yield recorded. It also improved cellobiose, glucose and xylose production by two folds, seven folds and one fold higher than that without Tween 80, respectively. Tween 80 reduced the loss of cellulases activities where more than 17% of the original cellulases activities were retained after 7 days of degradation. Nonetheless, Tween 80 did not improve the protein concentration consistently. Supplementation of Tween 80 increased lignin removal by 23%. Observations using SEM revealed that, with Tween 80, the presence of pores and surface cracks were more pronounced on the surface of degraded OPEFB fibers. As a whole, the reported effects showed an improved production of reducing sugars in the presence of Tween 80. Thus, Tween 80 addition appeared as a promising method in enhancing the bioconversion of OPEFB into value-added co-products.

Keywords Tween 80 · Biodegradation · Cellulose · Lignin · Sugar · Cellulase activity

(Q3) IMPACT FACTOR 1.337

IN-PRESS

Aisyah Zulkarnain
Master Student

Waste Biomass Valor
DOI 10.1007/s12649-016-9745-4

CrossMark

ORIGINAL PAPER

Alkaline Hydrolysate of Oil Palm Empty Fruit Bunch as Potential Substrate for Biovanillin Production via Two-Step Bioconversion

Aisyah Zulkarnain[1] · Ezyana Kamal Bahrin[1] · Norhayati Ramli[1] · Lai Yee Phang[1] · Suraini Abd-Aziz[1]

Received: 27 July 2016 / Accepted: 14 October 2016

Abstract High demand of natural vanillin in the worldwide market leads to the production of biovanillin using lignocellulosic biomass. In this study, alkaline hydrolysate of oil palm empty fruit bunch (OPEFB) was used as potential substrate for biovanillin production via two-step bioconversion. Based on the results obtained, 41 % vanillic acid and 39 % biovanillin were produced using alkaline hydrolysate of OPEFB as substrate. Besides that, formulated alkaline hydrolysate of OPEFB was employed based on the phenolic compounds composition in the alkaline hydrolysate of OPEFB in order to evaluate the significance of those compounds towards vanillic acid production using two level factorial design. Ferulic acid is the major component for the production of vanillic acid production with the significantly highest molar yield conversion of 53 %. For the combined interactions, the model showed that the combination of ferulic acid/*p*-coumaric acid and ferulic acid/*p*-hydroxybenzoic acid had antagonistic interaction as it significantly led to the reduction of vanillic acid. Vanillic acid as the intermediate compound in the two-step bioconversion of OPEFB provides a potential substrate for biovanillin production.

Keywords Biovanillin · Two-step bioconversion · Oil palm empty fruit bunch · Two-level factorial design · Phenolic compound

Introduction

Lignocellulosic biomass comprised of cellulose, hemicellulose and lignin as structural components. The chemical properties of its structural components make it a substrate with massive biotechnological value [1]. Recently, abundant amounts of lignocellulosic biomass are generated every year through many sectors such as the forestry and agricultural sectors which lead to environmental issues if they are not well managed by the industries. By adopting 'Waste to Wealth' concept, the conversion of the lignocellulosic biomass into value-added products such as such as biofuel, food additives and organic acids can be the best solutions to this problem. In 2010, Malaysia's palm oil industry generated about 46 million dry tonnes of oil palm empty fruit bunch (OPEFB) and the capacity is predicted to escalate to 49 million dry tonnes by 2020 which make it as one of the main by-products from the palm oil industry [2]. Therefore, there is a great potential for OPEFB to be used as the starting material for generating high-value products due to its availability throughout the year and its low cost.

Since OPEFB is made up of complex structure between cellulose, hemicellulose and lignin, thus, pretreatment are required to modify the OPEFB structure in order to get valuable product from this biomass [3]. In general, researchers are commonly focusing on the degradation of cellulose and hemicellulose of lignocellulosic biomass for further utilisation into fermentable sugars but less attention

EB GROUP ATTACHMENT 2017 (OUTBOUND)

Participants	Program	Research Theme	Host/Location	Duration	Sponsor
Tengku Arisyah Tengku Yasim Anuar	Research attachment	Nanocellulose and nanocomposite production	Kyushu Institute of Technology	14 August 2016 - 11 March 2017	JICA
Siti Suliza Salamat	Research attachment	Microbial diversity	Kyushu Institute of Technology	16 January - 14 February 2017	SATREPS
Liana Megashah	Research attachment	Characterization of Palm Oil Biomass Cellulose Nanofiber	Kyushu Institute of Technology	7 - 28 May 2017	JICA
Tengku Arisyah Tengku Yasim Anuar	Research attachment	Nanocellulose production	Kyushu Institute of Technology	27 June - 27 August 2017	JASSO
Liana Megashah	Research attachment	Characterization of Palm Oil Biomass Cellulose Nanofiber	Kyushu Institute of Technology	27 June - 27 August 2017	JASSO
Marahaini Mokhtar	Research attachment	Biohydrogen production	Kyushu Institute of Technology	4 July - 28 August 2017	JASSO
Prof. Dr. Mohd Ali Hassan	World Class Professor	Environmental Biotechnology	Universitas Indonesia	20 – 31 August 2017	Ministry of Education, Indonesia
Dr. Ahmad Muhaimin Roslan	World Class Professor	Environmental Biotechnology	Universitas Indonesia	20 – 31 August 2017	Ministry of Education, Indonesia
Nor Farhana Aziz Ujang	Research attachment	Analysis of microbial community structure using Miseq	Kyushu Institute of Technology	20 August - 16 September 2017	JICA
Enis Natasha Noor Arbaain	Research attachment	Characterization of oil palm empty fruit bunch (OPEFB)	Kyushu Institute of Technology	25 August - 24 October 2017	JASSO
Nur Fatin Athirah Ahmad Rizal	Research attachment	Biomass pretreatment	Kyushu Institute of Technology	14 - 24 October 2017	Sakura Science Program
Izzatul Syazana Ismail	Research attachment	Biosurfactant production using waste cooking oil	Kyushu Institute of Technology	23 October 2017 – 16 March 2018	JASSO
Nahrul Hayawin Zainal	Research training	Activated carbon production from oil palm kernel shell	Korea University	23 November - 28 December 2017	MPOB
Mohd Azwan Jenol	Research training	Enzymatic fuel cell from VFA biomass	Korea University	23 November - 28 December 2017	UPM

EB GROUP ATTACHMENT 2017 (INBOUND)

Participants	Program	Research Theme	Host/Location	Duration	Sponsor
Yuya Hashiguchi	Research attachment	Toxicity identification evaluation of palm oil mill effluent	KYUTECH and Biorefinery & Biomass Laboratory, UPM	21 June 2014 - 21 June 2017	JICA
Nalahyini Kumar	Industrial training	Production of biosurfactant by *Pseudomonas aeruginosa* RS6 and RW	Environmental Biotechnology Lab, Biotech 3	13 February - 21 April 2017	SATREPS
Everlyn Shanthi Pushparaja	Industrial training	Effect of fiber pretreatment on chemical composition	Biomass and Biorefinery Laboratory, UPM	13 February - 21 April 2017	JICA
Lau Pheck Kee	Industrial training	VFA production from biomass	Biomass and Biorefinery Laboratory, UPM	3 July - 30 August 2017	JASSO
Prof. Dr. Misri Gozan	Research attachment	Upscale fermentation for polylactic acid	Biomass and Biorefinery Laboratory, UPM	15 - 22 July 2017	JASSO
Yustinah	Research attachment	Upscale fermentation for polylactic acid	Biomass and Biorefinery Laboratory, UPM	15 July - 5 August 2017	JASSO

CONSULTANCY

Research Theme	Clients/Industrial Partner	Duration
Research Study on the Effectiveness of Biofertilizer Pellets for Landscape Plants	Indah Water Konsortium Sdn Bhd	September 2015 –March 2017
Survey on Municipal Solid Waste Composition, Utilization and Management in Selected Cities in Malaysia	Mitsubishi Heavy Industries Asia Pacific PTE. LTD.	September 2017 – February 2018
Biofertilizer and Biochar Pellets for Landscape Plants and Biofuel	CJ Bio Malaysia Sdn Bhd	May 2016 – April 2017
Start-up Co-composting of Palm Oil Empty Fruit Bunch and Palm Oil Mill Effluent Anaerobic Sludge in Semi Commercial Plant	TDM Plantations Sdn Bhd	Sept 2017 – March 2018
Implementation of Readily Available Technology for Bromelain Extraction and Purification from Pineapple Wastes for Value-added to Pineapple Industry	AlafPutra Biowealth Sdn. Bhd	September 2014 - May 2017

AWARD

Prof. Dr Mohd Ali received Anugerah Tokoh Pekerja Kategori Pengurusan dan Profesional (Akademik) 2017

Prof. Dr Mohd Ali received award from Malaysian Society for Microbiology 2017

Prof. Dr Mohd Ali received Malaysia's Research Star Award (Economic Impact Researcher)

Prof. Dr. Suraini was invited as Guest of Honours during Graduation Ceremony at Chulalongkorn University, Thailand

Assoc. Prof. Dr. Hidayah received BioEconomy Awards 2017 (Green & Renewable Technology)

Dr Rafein received Anugerah Penerbitan Makalah Jurnal 2017

NEWSPAPER CUTTING

NANOCELLULOSE FROM OIL PALM BIOMASS

Nanoselulosa pelbagai guna

DR. HIDAYAH ARIFFIN menunjukkan produk nanoselulosa kajian beliau.

Oleh ASHRIQ FAHMY AHMAD

SELULOSA seperti mana yang kita ketahui merupakan antara bahan yang terdapat di dalam tumbuhan.

Lambakan selulosa boleh ditemui dalam hampir semua sisa bio dan antara yang diberi perhatian adalah sisa bio dari industri minyak kelapa sawit.

Buat masa ini sisa bio sawit yang begitu banyak dilaporkan [illegible]

menghasilkan sisa bio yang begitu banyak dan tidak dimanfaatkan sepenuhnya dan ia berpotensi untuk menghasilkan nanoselulosa daripadanya secara besar-besaran," katanya.

boleh dihasilkan sesuai dengan kegunaannya.

Kajian berkaitan biopolimer, selulosa dan bahan komposit telah dijalankan oleh Dr. Hidayah dan pasukannya sejak beberapa tahun yang lalu dan kebanyakan kajian yang dilakukan berkaitan sisa bio industri sawit.

Pada peringkat global, teknologi nano merupakan antara teknologi terbaharu dan menyedari potensinya yang mampu membawa manfaat yang besar kepada manusia, pihak UPM telah membangunkan produk tersebut.

"Nanoselulosa secara amnya digunakan sebagai bahan yang berfungsi untuk meningkatkan ciri sesuatu produk.

"Contoh aplikasi produk itu adalah sebagai bahan penguat dalam produk plastik komposit yang mana mampu menambah [illegible]

berkesan dalam mengikat molekul air dan mengembang berbanding selulosa.

Hal demikian menyebabkan struktur yang terhasil adalah seperti gel walaupun pada kepekatan nanoselulosa yang rendah dalam air, menyebabkannya sesuai sebagai bahan pemekat dalam produk makanan.

Untuk menghasilkan nanoselulosa, bahan mentah yang diperlukan hanyalah selulosa yang diekstrak daripada sisa bio kelapa sawit.

Penghasilan nanoselulosa daripada selulosa adalah menerusi kaedah pengisaran tertentu dan berjaya menghasilkan nanoselulosa yang memiliki saiz diameter purata 20 hingga 100 nanometer (nm).

Ditanya jika nanoselulosa itu boleh dimanfaatkan dalam pelbagai produk mengapakah ia masih kurang ditemukan dalam pasaran negara?

Dr. Hidayah menjelaskan produk nanoselulosa di negara ini masih lagi diperingkat kajian dan pembangunan (R&D) dan agak sukar bagi pihaknya untuk mengembangkan produk tersebut.

"Tambahan pula ia dihasilkan daripada sisa bio dari industri kelapa sawit yang mana sebelum ini kita ketahui ia tidak dimanfaatkan kerana tiada nilai.

"Kesedaran orang ramai juga agak berkurang dan memerlukan promosi dan penerangan yang menyeluruh berkenaan penggunaan sisa bio tersebut," katanya.

Walau bagaimanapun, Dr. Hidayah memberikan jaminan bahawa nanoselulosa yang akan dijadikan pemekat makanan perlu menerusi kaedah pembersihan dan perawatan yang sesuai sama seperti proses penghasilan produk makanan lainnya.

Produk inovasi nanoselulosa dari UPM itu dikatakan setanding dengan nanoselulosa yang dihasilkan di negara-negara maju yang bersumberkan bahan selulosa lain.

Terkini, harga bagi sekilogram nanoselulosa itu adalah sekitar RM1,000 hingga RM15,000 dan pastinya ia menjanjikan potensi pasaran yang amat besar kelak.

Kajian yang bermula sejak dari 2013 itu dipercayai dapat memenuhi konsep 3P (profit, people, planet).

INFO

- Nanoselulosa secara semula jadinya memiliki sifat yang istimewa seperti kuat dari segi mekanikal, punyai luas permukaan spesifik yang tinggi, boleh diperbaharui dan mudah terurai secara bio (biodegradasi).
- Sifat istimewa tersebut menjadikan nanoselulosa bahan yang sangat sesuai untuk diaplikasikan dalam pelbagai produk.
- Antara produk biokomposit dan bahan pembungkus iaitu nanoselulosa berfungsi sebagai bahan untuk menguatkan produk, membran penapis bagi penapisan air dan penapis untuk topeng muka.
- Boleh digunakan dalam produk makanan sebagai bahan pemekat, dalam produk kosmetik dan farmaseutikal sebagai pembawa bahan aktif dan ubatan.

DR. HIDAYAH ARIFFIN (dua dari kanan) dan Dr. Mohd. Ali Hassan, serta dua pelajar melihat hasil nanoselulosa di Serdang, Selangor baru-baru ini.

NANOSELULOSA EKSTRAK BIOMAS SAWIT

Hasil penyelidikan UPM berfungsi tingkatkan ciri sesuatu produk

UPM Researchers Develop Nanocellulose from Palm Oil Biomass

SERDANG - Universiti Putra Malaysia (UPM) research team has successfully produced nanocellulose from palm oil [illegible]

INFINITI

UPM hasil nanoselulosa daripada biomas sawit

INOVASI

NEWSPAPER CUTTING

CAMPAIGN ON BIODIESEL FROM USED COOKING OIL

Tukar 1 liter minyak masak terpakai kepada RM1

Pegawai Sains Bioifineri Kompleks, Fakulti Sains Bioteknologi dan Biomolekular Universiti Putra Malaysia (UPM), Mohd. Ridzuan Othman (kiri) bersama salah seorang pelajar sarjana Bioteknologi UPM (kanan) yang turut serta dalam kempen tersebut berdiri di mesin penghasilan minyak biodiesel di sini, hari ini.

SERDANG 6 April - Kisah menjual balik minyak masak terpakai sudah banyak diperkatakan. Namun hakikatnya, ramai masih tidak mengetahui di mana dan bagaimana hendak menjual balik minyak masak terpakai itu.

Boleh jual jangan buang!

Mutakhir

- Mati dibunuh
- Meyuarat khas ASUM Sabtu ini
- Hab ikan air tawar, udang galah

Bank in tie-up with UPM to buy used cooking oil from public

MOST are unaware of the proper way to dispose of used cooking oil and that it can be recycled into fuel.

Universiti Putra Malaysia (UPM) and CIMB Foundation are collaborating to educate the public through a BioDiesel From Used Cooking Oil Programme.

The project encourages the public to drop off their used cooking oil at one of three collection centres in UPM where it will be processed into biodiesel.

CONFERENCES AND WORKSHOPS

EVENT	DATE	VENUE	PARTICIPANT
Teijin Nakashima Research Seminar on Biomaterial	28 January 2017	Okayama, Japan	• Assoc. Prof. Dr. Hidayah Ariffin • Tengku Arisyah Tengku Yasim Anuar
9th Asian Federation of Biotechnology Regional Symposium	9 - 11 February 2017	Manila, Philippines	• Prof. Dr. Mohd Ali Hassan • Prof. Dr. Suraini Abd Aziz
Nanocellulose Utilization Seminar: Possibility of nanocellulose from bamboo	23 February 2017	Hyatt Regency Fukuoka, Japan	• Tengku Arisyah Tengku Yasim Anuar
UPM-Kyutech Joint Seminar	8 March 2017	Universiti Putra Malaysia	• EB Group members
National Institute of Advanced Industrial Science and Technology (AIST) Seminar	15 March 2017	AIST Chugoku Center, Hiroshima	• Dr. Mohd Zulkhairi
Workshop- Organizing Your Thesis and Manuscript	21 March 2017	Universiti Putra Malaysia	• Tengku Arisyah Tengku Yasim Anuar • Liana Noor Megashah
SATREPS workshop for Introducing New Green Business Model	28 March 2017	Promenade Hotel Kota Kinabalu	• EB lecturers
2017 AFOB International Symposium and AFOB Board Meeting	6 - 7 April 2017	Gyeongju and Songdo, Korea	• Prof. Dr. Mohd Ali Hassan • Prof. Dr. Suraini Abd Aziz
The 1st International Symposium on Nanocellulosic Materials	20 – 22 May 2017	Hangzhou, China	• Assoc. Prof. Dr. Hidayah Ariffin
Biochemical and Molecular Identification of Bacteria & Fungi using Bioinformatics Tools	18 - 20 July 2017	Faculty of Biotechnology and Biomolecular Sciences, UPM	• Izzatul Syazana Ismail
The 11th Korea-ASEAN Joint Symposium on Biomass Utilization and Renewable Energy : Integration of Agriculture and Biotechnology	19 - 22 July 2017	Chulalongkorn University, Bangkok, Thailand	• Prof. Dr. Suraini Abd Aziz • Dr. Mohamad Faizal Ibrahim
The 13th Asian Congress on Biotechnology 2017	23 - 27 July 2017	Khon Kaen, Thailand	• Prof. Dr. Mohd Ali Hassan • Prof. Dr. Suraini Abd Aziz • Dr. Mohamad Faizal Ibrahim
Public Lecture on Utilisation of Microbial Resources	25 July 2017	Institute of Bioscience, UPM	• Izzatul Syazana Ismail

CONFERENCES AND WORKSHOPS

EVENT	DATE	VENUE	PARTICIPANT
Seminar on Embracing Biosafety, Biosecurity and Bioethics in Research	15 August 2017	Universiti Putra Malaysia	• Nur Atheera Aiza Md Razali • Nurul Hanisah Md Badrul Hisham
X-ray-CT Scan Training	21 - 23 August 2017	Kanazawa Institute of Technology, Kanazawa, Japan	• Prof. Dr. Mohd Ali Hassan • Prof. Dr. Suraini Abd Aziz
Transmission Electron Microscopy Workshop	31 August 2017	Kyushu Institute of Technology, Tobata Campus, Kitakyushu, Japan	• Tengku Arisyah Tengku Yasim Anuar
Seminar on Supercritical Processing of Biopolymers for Drug Delivery Application	4 September 2017	Universiti Putra Malaysia	• Nurshazana Mohamad
Workshop on Academic Writing and Publishing for Malaysian Researchers	5 September 2017	Faculty of Veterinary Medicine, UPM	• Izzatul Syazana Ismail
BioMalaysia and Bioeconomy 2017 Exhibition	11 - 13 September 2017	Kuala Lumpur Convention Centre	• Prof. Dr. Mohd Ali Hassan • Assoc. Prof. Dr. Hidayah Ariffin • Mohd Nor Faiz Norrrahim • Tengku Arisyah Tengku Yasim Anuar • Liana Noor Megashah
Elsevier Publishing Connect Workshop	14 September 2017	Auditorium Putra, UPM	• Khairiatul Nabilah Jansar • Izzatul Syazana Ismail
Thailand Graduation Ceremony Guest of Honours	27 - 29 September 2017	Chulalongkorn University	• Prof. Dr. Suraini Abd Aziz
National Electrospinning Workshop	11 October 2017	Technology Park Malaysia	• Tengku Arisyah Tengku Yasim Anuar • Liana Noor Megashah
AFOB-MC Bioenergy and Biorefinery Session: 2nd International Conference on Molecular Biology and Biotechnology	1 November 2017	PAUM Clubhouse, University of Malaya	• EB Group Members
Thick Film Fabrication Workshop	7 - 8 November 2017	Institute of Advance Technology, UPM	• Tengku Arisyah Tengku Yasim Anuar
Workshop on Application of HRTEM and FESEM in Material Science Research	7 -9 November 2017	Institute of Bioscience, UPM	• Liana Noor Megashah

CONFERENCES AND WORKSHOPS

EVENT	DATE	VENUE	PARTICIPANT
Workshop on Nanoenabled Products and Medical Devices: Testing and Regulation of Nanosafety	13 - 14 November 2017	SIRIM Berhad, Kulim Hi-Tech Park	• Assoc. Prof. Dr. Hidayah Ariffin • Tengku Arisyah Tengku Yasim Anuar
Symposium on Applied Engineering and Sciences (SAES2017)	14 - 15 November 2017	Universiti Putra Malaysia	• EB Group Members
Wood and Biofiber International Conference (WOBIC2017)	21 - 23 November 2017	Hotel Bangi-Putrajaya, Malaysia	• EB Group Members
Conference on Biomedical and Advanced Materials (BIO-CAM)	28 - 29 November 2017	BayView Hotel, Langkawi, Malaysia	• Assoc. Prof. Dr. Hidayah Ariffin
International Congress of The Malaysian Society for Microbiology	4 -7 December 2017	Hotel Bangi-Putrajaya, Malaysia	• Prof. Dr. Mohd Ali Hassan

EB STUDENTS
RESEARCH SUMMARY

PhD Student

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Supervisor : Dr. Norhayati Ramli

Bacterial community composition in the palm oil mill effluent treatment system for the development of bioindicator assessment system

The growing demand for palm oil has caused a substantial increase in the generation of palm oil mill effluent (POME). POME has been known to give the adverse environmental impacts including land and aquatic ecosystem contamination and the biodiversity loss if it is not properly treated. In Malaysia, the ponding system is commonly being used to treat POME because of the low cost and less maintenance required. However, only few studies have been conducted on the microbial aspects of POME and little is known about the bacterial diversity involved in the POME treatment. Therefore, this study aims to assess the bacterial community dynamics in the POME treatment system which the information would be useful to monitor the role in biodegradation. Further to that, the bacterial composition in the POME final discharge from different palm oil mills will be compared in order to propose the potential bioindicator to indicate contamination by the effluent. To achieve these objectives, the flow cytometry will be used to assess the functional status of bacterial community, while culture-independent approaches including PCR-DGGE and 16S rRNA gene sequencing on Illumina MiSeq platform will be applied to assess the bacterial community structure and composition.

Figure 1. POME samples obtained from different stages of the treatment system.

Figure 2. Samples preparation for the physicochemical analysis.

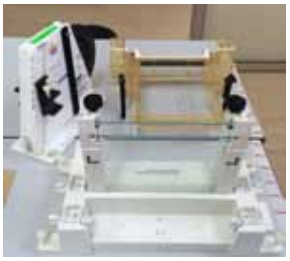

Figure 3(a&b). PCR-DGGE for the analysis of bacterial community structure and composition.

PhD Student

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Towards controlled depolymerization of polyhydroxyalkanoates by steam hydrolysis

Polyhydroxyalkanoate (PHA) has unique characteristics of thermoplastic, biodegradable and biocompatible biopolymer that can be produced intracellularly by microorganism and some plant species. The constituent of PHAs, polyhydroxybutyrate acid (PHB) is biocompatible with human as it is also a built compound of blood, made this producible biopolymer able to contribute very significantly to the biomedical applications especially in tissue engineering. Cascade utilization of polymers could be introduced before they are finally being released to the environment. Single use of bioplastics does not support the sustainability of the carbon cycle; therefore, a process to depolymerize polymers is needed. Medium to low-molecular weight PHA is important for various applications; feedstock for blending and re-polymerization process. Pyrolysis, abiotic hydrolysis and enzymatic hydrolysis of PHA have been extensively studied; however, steam hydrolysis of PHA is yet to be studied. Controlled depolymerization of PHA, involved with the concept of the material conversion to molecules that built up of the original material or lowering of its origin molecular weight. Depolymerization of PHA by steam was controlled by temperature and time. Depolymerization mechanism and kinetics were proposed and evaluated through characteristics of depolymerized PHA conferring to suitable standards.

Figure 1. Purification of dissolved PHB powder in methanol and hexane.

Figure 2. PHB disks arrangement prior to steam hydrolysis.

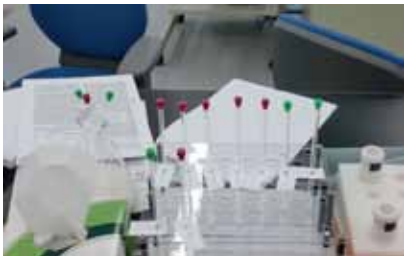

Figure 3. Prepared hydrolyzate samples in NMR tubes for proton NMR analysis.

Figure 4. Placing the sample's tube in the 500-MHz JEOL JNM-ECP500 FT NMR system.

PhD Student

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Sago biomass as a potential feedstock for bioelectricity generation

Microbial fuel cells (MFC) has gained a lot of attention due to its ability to convert the chemical energy into electricity. The MFC is considered as an expensive technology, thus makes is challenging to be commercialized in the near future. However, the utilization of renewable cheap biomass could be one of the possible approaches to overcome the aforementioned problems. Sago biomass has a great potential to be used as a carbon source for the production of bioelectricity using MFC system. Sago biomass, also known as sago hampas comprises of more than 50% of starch, which can be converted into glucose. Then, the glucose produced can further be used as electron donor in MFC system for the generation of bioelectricity. Recently, Chang et al. (2010) has reported the volatile fatty acid (VFA) platform derived from biomass has great potential as well as sugar platform. Thus, this study on the feasibility of sugar and VFA platform derived from sago hampas for the production of bioelectricity will be conducted. The fact that the electrochemical activity of Clostridium sp. has not yet fully understood, this study has great opportunity in the development for future MFC. The bioconversion of sago biomass into bioelectricity by Clostridium sp. in MFC system is expected to give positive and great impact in the advancement of MFC field.

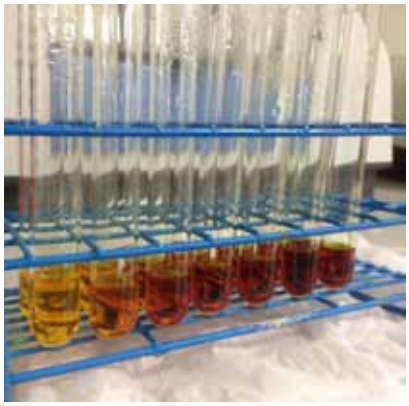

Figure 1. Fermentable sugars analysis using DNS method.

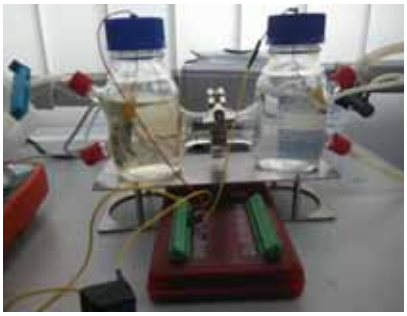

Figure 2. MFC Setup of bioelectricity generation using double chambers system.

PhD Student

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Nanofiber and nanocomposite production from super-heated steam treated oil palm biomass

Nanocellulose is a cellulosic material having one of its dimensions (length or diameter) in nanoscale. Nanocellulose has been listed as a focused nanomaterial in the 11th Malaysia Plan under strategic research. Cellulose nanofiber (CNF) shows outstanding properties such as extraordinary strength, high stiffness, and high crystallinity. All of these good properties impart CNF to be used in several applications ranging from consumer products to high-tech industrial applications such as medicine and pharmaceuticals, electronics, composites, membranes, porous materials, paper, and food. Oil palm biomass (OPB) which is abundant in Malaysia has high potential to be converted into nanocellulose. Nevertheless, the current production method of CNF requires complex processes and uses harsh chemicals. Wet disk milling (WDM) is a non-chemical method for CNF production, with the advantage of being simple and fast. We have developed an appropriate and efficient method which involves the use of superheated steam (SHS) and WDM for CNF production from OPB. Based on our current findings, the CNF produced from OPB by this method has an average diameter size of 40nm. Reinforcement of the CNF in polymeric materials such as polypropylene, polyethylene and polylactic acid managed to improve the mechanical properties of composite materials substantially as compared to neat polymer. In a nutshell, the ability to produce CNF from OPB will promote the use of OPB for a new high-end product, with the potential of new industry creation and eventually contributing to the economic growth.

Figure 2. Nanocomposite

Figure 1. Extruder.

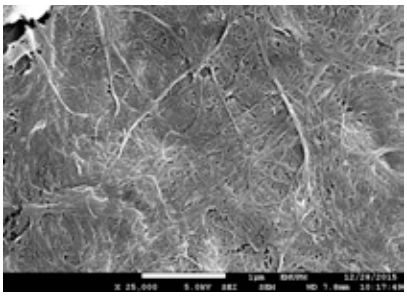

Figure 3. Nanofiber

PhD Student

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Co-composting oil palm empty fruit bunch and anaerobic sludge palm oil mill effluent in closed system

Co-composting of oil palm empty fruit bunch and sludge palm oil mill effluent are common practice in mill area. High lignocellulosic material slows down rate of degradation. Low level and inconsistent of aging sludge and different method of mill operations also contribute to inefficient compost process. A study to quantify microbes and lignocellulosic degradation able to determine detail of compost stage process and estimates of compost performance able to determine through modelling. Several process factor commonly included in compost mathematical model have known. There are about six common process factor has been applied in. Most popular is a deterministic model example substrate degradation limiting process to imitate limitation of actual process. Knowledge of process factor limiting fusion (incorporated into a single model) and direct inclusion of the possible interactions between the process factor as part of the model's structure could comprehend composting process. Composting is most dynamic type of process hence incorporation factor limiting modeling could gain new insight which compensates vague understanding and flexibility to first principle mathematical model (deterministic). This study could introduce practicality in modeling for dynamic behavior such as composting.

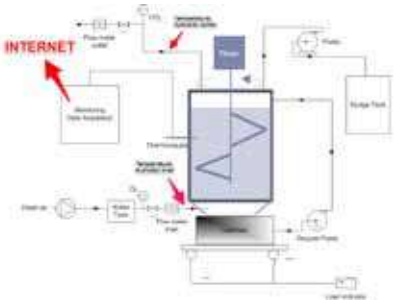

Figure 1: Composter Schematic Diagram

Figure 2: Composter

Figure 3: Temperature and Humdity Sensor with Datalogger

Figure 4: Compost

PhD Student

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Production of biochar and activated carbon from oil palm kernel shell

This is a new concept for the production of activated carbon, which is known as two-in-one carbonisation and activation system (Figure 1). This technology has been fully developed by collaboration between Malaysian Palm Oil Board (MPOB) and Universiti Putra Malaysia (UPM). This new system successfully process two-in-one carbonisation and activation system produces efficiently high quality of activated carbon with high yield by physical activation using steam (Figure 1). The process begins with biomass waste as input and ends with three forms of product yield i.e., charcoal, wood vinegar and fuel gas. Dry palm kernel shell (PKS) was fed into the reactor, heated using a diesel burner to a set temperature and held the temperature for a period of full carbonisation to obtain carbonised products (char). Then, the carbonised products subjected to steam activation in the same reactor and hold for the activation. The flow rate of water into the perforated pipes was monitored and duration of activation can be varied to investigate the effect of activation time on the quality of activated carbons derived from the reactor (Figure 2). Adsorption has been found to be a more effective method for the treatment of POME by using bioadsorbent produced. The results found that bioadsorbent was successfully reduce the concentrations with high percentage in the form of TSS, COD, colour and BOD in the final discharge POME. The amount of concentration for final discharge POME of bioadsorbent meets the river water quality making it suitable to be applying for palm oil mill industry wastewater treatment.

Figure 2. Activated carbon from oil palm kernel shell.

Figure 1. Carbonisation-activation system for the production of biochar and activated carbon.

PhD Student

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Expression of codon optimized recombinant cyclodextrin glycosyltransferase from *Escherichia coli*

Cyclodextrin glycosyltransferase (CGTase) (EC 2.4.1.19) represents one of the most important groups of microbial amylolytic enzymes, which forms circular α-(1, 4)-linked oligosaccharide substrates via covalent intermediate. The production of CGTase has attracted increasing interest owing to the special characteristics of the cyclodextrin with the shape of hollow truncated cone, hence it can be used to encapsulate a variety of compounds. The cyclodextrins have been widely used for various applications such as in the food, cosmetic and pharmaceutical industries. Currently, the production of CGTases from wild-type strains are relatively low at longer incubation time with the mixtures of α-, β- and γ-CDs produced in different ratio, hence contributed to the high cost for cyclodextrin production. Therefore, to tackle those problems, the over-expression of cgt gene in Escherichia coli expression system was carried out, by integrating the plasmid with His-tagged to ease the protein purification. Furthermore, to solve the issue of low enzyme expression by the recombinant strain, the optimization of codon usage and inducer supplementation was carried out, hence higher enzyme expression can be achieved for the cyclodextrin production.

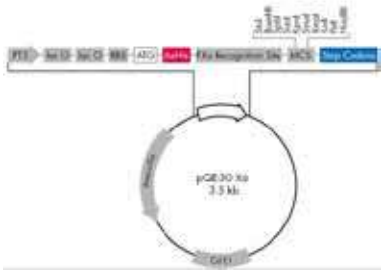

Figure 1. Schematic representation of the expression vector (pQE-30 Xa)

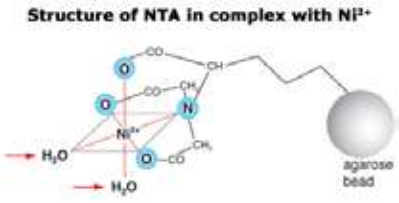

Figure 2. Structure of NTA in complex with Ni2+ for Ni NTA column

PhD Student

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Synthesis of bio-based polyesters from palm oil's fatty acids

New type of biopolyester was developed in this study by using fatty acids normally found in palm oil. Oleic and linoleic acids were converted into octadec-9-enedioic acid, a type of di-acid, by metathesis using the second generation Grubbs catalyst. Synthesis of bio-based polyester was then conducted by condensation copolymerization of the di-acid with aliphatic and aromatic diol using isopropyl titanate as a catalyst. Copolymers of aliphatic and aromatic polyesters were successfully produced, with 61% and 65% yield for di-acid/1,6-hexanediol and di-acid/4,4-biphenol, respectively. Polyester with aliphatic diol was easily soluble in organic solvents such as chloroform and acetone, while polyester with aromatic diol was insoluble in these solvents. Further modification of the biopolyesters was carried out by enzymatic epoxidation on the olefin site of each polyesters. Structure confirmation was conducted by 1H NMR, FT-IR and TOF-MS. Thermal properties of the biopolyester samples were analyzed by TGA and DSC.

Publication

Noor Farisha Abd.Rahim; Kohtaro Watanabe; Hidayah Ariffin; Yoshito Andou; Mohd Ali Hassan; Yoshihito Shirai, Chemistry Letter. 2014, 43(9), 1517-1519.

Seminar/Conference Attended

1. Advanced Materials Conference 2016 (Langkawi, Malaysia), 2016
2. Eco Materials Research Society Conference (Tokyo, Japan), 2014
3. International Symposium on Advanced Polymeric Materials (Kuala Lumpur, Malaysia), 2014
4. International Symposium on Applied Engineering and Sciences (UPM, Selangor, Malaysia),2013

Figure 1. Polyester from lipase--catalyzed of dicarboxylic acids and diols

Figure 2. Metathesis of fatty acids by second generation Grubbs catalyst

Figure 3. Unsaturated dicarboxylic acids from metathesis of oleic acid

Figure 4. Aliphatic and aromatic diols for polyester synthesis

PhD Student

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Pineapple crown and lemongrass leaves as potential substrates for biovanillin & p-hydroxybenzaldehyde production

Vanilla extract which naturally extracted from vanilla seed pod, is highly valued for its organoleptic flavor. The flavor contains almost 200 substances that contributed to complex flavor of vanilla. The two main contributors to the characteristic flavor of original vanilla are known as vanillin and p-hydroxybenzaldehyde. Since the natural vanilla extract is limited and highly priced, sustainable approach using renewable and cheap sources is very much needed as an alternative over chemically synthesized artificial vanilla. On the other hand, ferulic acid and p-coumaric acid are two phenolic acids that have been shown to act as natural precursors for biovanillin and p-hydroxybenzaldehyde production, respectively. These phenolic acids can be found abundantly in lignocellulosic biomass mostly from agriculture wastes. However, due to the recalcitrance of the lignocellulosic structure various pre-treatment are needed to enhance the release of the precursors. In this study, lemongrass leaves (LL) and pineapple crown (PC) are utilized as two potential sources of ferulic acid and p-coumaric acid using various pretreatments for high release of ferulic acid and p-coumaric acid before further transformed into biovanillin and p-hydroxybenzaldehyde, respectively.

Figure 1. Lemongrass leaves

Figure 2. Pineapple crown leaves

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Pretreatment of oil palm empty fruit bunch using lignocellulolytic enzymes cocktail for production of fermentable sugars

To date, Malaysia rank in the second place as a global palm oil producer. However, a non-systematic biomass management system despite the rapid growth of oil palm plantation in Malaysia contributes a lot to biomass accumulation in huge amount. Oil palm empty fruit bunch (OPEFB) can be categorized as one of the toughest lignocellulosic biomass to be degraded naturally due to its complexity in structure. Common industrial practice used chemical and physical treatment to treat the OPEFB as it performs faster in hydrolyzing the biomass than biological treatment does. However, as the world is moving towards green concept, chemical treatment is no longer suitable to be practiced because it produce harmful by-product and it give low yield of fermentable sugars. The idea of converting the unwanted OPEFB into value-added products came up due to the biomass pile up from oil palm plantation activity and palm oil refinery industry. In this study, the OPEFB was treated biologically using crude enzyme extract due to environmental concern. The OPEFB is subjected to enzymatic hydrolysis by crude lignocellulolytic enzymes to produce a fermentable sugars. Hence, the biological approach for delignification and saccharification process is expected to results in high lignin removal and consequently produces high fermentable sugars concentration.

Figure 1. *Pycnoporus sanguineus*

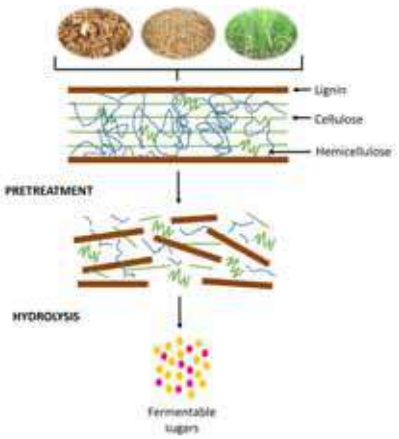

Figure 2. Overview of lignocellulosic biomass hydrolysis

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Recovery of sugars from oil palm frond for bioethanol production

In 2010, Malaysia generated approximately 80 million tonne of dry solid biomass from the oil palm industry and it is predicted to increase up to 110 million tonnes in the year of 2020. Oil palm empty fruit bunch, oil palm mesocarp fiber and oil palm frond are among the main oil palm wastes produced. The main concern in the application of lignocellulosic materials is that it requires aggressive pretreatment to break down the complex matrix formed by cellulose, hemicellulose and lignin. Since initial conversion of biomass to sugars is considered as the key bottleneck in bioproducts production, researchers are looking at more efficient, environmental friendly methods which results in more lignin removal and higher surface area for enzymatic reaction. Among available pretreatment methods, hydrothermal pretreatment appeared to effectively improve the digestibility of lignocellulosic biomass which leads to higher sugar yield. This work investigates the performance of hydrothermal pretreatment in improving sugar recovery from oil palm frond. Findings from this study are expected to provide better understanding on hydrothermal hydrolysis and further highlight the potential of oil palm frond as a renewable carbon source.

Figure 1. Sample analysis

Figure 2. Sand bath reactor

Figure 3. Pretreated oil palm frond fiber

PhD Student

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Prof. Dr. Yoshihito Shirai

The use of oil palm empty fruit bunch and palm oil mill effluent as compost in oil palm plantations: nutrients recycling system for oil palm industry

Fertilizers are used to enhance the growth and health plants. Frequent and long-term application of chemical fertilizer could affect soil biodiversity. Malaysia produces about 59 percent of the world's supply of palm oil and second largest produce after Indonesia. Excess fertilizer application to oil palm plantation may happen to increase oil yield. This has caused increased consumption and excessive chemical fertilizer application that eventually led to environmental pollution. In Malaysia one cycle of oil palm plantation need around 25 years. Many research on physical and chemical characteristic for short and long term done on plant and soil of oil palm plantation. By the way, effect on frequently application for long term used inorganic fertilizer still make question on affect on soil diversity has not been reported. So, this research conduct for this investigated application base on physical characteristic, chemical composition, microbial diversity and oil palm production correlation.

Figure 1: Oil palm Plantation at Felda Serting Hilir Negeri Sembilan Malaysia

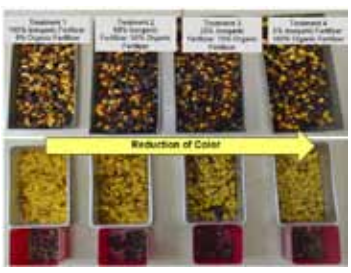

Figure 2: Laboratory work at Pusat Penyelidikan Pertanian Tun Razak, Jengka, Pahang Malaysia

PhD Student

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Cellulose nanofiber and nanocomposite production from oil palm mesocarp fiber

Million tonnes of oil palm biomass have been generated from both plantation and mill, and one of them is oil palm mesocarp fibers (OPMF). It has been reported that due to the abundance of OPMF generation daily, it is inefficiently burnt as a method of disposal, which consequently leads to the environmental pollution. Therefore, particular attention can be given to produce valuable bioproducts from OPMF, such as cellulose nanofiber (CNF). In this study, cellulose was extracted from OPMF by NaClO2 and KOH treatments prior to nanofibrillation by electrospinning, ultrasonication and high-pressure homogenization. Scanning electron microscopy, X-ray diffraction and Thermogravimetric analysis confirmed the occurrence of fibers having diameter ranging from 40-100 nm with improvement on crystallinity and thermal stabilility. The obtained CNF was then being used as a reinforcement material for nanocomposite production which was prepared by internal mixing and extrusion. Mechanical analysis revealed that nanocomposites prepared by extrusion were 35.5% higher in terms of tensile strength, 33.7% higher for Young's modulus, 66% higher for flexural strength and 19.7% higher for flexural modulus compared to nanocomposites prepared by internal mixing. Results from this finding indicate that nanofiber orientation plays a role in enhancement of mechanical properties of the biocomposites.

Publication

Yasim-Anuar, T.A.T., Ariffin, H., Norrrahim, M.N.F., Hassan, M.A., 2017. Factors affecting spinnability of oil palm mesocarp fiber cellulose solution for the production of microfiber. Bioresources. 12, 715-734.

Figure 1. Flow diagram of cellulose nanofiber and nanocomposite production from OPMF

PhD Student

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Toxicity identification evaluation of palm oil mill effluent

Palm oil mill effluent (POME) contains complex vegetative matters including high degradable organic matter. Serious environmental pollutions were reportedly occurred throughout discharging process of POME directly into rivers. Therefore, in this study, the toxicity effect of POME final discharge samples from two different palm oil mills (A and B) were evaluated based on whole effluent toxicity (WET) studies and toxicity identification evaluation (TIE) tests using bacteria E. colii, microalgae S. dimorphus and Invertebrate D. magna. The WET test showed that significant growth inhibition of all organisms from POME final discharge of palm oil mill B and the sample was further experimented in TIE testing. The TIE results revealed that solid phase extraction (SPE) and acidic and alkaline treatment were effective in reduction and removal of toxicants and eliminating growth effects. It was anticipated that an excess non-polar organic compounds and acidic and alkaline lignin groups in the effluent caused the main toxicity. This study illustrates that even though POME has undergone many treatment stages, the final discharge still contained toxic compounds. Hence, advance treatments are necessary to help eliminate the toxicants from POME final discharge.

Figure 2. POME final discharge pond

Figure 1. Aquatic organim (D. magna)

Figure 3. POME final discharge sample A and B

Master Student

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Application of metabolic engineered *E. coli* BW25113 strain for utilization of palm oil mill effluent (POME) to enhance hydrogen production

Hydrogen energy is an energy resource that potential to become an alternative resource to liquid fossil fuels. This premium energy resource is a renewable, clean and environment-friendly. At present, the biological approach is known as the best method for hydrogen production due to least energy intensive, cheap production cost and environmentally friendly. Biological approaches to hydrogen production have been extensively applied to the study of the bioremediation (e.g. agricultural waste, kitchen waste, domestic waste and etc). However, the low yield of hydrogen and limited carbon sources utilization are two majors drawback for producing hydrogen through this method. Therefore, the aim of the present work is to investigate potential utilization of various carbon sources from biomass, palm oil mill effluent (POME) by genetically modified microorganism for production of hydrogen. The information obtained throughout the study will deliver substantial evidence for the ability to produce hydrogen from various carbon sources found in POME by using metabolic engineered strain. Hence numerous applications and approaches will be widely available due to the succession of this project.

Figure 1. Fermentation in incubator shaker

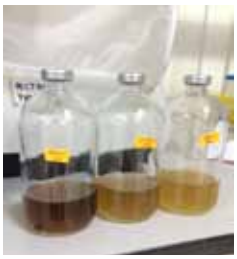

Figure 2. Fermentation using engineered strain

Figure 3. Fermentation using parental strain

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Biological pretreatment of oil palm empty fruit bunch (OPEFB) using locally isolated fungus

Oil palm empty fruit bunch (OPEFB) contains lignocellulosic components that can be converted into value-added products through several alternative pretreatment such as physical, chemical, physicochemical and biological pretreatment. Nowadays, biological pretreatment is being considered to replace the conventional pretreatment (physicochemical pretreatment) as it offers a low energy and an environmental friendly pretreatment. This technique uses microorganisms or enzyme as catalyst to modify the lignin structure and degrade the hemicellulose content in order to obtain cellulose that can be utilized for other applications. Biological pretreatment is classified into two categories (microbial pretreatment and enzymatic pretreatment) based on the biological agent used in the pretreatment. Particularly, biological pretreatment using fungus is considered as a cheaper option compared to enzymatic. In general, there are three types of wood-rot fungi that commonly used in biological pretreatment, which are white-rot, soft-rot and brown-rot fungi. White- rot fungi are considered as the primary agents of delignification that function through their extracellular enzymes and contribute to the modification of lignocellulosic structure and hemicellulosic removal. Thus, biological pretreatment using fungus has a great potential to convert the OPEFB into value-added products.

Figure 1. Culture of indigenous fungus on agar plate

Figure 2. Water extractive analysis

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Production of polyhydroxyalkanoates from an engineered *Escherichia Coli* through molecular biotechnology approach

Polyhydroxyalkanoates (PHA) are intracellular carbon and energy storage materials that can be found in numerous microorganisms. PHAs have been getting a lot of attention due to their similarity of material properties to conventional plastics, inherent biodegradability, sustainable and environmental friendly. Biosynthesis of PHA consists of three enzymes which are acetyl-CoA acetyltransferase (phaA), acetoacetyl-CoA reductase (phaB) and PHA synthase (phaC). Comamonas sp. is one of the strains commonly used for PHA production. In order to develop higher PHA production from bacterial respond strategy, PHA biosynthesis operon of Comamonas sp. EB172 was introduced into Escherichia coli BW25113. E. coli was chosen due to the complete genome information available and the absence of depolymerization gene. Accumulation of PHA in E. coli can be regulated by metabolic engineering and there are two important intermediates in PHA production which are acetyl-CoA and NADPH. Several single gene deletion in E.coli were found to be associated with PHA metabolism activity and P1 transduction was performed for multiple genes knockout for higher PHA production. E. coli.

Figure 1. Pathway

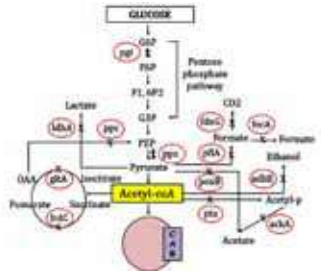

Figure 2. Metabolic pathway which lead to accumulation of PHA

Figure 3. Gas chromatography

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Biobutanol production from sago hampas using *C. acetobutylicum*

In recent years, there is a high demand towards the biobutanol production instead of bioethanol due to its superior characteristics. Biobutanol has higher energy content, more miscible with diesel, less corrosive and can be shipped in unmodified gasoline pipelines. It is a four carbon atoms alcohol that not only can serve as transportation fuel, but can also used as solvent in manufacturing industry and as an intermediate in chemical synthesis. Production of biobutanol is commonly done using acetone-butanol-ethanol (ABE) fermentation by solventogenic clostridia species. Nevertheless, one of the major problems in biobutanol production is the cost of substrate. Therefore, alternative substrate like sago hampas that contain both starchy and lignocellulosic biomass can be served as feedstock for ABE fermentation process. Although biomass residue can be used as fermentation substrate, it needs several processes to convert it into sugar and then biobutanol. The problem arises from the potential loss of sugar through varied steps process while producing the biobutanol also become one of the aim in conducting these experiments in a simultaneous process of saccharification and ABE fermentation.

Figure 1. Culturing inoculum for ABE fermentation

Figure 2. Determination of ABE and organic acids using gas chromatography (Model GC-17A, Shimadzu, Japan)

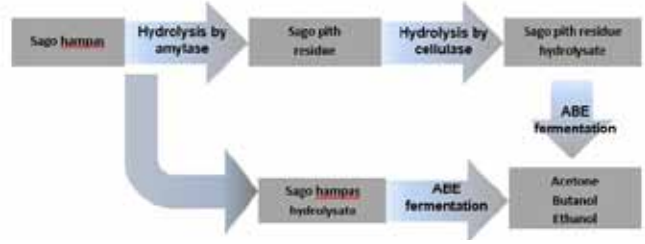

Figure 3. Conversion of sago hampas into biobutanol through ABE fermentation

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Biosurfactant production from waste cooking oil using *Pseudomonas aeruginosa* RW9

Biosurfactant aid in the production of fine chemicals, the characterization of surface and surface coatings, additives for environmental remediation and also used as a biological control agent. Furthermore, biosurfactant offers several advantages over their chemical surfactants such as their ecological acceptance in biodegradability, low toxicity, potentially high activities effectiveness and stability at extreme temperature, pH, and even salinity. In addition, the microbial surfactant is surface-active metabolites and can be produced by microorganism when grown on oil substrate or water miscible. This kind of microbial surfactants possesses the characteristic of reducing surface tensions by using the same mechanisms as chemical surfactants. Biosurfactants have not yet been employed extensively in the industry due to high production cost. Thus, the possible strategy to reduce the cost is the utilization of alternative substrates such as waste cooking oil to permit cell growth and product accumulation. Hence, the main objective outlined in this study is to obtain the optimal biosurfactant production from waste cooking oil by *Pseudomonas aeruginosa* RW9 in shake flask experiments and also in pilot scale fermenter (2 L bioreactor). Another objective is to purify the microbial surfactant produced by green purification method and to determine the performance and efficiency of biosurfactant produced on different types of hydrocarbons.

Figure 1. Pseudomonas aeruginosa RW9 was used for biosurfactant production

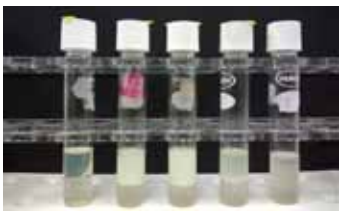

Figure 2. Emulsification activity of biosurfactant on diesel

Figure 3. Solvent extraction of biosurfactant

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Production of glucose from mixed oil palm biomass

As one of palm oil producer country, Malaysia generates an excessive amount of oil palm biomass, such as empty fruit bunch, mesocarp fiber, fronds, and trunks. Currently, the main disposal method for these biomass are through dumping or incineration which then causing pollution towards the environment. To mitigate this issue, biomass needs to recycle or reprocess. Biomass can be considered as lignocellulosic materials, and are rich in cellulose, hemicellulose, and lignin. Cellulose and hemicellulose are valuable to be converted into fermentable sugars through enzymatic saccharification process. However, the materials are in complex fibrous form, thus it reduces the enzymatic digestibility. A pretreatment process is required as it opens up the lignocellulosic structure to make cellulose more accessible by the enzyme. Mainly, there are three approaches of pretreatment available such as physical, chemical, and biological with various combinations such as physicochemical, biophysical, etc. Hot compressed water process falls into a physicochemical reaction which it loosens up the structure and assists autohydrolysis reactions within the biomass. Therefore, enzyme penetrating will be facilitated and therefore a low number of enzyme loading which will enhance the glucose yield.

Figure 1. Oil palm biomass involved in pretreatment that are frond (OPF), empty fruit bunch (OPEFB), and mesocarp fibre (OPMF).

Figure 2. Saccharification process of mixed oil palm biomass

Figure 3. Pretreated solid after saccharification process

Figure 4. Standard sugar for sugar analysis

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Non-chlorinated nanocellulose production from oil palm biomass

In the midst of new generating idea regarding nanomaterial, cellulose from plant biomass found as potential producing cellulose nanofiber (CNF). CNF becomes preferable in many application like bio-composites, pulp and paper, biomedical, etc. Most pretreatment on cellulose extraction predominantly use harsh treatment and required chlorinated bleaching. This is unfavourable due to impact on ecology. Therefore, the study focused on extract cellulose from oil palm biomass by highlighting the use of totally-chlorine free treatment. Within research, multi-step treatment was conducted by comparison with soda pulping as promising method obtaining high yield cellulose. Multi-step is a combination of superheated steam (SHS), enzymatic hydrolysis and alkaline treatment. SHS treatment beneficial removed hemicellulose with less energy required and shorter time. Whereas, xylanase enzyme attack xylan or recalcitrant hemicellulose to break the link between cellulose-lignin. Additionally, xylanase enhances chemical accessibility to remove lignin by further alkaline treatment. Lastly, the peracetic acid used as a bleaching agent to increase pulp brightness. In results, cellulose yield in multi-step treatment in the range of 83% to 87% comparable to soda pulping. Others estimation including thermal stability, structure, morphological and crystallinity. CNF proved to produce using wet disc milling (WDM). Present work interest with a feasibility study of WDM throughput by the effect on degree of polymerization.

Figure 2. Fibrillation cellulose nanofiber from wet disc milling (WDM)

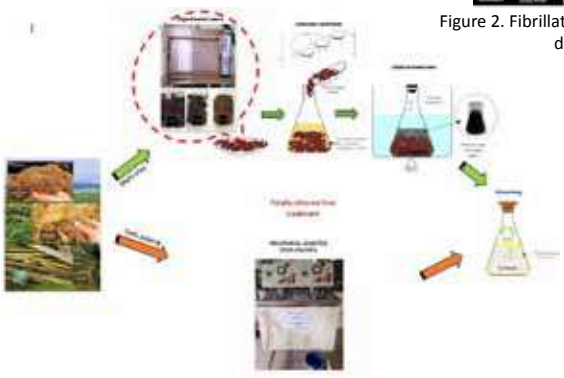

Figure 1. Green processing of cellulose extraction

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Elucidation of uncharacterized pseudogene for biohydrogen production

Hydrogen holds a promise for a renewable and clean energy source. Molecular of hydrogen gas (H2) has highest energy content compared to other gaseous fuels. H2 known as carbon free gas and it is completely oxidized to water once it is combusted. H2 can be generated by various methods either chemical or biological approaches such as using water electrolysis, natural gas, coal and waste material. However, hydrogen through biological method (biohydrogen) gain a great interest as it can be produced easily from a variety of carbon sources through dark fermentation.

Escherichia coli (E. coli) is the most extensively used bacterium for biohydrogen production. By screening this strain using chemochromic membranes, pseudogene found as one of the essential genes that related in hydrogen metabolism. A pseudogene is a DNA sequence with high homology to a functional gene. However, it is regarded as defunct relatives due to a few types mutation and strain evolution. To date, a comprehensive study of *E. coli* pseudogenes related to hydrogen metabolism has not been conducted. In this study, the actual sequence of specific pseudogene was investigated via single gene knockout method.

Figure 1. qRT-PCR machine for transcription analysis

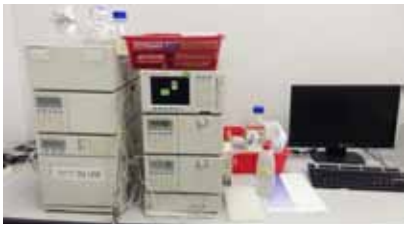

Figure 2. HPLC used for organic acid analysis

Figure 3. Hydrogen detection using Gas Chromatography

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Expression of β-glucosidase gene in *Saccharomyces cerevisiae* for Bioethanol Production

Concerns on fossil fuel consumption has led to bioethanol emerging as an alternative renewable fuel. In Malaysia, abundance of oil palm waste generated including oil palm empty fruit bunch (OPEFB) offers great potential as lignocellulosic substrate. For efficient hydrolysis, high conversion rates from cellulase enzyme constituents; endoglucanase, exoglucanase and β-glucosidase, are deemed essential. However, common low β-glucosidase expression has resulted in cellobiose build-up, thus causing feedback inhibition. One approach to meet these challenges require construction of yeast strain expressing β-glucosidase capable of carrying out simultaneous saccharification and bioethanol fermentation. To this effort, this study has expressed a codon optimized β-glucosidase gene, isolated from local Trichoderma sp. isolate, in Saccharomyces cerevisiae. Following fermentation with oil palm biomass substrate, the resultant cell growth, liberated sugar concentration, enzyme activity and bioethanol production were quantified. In short, this study demonstrates the feasibility of recombinant yeast with β-glucosidase expression towards enhancing bioethanol production.

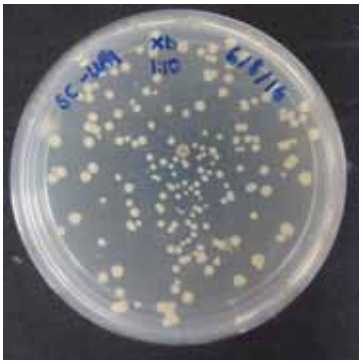

Figure 1. Selective *Saccharomyces cerevisiae* transformant growth

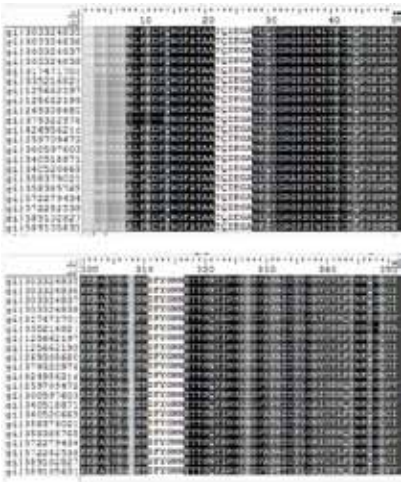

Figure 2. Conserved amino acids of β-glucosidases from Trichoderma spp.-

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Escherichia coli yqiG pseudogene in hydrogen production

Hydrogen considered as environmental friendly fuel and renewable energy if it produced from renewable sources. Hydrogen production through dark fermentation considered as an effective biological approach which brings several advantages such as easy operation of bioreactor, higher production rate, and may utilize various substrates. *Escherichia coli* has been extensively used in hydrogen production. *E. coli* is well characterized bacteria and the metabolic engineering best-studied. Mutant strain can be constructed by genetically manipulate their metabolic pathway so called metabolic engineering.

Pseudogenes are from active genes which turn into junk genes because of transcription and translation disruption. The presence of stop codons, repetitive element frame shift and lack of transcription might interrupt the gene to function well. However, the functions of pseudogenes are still unknown. In our preliminary study, we found out that yqiG pseudogene is essential for hydrogen production. Thus, in this study, we try to characterize the function of yqiG pseudogene in *Escherichia coli* for hydrogen evolution. Knock-out of yqiG gene in *E. coli* resulted in less hydrogen formation in complex glucose compared to complex formate media. Without the presence of yqiG gene, the hydrogen metabolic pathway was interrupted. Hence, yqiG pseudogene is important for hydrogen production and proves that some of the pseudogenes are functions in *E. coli*.

Figure 1. Small serum bottles and anaerobic flask was used for fermentation purpose

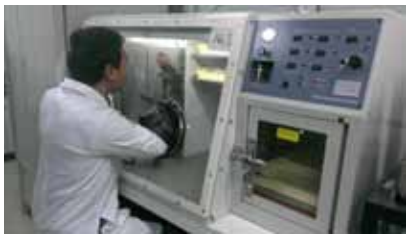

Figure 2. Inoculum was transferred into vials containing media in anaerobic chamber

Figure 3. Transcriptional analysis (gene expression) was analyzed by using RT PCR

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Co-composting of kitchen waste and sawdust with addition of biochar

Malaysia is facing crucial solid waste management issue due to population, economic growth, lack of waste management legislation, infrastructure and attitude of public especially in urban areas. Ministry of Housing and Local Government reported that in 2010, peninsular Malaysia alone has generated an estimated 25,000 metric tonnes of municipal solid waste (MSW) daily of which 50% were kitchen wastes (at source) whereas 930 tonnes food unconsumed and being disposed.
Composting seems to be feasible approach since kitchen wastes has high moisture content, high organics-to-ash ratio, and loose physical structure. However, composting of kitchen wastes need to be sustained to reduce problem that commonly arise while the process is undergone. Recent studies showed the interest of researchers on applying biochar to compost to improve degradation process. Unique characteristics of biochar which has high porosity, sorption capacity and cation exchange capacity can allow microorganisms to live at the surface and promotes different activity in soil. Recent studies has shown that application of biochar into the composting process improve physico-chemical characteristics of composts. In summary, this research can contribute to improve waste recycling system in this country by utilizing biomass produced from local and industry.

Figure 1. Biochar from coconut shell used as treatment to improve composting process

Figure 3. Compost product

Figure 2. Kitchen waste collected from Serdang food court

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Biobutanol produced from simultaneous saccharification and fermentation using in-situ recovery

The increasing demand of energy as is expected as human population becomes 10 billion by 2050 has led to the discovery of new alternative energy for our future generation. Biobutanol is one of the next promising future sources of energy that can substitute the depletion of underground fossil fuels. As compared to other energy sources, biobutanol is the most suitable bioenergy as it has less negative impacts on the environment and produces better energy density than ethanol. However, the process of biobutanol extraction is rather challenging whether in the form of high biomass, low yield of butanol, low butanol titer, slow fermentation, or with the degeneration of microbes. Therefore, this study is conducted to increase the recovery of biobutanol produced from simultaneous saccharification and fermentation by using free pretreated oil palm empty fruit bunch (OPEFB) waste as substrate. Powerful microbe like Clostridium acetobutylicum can utilize sugar release after enzymatic attack of OPEFB and produce biobutanol. By applying in-situ recovery such as gas stripping technique, it will reduce the butanol toxicity and improve the fermentation efficiency. This is because this method has high selectivity of acetone, butanol, ethanol (ABE) which are stripped out without interfering the fermentation system. Then, further purification of butanol using distillation process will be carried out. The gas stripping-distillation recovery system is believed to be the next future system for large scale biobutanol processing.

Figure 1. Sample injection into Gas Chromatography

Figure 2. Bioreactor

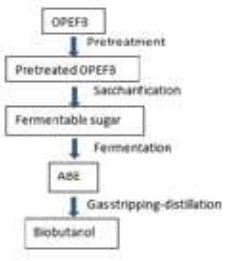

Figure 3. Overall process of biobutanol recovery

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Treatment for POME final discharge using wetland system

Palm oil industries are the largest industries in Malaysia so there were more than 3.79 million hectares of land, occupying more than one-third of the total cultivated areas and 11% of the total land area, under palm oil cultivation in Malaysia in the year 2003. Malaysia produces a large amount of palm oil every year and resulting into production of more than 13 million tons of crude palm oil yearly also its cover 11% of Malaysian land for plantation area. The POME contains high COD, high BOD, soluble materials, some gases such as CH_4, $S0_2$ and NH_3. It also contain halogens, low pH (acidic), large amount of solid, high oil and grease, it is hot, brownish colloidal suspension contain high concentration of organic matters and contain N, P, K, Mg, Ca, Al with low concentration of Pb that can cause a pollution if it is discharging without proper treatment. An average of about 53 million m3 POME is being produced per year in Malaysia. Therefore we need to treat this wastewater. For this experiment, the approach to treat POME that will be by using the wetland system. This wetland system is more compatible as compare to other system to treat the POME final discharge since it is more cost effective and less side effects as compared to the biological and chemical approach.

Figure 1. Using Dissolved Oxygen meter

Figure 2. Wetland system in biorefinery

Figure 3. Sampling water from wetland system

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Production xylooligosaccharide and biosugars from oil palm mesocarp fiber

Oil palm mesocarp fiber (OPMF) is one of the massive biomass generated from oil palm production. It is estimated that the palm oil production increased from 8.5 million tons in 2000 to 10.5 million tons in 2010. Therefore a research on utilization of this biomass should be undertaken. OPMF is lignocellulosic material that consists mainly three polymers; cellulose (20-50%), hemicelluloses (20-40%), and lignin (10-28%). Different sources of biomass were used to produce xylooligosaccharides such as corn cobs, sugarcane bagasse, and eucalyptus globulus wood. Pretreatment is one of the methods carried out to obtain xylooligosaccharides (XOs) from biomass. In this study, hydrothermal pretreatment was performed on OPMF as a substrate to obtain XOs and biosugars from the hydrolysis of hemicellulose. Hydrothermal pretreatment is considered the method of choice since it uses only water that acts as a catalyst. Furthermore, it is greener approach method, which is eco-friendly to the environment because no addition of chemicals in the pretreatment reaction. There are many applications of XOs in the food related product, health and medicinal industry such as prebiotic, anti-obesity diets and ripening agent.

Figure 1. Sand bath reactor for hydrothermal process

Figure 2. HPLC for analysis

Figure 3. EDX analysis for morphological characteristics

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Biobutanol production through simultaneous saccharification and fermentation from oil palm empty fruit bunch

Biobutanol has become one of the potential biofuels that serve as an alternative to fossil fuels. Biobutanol production has been successfully conducted through simultaneous saccharification and fermentation (SSF) using oil palm empty fruit bunch (OPEFB). OPEFB is one of the low cost lignocellulosic biomass, with high cellulose and hemicellulose content which can be saccharified into sugars by cellulase enzymes. The sugars are subsequently fermented by Clostridium acetobutylicum ATCC 824 into biobutanol. The SSF process involves the one-step addition of Clostridia species, cellulase enzymes and OPEFB in a vessel. The SSF process generates biobutanol yield that is comparable with the separate hydrolysis and fermentation (SHF) with improvements in the terms of reducing steps in the OPEFB conversion to biobutanol. However, the SSF process needs to undergo optimisation to increase the biobutanol production and scale-up of the process is on-going.

Figure 1. Fermentation of simultaneous saccharification and fermentation for biobutanol production

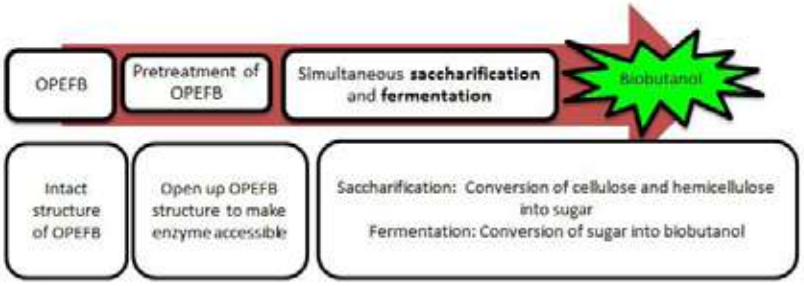

Figure 2. Simple experimental design of biobutanol production from oil palm empty fruit bunch

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Effect of physico-chemical and biological pretreatment of oil palm biomass for fermentable sugars production

Oil palm empty fruit bunch (OPEFB) and oil palm mesocarp fiber (OPMF) are lignocellulosic biomass wastes that abundantly generated in palm oil mills which provides potential bioresouces for the conversion into value added products such as biosugars. The presence of hemicelluloses and lignin hinders the access of cellulose thus resulting in low efficiency of the hydrolysis. Effective pretreatments are needed to reduce the recalcitrance of lignocellulosic structures to improve fermentable sugars production. This study proposes an environmental approach by combining of superheated steam (SHS) pretreatment and biological pretreatment (laccase) of OPEFB and OPMF to improve fermentable sugar production. SHS is expected to open up the structure by solubilise the hemicelluloses so that the laccase can accessible attack the lignin structure. It loosened the compact wrap of lignin carbohydrate complex and consequently enhances saccharification efficiency of cellulose. Further improvement on the combination process is expected to enhance fermentable sugars production.

Figure 1. Superheated steam oven

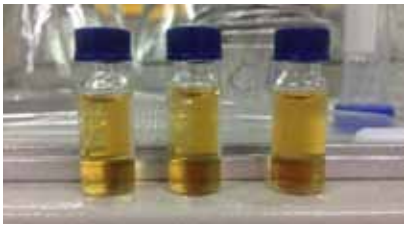

Figure 2. Fermentable sugar after 48 hours saccharification

Figure 3. Pretreated OPMF using superheated steam

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Essential oil from pineapple peels

The pineapple industry produces a substantial amount of solid waste like peels, cores, stems, crowns and pulp. Pineapple waste disposal can cause to microbial spoilage and environmental problems due to the waste material containing high moisture and sugar content. Utilization of pineapple waste, focusing on the peels, to produce a high value added product of essential oil is a good option. However, there is no suitable extraction method of essential oil from pineapple peel has been reported. Therefore, this study aims to select green methods with no chemical involve for extraction of essential oil from pineapple peels. Three methods used in the study were (1) hydro-distillation (HD), (2) hydro-distillation with enzyme-assisted pretreatment (HDEA) and (3) supercritical fluid extraction (SFE). The aromatic compounds of the obtained essential oil are analyzed using GC-MS. Moreover, upon completion of the extraction, the sample's cell walls are observed under Scanning Electron Microscopy (SEM). Overall, this study will be selecting a suitable method for extraction of essential oil from pineapple peels, indirectly, promoting a proper way for pineapple waste management by producing a high value added product.

Figure 1. Pineapple Peels collected at Ladang Nenas Sg Telur, Johor

Figure 3. Substrate pretreatment using cellulase enzyme prior to hydro-distillation

Figure 2. Schematic diagram of SC-CO_2 extraction apparatus (DEVEN Supercritical, Pvt Ltd, India

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Surfactant production from used cooking oil

The biosurfactants or microbial surfactants have gained attention because of their biodegradability, low toxicity, and ecological acceptability compared to chemical surfactants. Biosurfactants spontaneous release and function are often related to hydrocarbon uptake; therefore, they are predominantly synthesized by hydrocarbon-degrading microorganisms. Used cooking oil is an excellent candidate as substrate for the biotransformation into biosurfactants because it is cheap and renewable hydrocarbon source. Thus it can reduce the total production cost as well as minimizing the oil pollution in the environment. In this study, the production of biosurfactant from used cooking oil by biosurfactant-producing microorganisms is conducted. The characterization of biosurfactant such as the effect of temperature, pH, and salt content on the stability of biosurfactant is determined. This step is vital as environmental factors are extremely important in the yield and quality of the biosurfactant produced in terms of surface tension, interfacial tension, and emulsification index. Further step is to evaluate the capability of the biosurfactant and its ability on enhancing removal of heavy metals in the water systems contaminated with heavy metals. As a conclusion, the present study suggests a promising alternative to alleviate heavy metals in the environments as well as recycling used cooking oil through the production of biosurfactant.

Figure 1. Production of biosurfactant in incubator shaker by local isolate

Figure 2. Biosurfactant precipitates in acidic condition

Figure 3. Raw biosurfactant was dried using a rotary evaporator prior to purification

NEW REGISTERED STUDENTS

Name : Abubakar Abdullahi Lawal
Program : PhD
Supervisor : Prof. Dr. Mohd Ali Hassan
Research Title : One-step CO2 enhanced steam activation for activated biochar production

Name : Chin Kok On
Program : Master
Supervisor : Prof. Dr. Mohd Ali Hassan
Research Title : Extraction of tocotrienols from OPMF

Name : Erwan Syah Tugiman
Program : Master
Supervisor : Prof. Dr. Mohd Ali Hassan
Research Title : Biochar as organic soil amendment as alternate fertilizer

Name : Nurul Atiqah Osman
Program : Master
Supervisor : Dr. Ahmad Muhaimin Roslan
Research Title : Biobutanol production from non-food biosugar

Name : Nur Aina Natasha Mohd Asmadi
Program : Master
Supervisor : Dr. Mohd Rafein Zakaria
Research Title : Biosurfactant production from empty fruit bunch pressed oil

ALUMNI 2017

Dr. Nur Ain Zamzuri

Title of Project: One-step biotransformation of ferulic acid into biovanilin by recombinant *Escherichia coli*

Former Supervisor:
Prof. Dr. Suraini Abd Aziz

Dr. Dhurga Devi Rajaratnam

Title of Project: Controlled depolymerisation of poly (3-hydroxybutyrate-co-3-hydroxyhaxenoate) by superheated steam for oligoester production

Former Supervisor:
Assoc. Prof. Dr. Hidayah Ariffin

Mohammed Abdillah Ahmad Farid

Title of Project: Utilization of Biomass-Derived Activated Carbon as Catalyst Support and Bio-Adsorbent in Biodiesel Production using Waste Cooking Oil as Feedstock

Former Supervisor:
Prof. Dr. Mohd Ali Hassan

Muhammad Nazmir Mohd Warid

Title of Project: Optimization of oil palm biomass superheated steam treatment improving fiber characteristics and biocomposite performance

Former Supervisor:
Assoc. Prof. Dr. Hidayah Ariffin

Zulnaim Dzulkarnain

Title of Project: Co-composting of municipal sewage sludge and landscaping waste by pilot plant scale and the application of compost to an ornamental plant, Tagetes erecta

Former Supervisor:
Prof. Dr. Mohd Ali Hassan

Aisyah Zulkarnain

Title of Project: Alkaline hydrolysate of oil palm empty fruit bunch as potential substrate for biovanilin production via two-step bioconversion

Former Supervisor:
Prof. Dr. Suraini Abd Aziz

Iffah Nabilah Mohd Ariff

Title of Project: Production of cellulolytic enzymes via solid state fermentation of spent mushroom substrate by *Trichoderma asperellum* UPM 1

Former Supervisor:
Prof. Dr. Suraini Abd Aziz

Siti Suhailah Sharuddin

Title of Project: Assessment of Physicochemical and Community Profiles in Bacterial Ecology of Palm Oil Mill Effluent Final Discharge and Polluted River Water

Former Supervisor:
Dr. Norhayati Ramli

LIST OF ALUMNI (2011-2016)

Year	Alumni	Current work place	Current position	Highest qualification with EB group	Former supervisor
2011	Dr. Tabassum Mumtaz	IFRB , Bangladesh	Principal Scientific Officer	PhD	Prof. Dr. Mohd Ali Hassan
	Lim Siong Hock	Self Employed	Self Employed	MSc	Prof. Dr. Mohd Ali Hassan
	Farah Nadia Omar	UPM, Selangor	PhD Student	MSc	Assoc. Prof. Dr. Nor'Aini Abdul Rahman
	Halimatun Saadiah Hafid	UPM, Selangor	PhD Student	MSc	Assoc. Prof. Dr. Nor'Aini Abdul Rahman
	Isnazunita Ismail	SIRIM Berhad, Shah Alam, Selangor	General Manager	MSc	Prof. Dr. Suraini Abd Aziz
	Dr. Nazlina Haiza Mohd Yasin	UKM, Selangor	Postdoctoral Researcher	MSc	Assoc. Prof. Dr. Nor'Aini Abdul Rahman
	Nurul Kartini Abu Bakar	MTDC, Kuala Lumpur	Acting Head, Processing TAF/CRDF Unit	MSc	Prof. Dr. Suraini Abd Aziz
2012	Dr. Norhayati Ramli	UPM, Selangor	Senior Lecturer	PhD	Prof. Dr. Suraini Abd Aziz
	Dr. Nurul Asyifah Mustapha	KYUTECH, Japan	Postdoctoral Researcher	MSc	Prof. Dr. Suraini Abd Aziz
	Dr. Mitra Mohammadi	Khedgarayan Mohatar Institute of Higher Education	Assistant Professor	PhD	Prof. Dr. Mohd Ali Hassan
	Mohd Najib Ahmad	MPOB, Selangor	Research Officer	MSc	Prof. Dr. Mohd Ali Hassan
	Dr. Mohd Rafein Zakaria	UPM, Selangor	Senior Lecturer	MSc	Prof. Dr. Mohd Ali Hassan
	Dr. Ahmad Amiruddin Mohd Ali	KYUTECH, Japan	Postdoctoral Researcher	PhD	Prof. Dr. Yoshihito Shirai
2013	Dr. Mior Ahmad Khushairi Mohd Zahari	UMP, Pahang	Senior Lecturer	PhD	Prof. Dr. Mohd Ali Hassan
	Dr. Mohamad Faizal Ibrahim	UPM, Selangor	Senior Lecturer	PhD	Prof. Dr. Suraini Abd Aziz
	Dr. Ezyana Kamal Bahrin	UPM, Selangor	Senior Lecturer	PhD	Prof. Dr. Suraini Abd Aziz
	Fairouz Jahaan Mohd Aanifah	MQA, Selangor	Assistant Director	MSc	Prof. Dr. Suraini Abd Aziz
	Siren Linggang	Dept of Agriculture Sarawak, Sarawak	Research Officer	MSc	Prof. Dr. Suraini Abd Aziz
2014	Dr. Saleha Samsudin	UniMAP, Perlis	Senior Lecturer	PhD	Prof. Dr. Mohd Ali Hassan
	Dr. Nor Asma' Abdul Razak	UPM, Selangor	Research Officer	PhD	Prof. Dr. Mohd Ali Hassan
	Mohamad Nafis Abdul Razak	Johor Bahru District Office, Johor	Admin Executive	MSc	Prof. Dr. Suraini Abd Aziz
	Sheril Norliana Suhaimi	Segi University Kota Damansara, Selangor	Junior Lecturer	MSc	Assoc. Prof. Dr. Phang Lai Yee
	Dr. Ahmad Muhaimin Roslan	UPM, Selangor	Senior Lecturer	PhD	Prof. Dr. Yoshihito Shirai
	Mohd Azwan Jenol	UPM, Selangor	PhD student	MSc	Prof. Dr. Suraini Abd Aziz
	Nur Amelia Azreen Adnan	Monash University Malaysia, Selangor	Research Assistant	MSc	Assoc. Prof. Dr. Phang Lai Yee
2015	Dr. Dayang Salwani Awang Adeni	UNIMAS, Sarawak	Senior Lecturer	PhD	Prof. Dr. Suraini Abd Aziz
	Dr. Juferi Idris	UiTM, Sarawak	Senior Lecturer	PhD	Prof. Dr. Mohd Ali Hassan
	Dr. Mohd Huzairi Mohd Zainudin	UPM, Selangor	Research Officer	PhD	Prof. Dr. Mohd Ali Hassan
	Dr. Sharifah Soplah Syed Abdullah	UniKL, Malacca	Senior Lecturer	PhD	Prof. Dr. Yoshihito Shirai
	Che Mohd Hakiman Che Maail	Biosyntech Sdn Bhd, Selangor	Sales Executive	MSc	Assoc. Prof. Dr. Hidayah Ariffin
	Nur Falia Shazana Manja Farid	Lynas Malaysia Sdn Bhd	Lab Analysts	MSc	Assoc. Prof. Dr. Hidayah Ariffin
	Mohd Rahimi Zakaria @ Mamat	Malaysia Rubber Board, Selangor	Research Officer	MSc	Assoc. Prof. Dr. Hidayah Ariffin
2016	Izzudin Ibrahim	UPM, Selangor	Research Assistant	MSc	Prof. Dr. Mohd Ali Hassan
	Rozaimi Abu Samah	UMP, Pahang	Senior Lecturer	PhD	Prof. Dr. Suraini Abd Aziz
	Nur Sharmila Sharip	UPM, Selangor	PhD Student	MSc	Assoc. Prof. Dr. Hidayah Ariffin
	Mohd Ridzuan Othman	UPM, Selangor.	Science Officer	MSc	Prof. Dr. Mohd Ali Hassan
	Dr. Zuraidah Zanirun	Self employed	Self employed	PhD	Prof. Dr. Suraini Abd Aziz
	Dr. Noor Ida Amalina Adamad Nordin	UMP, Pahang	Senior Lecturer	PhD	Assoc. Prof Dr Hidayah Ariffin

EB ALUMNI WALL OF FAME

Dr. Shahrakbah Yacob

Shahrakbah Yacob (D.Eng.) currently is Head of Minamas R&D center. His main role is to conduct plantation agricultural research on oil palm and rubber, and to provide support services to Minamas Plantation, Indonesia.

He obtained his BSc. Biotechnology from Universiti Pertanian Malaysia back in 1995. Later pursued his post-graduate study at the University of Canberra, Australia and was honoured with Master of Applied Sciences (1997). Dr. Shahrakbah graduated from Kyushu Institute Technology (Kyutech), Japan in 2005 under supervision of Prof. Dr. Yoshihito Shirai and Prof. Dr. Mohd Ali Hassan. He played a key role in setting up the first semi-commercial biogas pilot plant for FELDA under the joint research collaboration "Utilization of Biogas and Biomass for New Bioproducts" between UPM–FELDA–Kyutech. From 2000 until 2006 he was a lecturer at the Department of Biotechnology, UPM before changing his career path towards industrial practices by joining Applied Agricultural Research Sdn. Bhd as an agronomist. In 2011 he joined Sime Darby Plantation Berhad as Vice President/Principal Agronomist and led a group of agronomists/scientists in the fields of rubber, soils/water management, precision agriculture and sustainability. Recently, he has been entrusted with a bigger responsibility as Head of R&D for Minamas Plantation based in Indonesia.He has travelled vastly to various part of the globe, namely Africa, South America, and Asia-Oceanic in realising the vision of Sime Darby Plantation in delivering sustainable future. Deeply ingrained as his motto "Berilmu Berbakti" (With Knowledge We Serve), Dr. Shahrakbah continues to engage local and international multistakeholders and to create awareness in various fields of science among them are soils science, agronomy, environment and sustainability. His passion in discovering new knowledge via research activities continues and regularly appears in scientific forum to share/ exchange new findings.

We are proud to have Dr. Shahrakbah as one of EB group Alumni and wishing him all the best in his career ahead.

EB 2017 IN PICTURES

2 February 2017, Visit from Majlis Bandaraya Melaka, Biorefinery Complex, UPM

2 Mac 2017, Launching Ceremony of Used Cooking Oil Collection, Biorefinery Complex, UPM

8-9 March 2017, UPM-Kyutech Joint Seminar, Biotech 1, FBSB, UPM

20 March 2017, SATREPS Seminar, D'Saji KL Titiwangsa, Kuala Lumpur

28 March 2017, International SATREPS Workshop, Kota Kinabalu, Sabah

EB 2017 IN PICTURES

30 March-3 April 2017, EB Retreat Sabah, Kota Kinabalu & Kundasang, Sabah

10 April 2017, Signing Ceremony of MOA between UPM & Kyutech, Kyutech, Japan

4 May 2017, Joint Coordination Committee (JCC) Meeting, Biorefinery Complex, UPM

17 April 2017, Visit from Biofuel Section, Ministry of Plantation Industries & Commodities (MPIC), MPOB and CIMB, Biorefinery Complex, UPM

5 May 2017, Visit from Mitsubishi Material, Japan, Biorefinery Complex, UPM

EB 2017 IN PICTURES

9 May 2017, Visit from Ketua Setiausaha Negara (KSN), Biorefinery Complex, UPM

13 July 2017, EB Raya, Biorefinery Complex, UPM

23 August 2017, Visit from Sekolah Menengah Sains Hulu Selangor, Biorefinery Complex, UPM

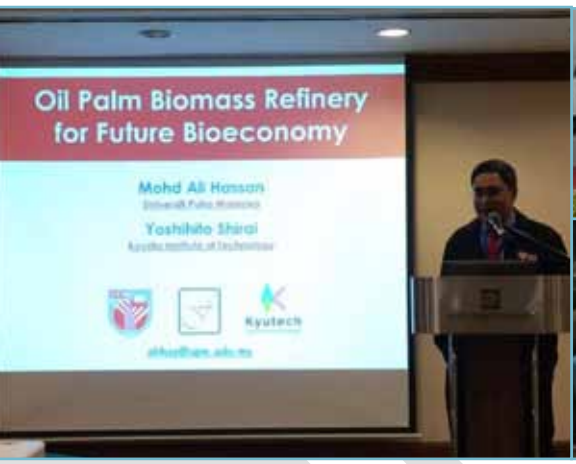
17 July 2017, Visit from Universitas Indonesia, Biorefinery Complex, UPM

EB 2017 IN PICTURES

12 September 2017, Visit from Sabak Bernam Polytechnic, Biorefinery Complex, UPM

Research Attachment at Kyutech, Japan

14-15 November 2017, International Symposium on Applied Engineering and Sciences (SAES2017)



22-23 November 2017, Wood and Biofiber International Conference 2017 (WOBIC2017)

Editorial Team

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ENVIRONMENTAL BIOTECHNOLOGY RESEARCH GROUP

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