



UPM
UNIVERSITI PUTRA MALAYSIA
BERILMU BERBAKTI

ENVIRONMENTAL BIOTECHNOLOGY

RESEARCH GROUP



2018

Research Report

FACULTY OF BIOTECHNOLOGY AND BIOMOLECULAR SCIENCES

EB GROUP 2017



Environmental Biotechnology Research Group (EB Group), Faculty of Biotechnology and Biomolecular Sciences (FBSB), Universiti Putra Malaysia was officially formed in 2005. Currently, EB Group focuses on four themes which are biocompost, biomaterial, bioenergy and biobased chemicals. EB Group undertakes research in core areas of oil palm biomass utilisation, specifically in the production of renewable and valuable green bioproducts. Other potential biomass such as kitchen waste, landfill leachate and sago wastes also been studied. There are nine principal researchers with 13 PhD students, 17 Master students and 4 research assistants. Our facilities include three laboratories and a refinery complex. The Environmental Biotechnology Laboratory (General and Molecular) are located at Biotech 3, FBSB within the main campus area, while the Biomass Technology Laboratory (BTL) is situated next to the Biorefinery Complex, nearby Bukit Ekspo UPM.

We aim to be a high performance research group conducting research on oil palm biomass and other renewable resources in Malaysia into valuable green products, with our tagline “EB for 3P” (Environmental Biotechnology – for Profit, People and Planet). We conduct collaborative research in close industries locally and internationally such as MOSTI, IWK Sdn. Bhd., FELDA, SIRIM, YPJ Plantation Sdn. Bhd., CJ Bio Malaysia Sdn. Bhd. (Korea) CES (Korea), Renagen South East Asia Sdn. Bhd. (JAPAN), AIST (Japan), MITSUBISHI (Japan).

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MASTER STUDENTS

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EB LABORATORY



INTRODUCTION

Biorefinery complex of Environmental Biotechnology (EB) group is the first pilot processing in UPM that incorporate a holistic approach in exploiting solid biomass into value added products through green technology. EB group has two main laboratories which are:

BIOMASS AND BIOREFINERY LABORATORY

EB LAB AT BIOTECH 3

BIOMASS AND BIOREFINERY LABORATORY

Biomass and Biorefinery laboratory (BBL) located near to University Agricultural Park (TPU) and UPM golf course, was operated last year starting from January 2014. The whole area of BBL covers 1075 m². The facilities includes:



PILOT PLANT

Biochar, biocompost, biodiesel and biogas pilot plants are developed based on our extensive research for 20 years in environmental biotechnology.

It is majorly equipped with solid biomass and biocompost machinery.

GENERAL FACILITIES

The general facilities includes postgraduate students room which accommodates 30 students, researcher rooms, meeting room and seminar room (can accommodate a maximum of 100 people at a time).



LABORATORY

The laboratory comprises of a chemical room, a culture room, a bioreactor room, an analysis room and a cold room.

It also fully equipped with instruments for environmental biotechnology research.

EQUIPMENT IN GENERAL LABORATORY

- 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

EQUIPMENT IN MOLECULAR LABORATORY

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



EB LAB AT BIOTECH 3

Environmental Biotechnology (EB) Research Group has two laboratories in BioTech 3: Environmental Biotechnology Lab and Environmental Biotechnology (Molecular) Lab. There are about 15 students (postgraduates and undergraduates) currently working in both labs. Environmental Biotechnology Laboratory is a general laboratory mainly focusing on research related to biopolymers, biomaterials and biochemicals. While for the molecular laboratory, they focusing on genetic and molecular work.



MESSAGE FROM THE EB GROUP LEADER



PROFESSOR DATO' DR. MOHD ALI HASSAN

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 2018.

- Our research group comprises of 9 academic staff members, 2 post-doctorate researcher and 11 associate researchers.
- Our current student enrolment are 13 PhD, 17 MS and 18 undergraduate students. In addition we also have 3 students on the PhD Dual-Degree program with Kyushu Institute of Technology, Japan.
- In 2018, 2 PhD students and 9 MS students graduated from our laboratory.

“We continue to operate the Biorefinery@ UPM Complex, comprising of the Biomass Technology Laboratory and the Pilot Plants 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 2013-2018, with a matching grant from The Ministry of Education Malaysia, 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. Alhamdulillah we commercialized the compost project at Kemaman Palm Oil Mill under TDM Berhad as our industry partner.

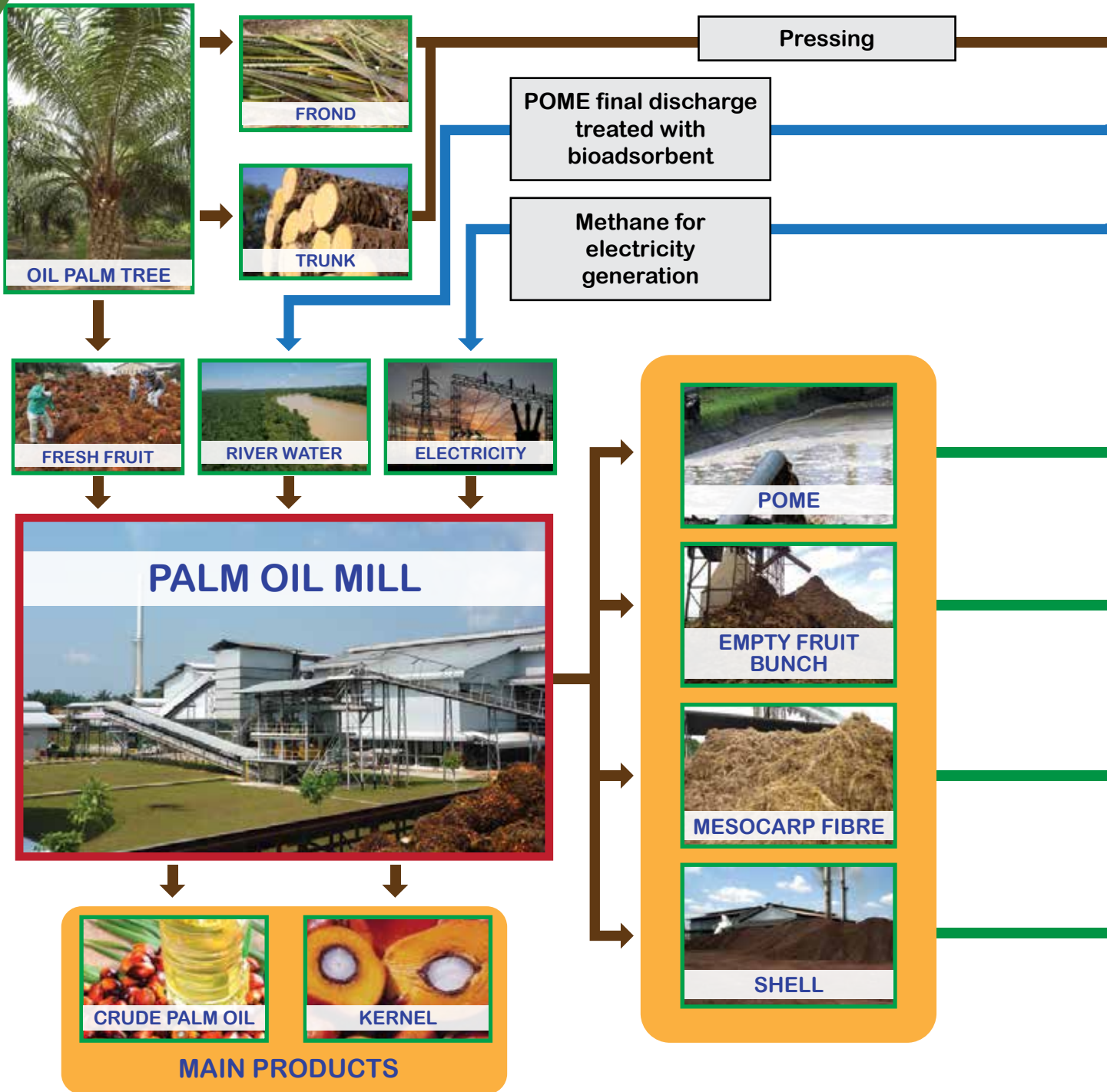
- In terms of output, we successfully published 28 research papers in 2018, with 9 in Quartile 1 (Q1) and 5 in Quartile 2 (Q2), with a total of 72.9 Impact Factors.

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 Dato' Dr. Mohd Ali Hassan

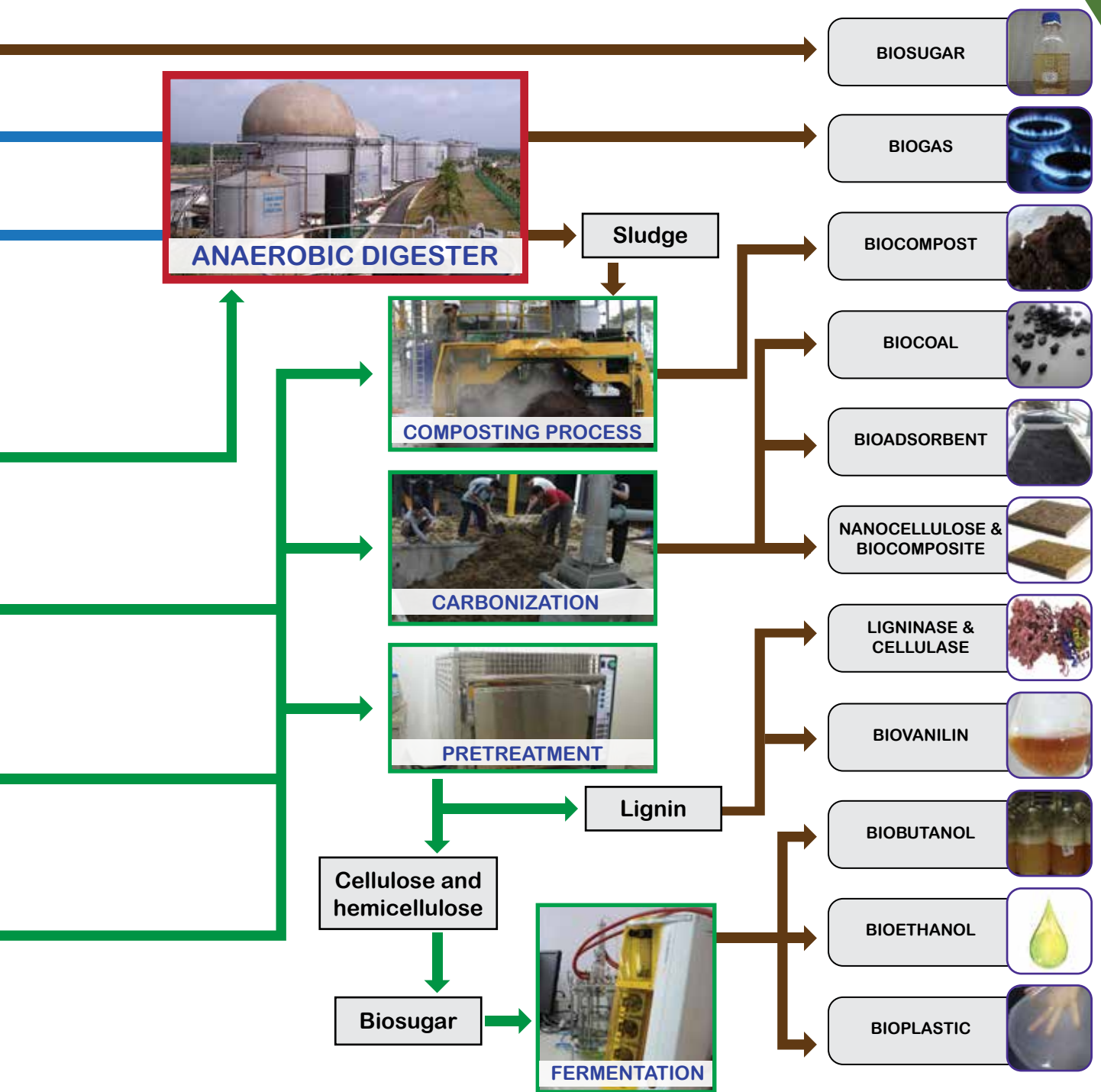
EB GROUP



← **TRADITIONAL TECHNOLOGY**



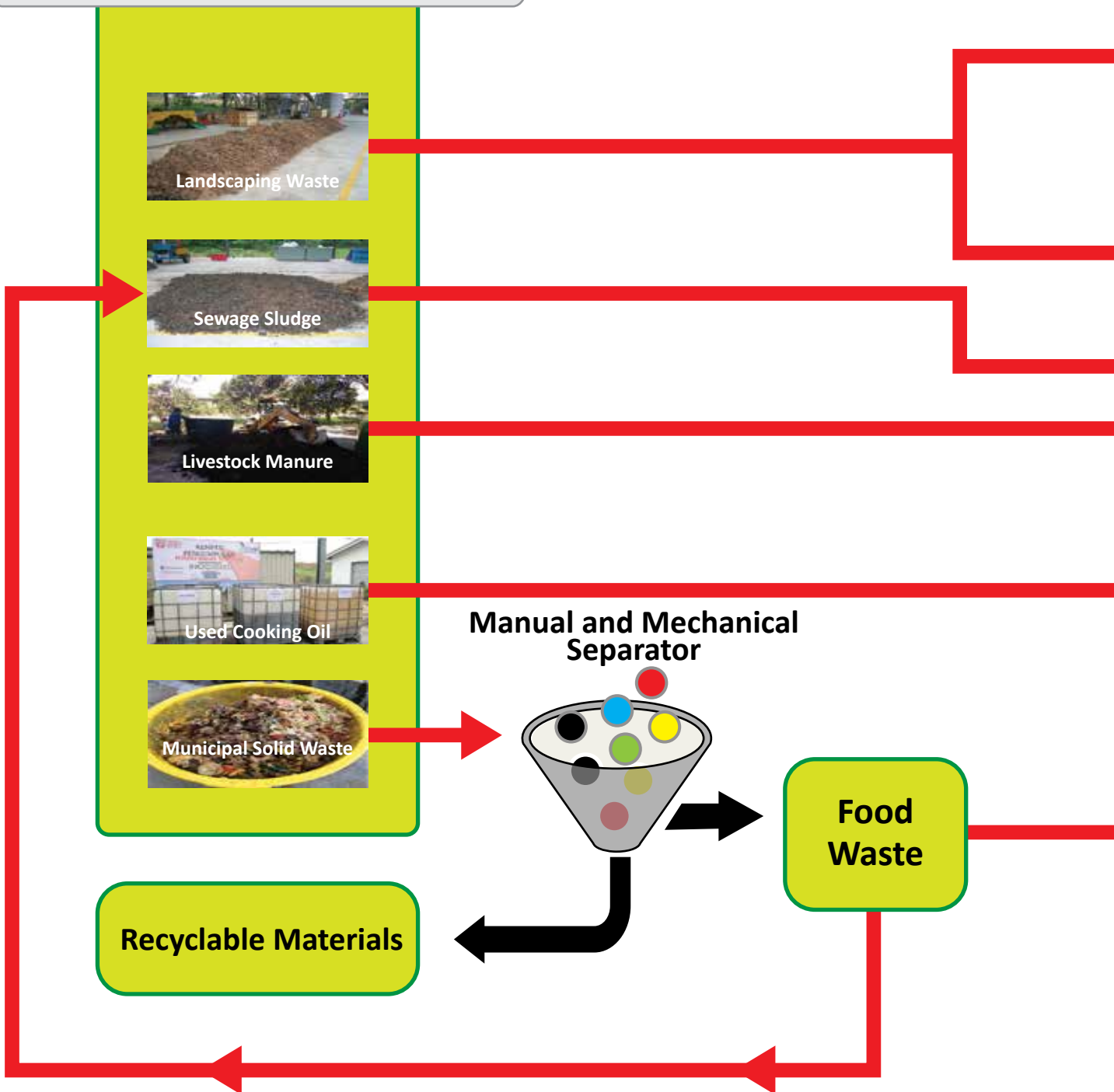
BIG PICTURE



EMERGING TECHNOLOGY

EB GROUP MAIN PROJECTS

**WASTE COLLECTION FROM:
UNIVERSITI PUTRA MALAYSIA
SRI SERDANG
INDAH WATER FACILITY
WORLDWIDE**





UPM
UNIVERSITI PUTRA MALAYSIA
BERILMU BERSAKTI



Kyutech
Kyushu Institute of Technology

IndahWater

WORLDWIDE
HOLDINGS

**BIOREFINERY COMPLEX AT
UNIVERSITI PUTRA MALAYSIA**



Carbonization Process



BIOCHAR



Composting Process



BIOCOMPOST



Biodiesel Production



BIODIESEL



Biogas Production



BIOGAS

SATREPS

Science and Technology Research Partnership
for Sustainable Development Program

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

FACTS AND FIGURES

STATUS: COMPLETED
(4 YEARS: Sept 2014 –
Aug 2018)



TOTAL ALLOCATION: RM 17 million
(Malaysia RM 3 million,
Japan RM 14 million)



**18 RESEARCHERS
INVOLVED**



**20 STUDENTS
GRADUATED**
6 PhDs, 14 MSc

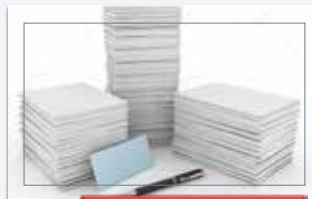


MALAYSIA
LEADER: PROF. DATO' DR MOHD ALI HASSAN



JAPAN

LEADER: PROF. DR YOSHIHITO SHIRAI



**57
PUBLICATIONS**



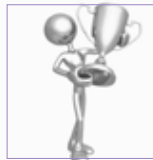
**6 INTELLECTUAL
PROPERTIES**

- 2 Patents
- 4 Copyrights



**2 COMMERCIALIZED
PRODUCTS**

- Nanocellulose by ZoepNano Sdn. Bhd.
- Biocompost by TDM Plantation Sdn. Bhd.



**2 AWARDS
(Nanocellulose)**
*Bioeconomy Innovation
Awards 2017*

- Most Commercial
Ready Product
- Most Innovative
Product



4 PRODUCTS

Nanocellulose
Biocompost
Biochar
Biocomposites



1 PILOT PLANT
@ Keningau Palm Oil Mill,
Sabah

IMPACT:

- Creation of new job and market through commercialized products
- Novel indicator species to detect pollution in the environment due to palm oil mill wastewater discharge
- Clean recycled water for factory use



EB GROUP RESEARCHER

PROFESSOR DR MOHD ALI HASSAN



Selected Publications (2014-2018):

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.
6. Farid, M.A.A., Hassan, M.A., Taufiq-Yap, Y.H., Ibrahim, M.L., Hasan, M.Y., Ali, A.A.M., Othman, M.R. and Shirai, Y., 2018. Kinetic and thermodynamic of heterogeneously K₃PO₄/AC-catalysed transesterification via pseudo-first order mechanism and Eyring-Polanyi equation. *Fuel*, 232, pp.653–658.

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: 37

Citation: 4049

Contacts:

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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)

**Specialization:**

Biochemical Engineering/Enzyme Technology

Current research interest:

Bioenergy and biobased chemicals from agricultural wastes

h-index: 25

Citation: 1856

Contacts:

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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)

EB GROUP RESEARCHER

PROF. DR SURAINI ABD-AZIZ

Selected Publications (2014-2018):

1. Zulkarnain, A., Bahrin, E. K., Ramli, N., Lai Yee, P. and Abd-Aziz, S.. (2018). Alkaline hydrolysate of oil palm empty fruit bunch as potential substrate for biovanillin production via two-step bioconversion. *Waste and Biomass Valorization*. 9(1): 13-23.
2. Zainal, N.H., Abdul Aziz, A., Idris, J., Jalani, N.F., Mamat, R., Ibrahim, M.F., Hassan, M.A. and Abd-Aziz, S. (2018). Double insulated reactor of carbonisation-activation steam system for improved yield and surface area of palm kernel shell activated carbon. *Journal of Cleaner Production*. 182: 830-837.
3. Md Razali, N.A.A., Ibrahim, M.F., Bahrin, E.K. and Abd-Aziz, S. (2018). Optimisation of simultaneous saccharification and fermentation (SSF) for biobutanol production using pretreated oil palm empty fruit bunch. *Molecules*. 23, 1944; doi:10.3390/molecules23081944.
4. Zainal, N.H., Abdul Aziz, A., Ibrahim, M.F., Idris, J., Hassan, M.A., Bahrin, E.K., Jalani, N.F., Abdul Wafti, N.S. and Abd-Aziz, S. (2018) Carbonisation-activation of oil palm kernel shell into activated carbon and methylene blue adsorption kinetics. *Journal of Palm Oil Research*. 30(3): 495-502.

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.

Conference/Workshop/Seminar

1. Co-chairman. Asian Federation of Biotechnology Malaysia Chapter International Symposium. 18-21 August 2018. Kuching, Sarawak, Malaysia
2. Invited presenter. Summer Forum 2018. 22-24 August 2018. Songdo, Incheon, Korea.
3. Invited speaker. Korean-Asian Joint Symposium 2018 on Biomass Utilization and Renewable Energy. 10-14 September 2018. Korea University, Korea.
4. Invited speaker. Workshop on Biorefinery Enzymes for Renewable Chemicals: From Discovery to Industrial Applications. 26-30 November 2018. Sirindhorn Science Home, Thailand Science Park, Pathum Thani, Thailand.
5. Invited speaker. Second International Conference on Applied Microbiology. 6-8 December 2018. Chiayi University, Taiwan.

Award

Top Research Scientist 2018 awarded by Academy Science Malaysia

EB GROUP RESEARCHER

ASSOCIATE PROFESSOR DR HIDAYAH ARIFFIN



Selected Publications (2017-2018):

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. Eksiler, K., Andou, Y., Yilmaz, F., Shirai, Y., Ariffin, H., Hassan, M.A., 2017. Dynamically controlled fibrillation under combination of ionic liquid with mechanical grinding. *J. Appl. Polym. Sci.* 134.
3. Yasim-Anuar, T.A.T., Ariffin, H., Norrrahim, M.N.F., Hassan, M.A., Tsukegi, T. and Nishida, H., 2019. Sustainable one-pot process for the production of cellulose nanofiber and polyethylene/cellulose nanofiber composites. *Journal of Cleaner Production*, 207, pp.590-599.
4. Norrrahim, M.N.F., Ariffin, H., Yasim-Anuar, T.A.T., Ghaemi, F., Hassan, M.A., Ibrahim, N.A., Ngee, J.L.H. and Yunus, W.M.Z.W., 2018. Superheated steam pretreatment of cellulose affects its electrospinnability for microfibrillated cellulose production. *Cellulose*, 25(7), pp.3853-3859.
5. Kian, L.K., Jawaid, M., Ariffin, H. and Karim, Z., 2018. Isolation and characterization of nanocrystalline cellulose from roselle-derived microcrystalline cellulose. *International journal of biological macromolecules*, 114, pp.54-63.
6. Rajaratanam, D.D., Ariffin, H., Hassan, M.A., Rahman, N.M.A.N.A. and Nishida, H., 2018. In vitro cytotoxicity of superheated steam hydrolyzed oligo ((R)-3-hydroxybutyrate-co-(R)-3-hydroxyhexanoate) and characteristics of its blend with poly (L-lactic acid) for biomaterial applications. *PLoS one*, 13(6), p.e0199742.
7. Megashah, L.N., Ariffin, H., Zakaria, M.R. and Hassan, M.A., Multi-step pretreatment as an eco-efficient pretreatment method for the production of cellulose nanofiber from oil palm empty fruit bunch.

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: 16

Citation: 769

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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)



EB GROUP RESEARCHER

ASSOCIATE PROF DR MOHD RAFEIN ZAKARIA

Specialization:

Environmental biotechnology,
Biomass valorization,
Hydrothermal pretreatment,
Polyhydroxyalkanoates

Current research interest:

Biomass valorization in biorefinery
concept

h-index: 13

Citation: 435

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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, N., Zakaria, M., Mohd Yusoff, M., Fujimoto, S., Inoue, H., Ariffin, H., Hassan, M. and Shirai, Y., 2018. Subcritical Water-Carbon Dioxide Pretreatment of Oil Palm Mesocarp Fiber for Xylooligosaccharide and Glucose Production. *Molecules*, 23(6), p.1310.
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



Selected Publications:

1. Mohd-Nor, D., Ramli, N., Sharuddin, S.S., Hassan, M.A., Mustapha, N.A., Amran, A., Sakai, K., Shirai, Y., Maeda, T., 2018. Alcaligenaceae and Chromatiaceae as reliable bioindicators present in palm oil mill effluent final discharge treated by different biotreatment processes. *Ecol. Indic.* 95, 468-473
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. Mustapha, N.A., Hu, A., Yu, C.P., Sharuddin, S.S., Ramli, N., Shirai, Y., Maeda, T., 2018. Seeking key microorganisms for enhancing methane production in anaerobic digestion of waste sewage sludge. *Appl. Microbiol. Biotechnol.* 102, 5323-5334.
4. 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.
5. 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.
6. 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.
7. 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 (5), 506-513.

Specialization:

Microbial Biotechnology,
Environmental Microbiology

Current research interest:

Metagenomics of waste and wastewater;
Strain improvement and utilization of biomass for the production of enzymes and bio-based products

h-index: 4

Citation: 48

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Academic Qualification:

- (a) PhD (Microbial Biotechnology),
Universiti Putra Malaysia (2012)
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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.
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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.
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7. Biran, N.M., Yusoff M.Z.M., Maeda T., Zakaria M.R., Yee, L-N & Hassan M.A., (2018). Triple knockout of frdC gltA and pta genes enhanced PHA production in escherichia coli. Asia-Pacific Journal of Molecular Biology and Biotechnology. 26. 11-18.

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2. Nur Fatin Athirah Ahmad Rizal, Mohamad Faizal Ibrahim*, Mohd Rafein Zakaria, Ezyana Kamal Bahrin, Suraini Abd-Aziz, Mohd Ali Hassan. Combination of superheated steam with laccase pretreatment together with size reduction to enhance enzymatic hydrolysis of oil palm biomass. *Molecules*, 2018, 23(4):811.
3. Nahrul Hayawin Zainal, Astimar Abdul Aziz, Juferi Idris, Nor Faizah Jalani, Ropandi Mamat, Mohamad Faizal Ibrahim, Mohd Ali Hassan, Suraini Abd-Aziz* (2018). Reduction of POME final discharge residual using activated bioadsorbent from oil palm kernel shell. *Journal of Cleaner Production*, 182, 830-837.
4. Ibrahim, Mohamad Faizal, Norhayati Ramli, Ezyana Kamal Bahrin, and Suraini Abd-Aziz* (2017). Cellulosic biobutanol by Clostridia: Challenges and improvements. *Renewable and Sustainable Energy Reviews*, 79: 1241-1254.
5. Mohamad Faizal Ibrahim*, Suraini Abd-Aziz, Mohd Ezreeza Mohamed Yusoff, Lai Yee Phang, Mohd Ali Hassan (2015). Simultaneous enzymatic saccharification and ABE fermentation using pretreated oil palm empty fruit bunch as substrate to produce butanol and hydrogen as biofuel. *Renewable Energy*, 77:447-455.

BOOK CHAPTER

Suraini Abd-Aziz*, Mohamad Faizal Ibrahim and Mohd Azwan Jenol (2018). Biological pretreatment of lignocellulosic biomass for volatile fatty acid production in *Emerging Areas in Bioengineering: Advanced Biotechnology (Volume 7)*, Wiley VCN, Weinheim, pp: 191-202.

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2. Keynote Speaker. International Meeting Collaboration Technologies 2018 (IMCT 2018) on Sustainability Green Technology. Anyer Resort, Banten, Indonesia. November 2018.
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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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5. Zulkarnain, A., Bahrin, E.K., Ramli, N., Phang, L.Y., Abd-Aziz, S., 2018. Alkaline Hydrolysate of Oil Palm Empty Fruit Bunch as Potential Substrate for Biovanillin Production via Two-Step Bioconversion. *Waste and Biomass Valorization* 9, 13–23.
6. Md Razali, N. A. A., Ibrahim, M. F., Bahrin, E. K., & Abd-Aziz, S. 2018. Optimisation of simultaneous saccharification and fermentation (SSF) for biobutanol production using pretreated oil palm empty fruit bunch. *Molecules*, 23(8).

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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.
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5. Roslan, A.M., M.A. Hassan Shirai, Y., 2016. Superheated steam as a cheap and appropriate treatment to improve fermentable biosugars yield from oil palm frond petiole. *Sejong University-UPM Biotechnology Joint Symposium, Sejong University, Korea.*
6. Nabilah-Jansar, K., Roslan, A.M. and Hassan, M.A., 2018. Appropriate Hydrothermal Pretreatment of Oil Palm Biomass in Palm Oil Mill. *Pertanika Journal of Scholarly Research Reviews*, 4(1).
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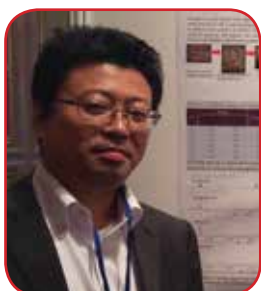
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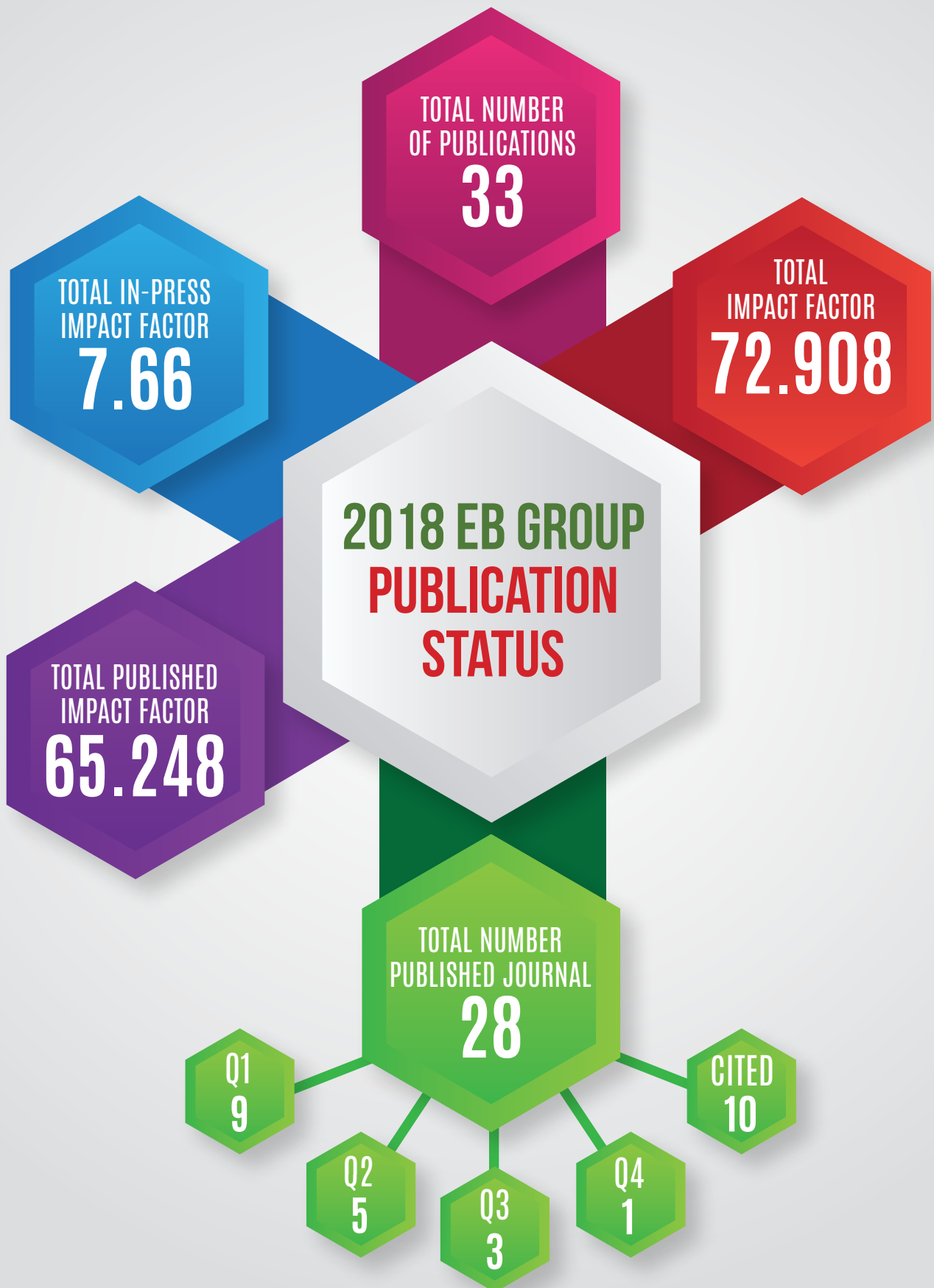


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PUBLICATIONS





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Renewable and Sustainable Energy Reviews

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Advanced bioprocessing strategies for biobutanol production from biomass

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Biobutanol
Consolidated bioprocessing
Simultaneous saccharification fermentation
Clostridium

ABSTRACT

Biobutanol production as a renewable and sustainable biofuel is gaining interest in replacing non-renewable and depleting petrol fuel. In addition to its superior characteristics over bioethanol as a fuel in transportation, butanol is also in demand as a chemical substituent for various industries. Therefore, many researchers have investigated to produce biobutanol at a low cost by considering suitable feedstock material and bioprocessing technologies. Renewable materials such as starch, lignocellulosic, and algal biomass are some of the common feedstock utilized for biobutanol production, and each of them has its own advantages. The limitations of the conventional batch fermentation have been overcome by several fermentation operations and integrated bioprocessing technologies, which had improved biobutanol production efficiency. The success of fermenting biomass into biobutanol relies on the suitability of fermentation operation to correlate with the microbial behavior together with bioprocessing strategies in order to improve the whole process to be viable for industrial scale. Therefore, this review discusses the bioprocessing technologies and suitable strategies that have endeavored to enhance biobutanol production from renewable biomass.



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Sustainable one-pot process for the production of cellulose nanofiber and polyethylene / cellulose nanofiber composites

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ABSTRACT

Conventional cellulose-based nanocomposites production requires two separate unit operations for the processing: (i) cellulose nanofibrillation unit, and (ii) polymer nanocomposites compounding unit. This two-unit process could be less efficient in terms of energy usage and material handling compared to a one-unit process. Moreover, the present of downtime in between the two steps may affect the overall productivity of the product. In this study, a one-pot process was adapted for nanofibrillation of oil palm mesocarp fiber (OPMF) cellulose and subsequently compounding of the cellulose nanofiber (CNF) with polyethylene (PE) for composites making. Both of these steps were conducted in an extruder with specially-designed twin screw, to allow nanofibrillation and compounding to occur in the same unit. It was interesting to note that CNF produced had diameter range of 80–100 nm, with an aspect ratio of 260. These superior physical properties have led to the excellent mechanical properties of the PE/OPMF-CNF nanocomposites, whereby PE/OPMF-CNF (3 wt%) recorded an increment of 57 and 198% for tensile strength and flexural strength, respectively, compared to the neat PE. Homogeneous dispersion of CNF in the PE matrix was also observed, suggesting the suitability of the one-pot processing method for cellulose-based nanocomposites production. Overall performance of the nanocomposites was similar to that prepared in a two-pot process; with the one-pot process was almost doubled in the productivity

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Reduction of POME final discharge residual using activated bioadsorbent from oil palm kernel shell



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Keywords:

Carbonisation-activation

Oil palm kernel shell

Activated carbon

Steam

Bioadsorbent

ABSTRACT

A double insulated carbonisation-activation reactor was developed in order to produce activated carbon with high yield and surface area. This reactor was double insulated using low cement castable and covered around the internal space of the reactor with stainless steel plated and fibre glass jacketed heat insulation layer, which allow efficient heat transfer into the bed of material in the reactor. The carbonisation of oil palm kernel shell (OPKS) at 400 °C, followed by steam activation at 500–1000 °C continuously in the same reactor, with steam flow rate of 12.80–18.17 L/min had improved the activated carbon surface area from 305 ± 10.2 m²/g to 935 ± 36.7 m²/g and gave a high yield of 30% within 7 h retention time with a low gaseous emission. The activated carbon produced was successfully applied as bio-adsorbent for the treatment of POME final discharge with the reduction of TSS, COD, colour and BOD up to 90%, 68%, 97% and 83%, respectively which met the standard set by Department of Environment Malaysia (DOE).

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IMPACT FACTOR: 4.908 (Q1)



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Full Length Article

Kinetic and thermodynamic of heterogeneously K₃PO₄/AC-catalysed transesterification via pseudo-first order mechanism and Eyring-Polanyi equation



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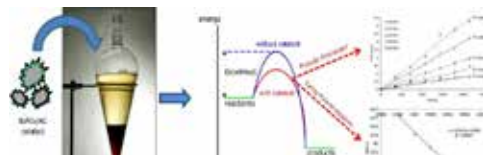
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Alcaligenaceae and *Chromatiaceae* as reliable bioindicators present in palm oil mill effluent final discharge treated by different biotreatment processes



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ARTICLE INFO

Keywords:
Palm oil mill effluent
Bioindicator
Final discharge
River pollution
Biotreatment

ABSTRACT

This study was undertaken to confirm the reliability of the proposed potential bioindicators, *Alcaligenaceae* and *Chromatiaceae* to specifically indicate contamination in river water by palm oil mill effluent (POME) final discharge. The use of bioindicators could assist in determining the specific cause of contamination in water bodies. *Alcaligenaceae* and *Chromatiaceae* were shown by a previous study to be present in river water contaminated with the final discharge from the treatment of POME. In the present study, the compositions of the bacterial communities in the POME final discharge obtained from four different palm oil mills which used different biotreatments of POME were elucidated using high-throughput MiSeq. The four POME final discharges studied showed different species richness and evenness among them. However, the bacterial community compositions in the different final discharges exhibited almost similar patterns in that the phylum *Proteobacteria* was dominant in all the samples. The proposed bioindicators, the *Alcaligenaceae* and *Chromatiaceae* families, were found to be present in all the four final discharges despite the different characteristics of the mills and the different biotreatment processes used by them. These bioindicators were also strongly and positively correlated with the biochemical oxygen demand (BOD₅) concentration. This makes them reliable bacterial indicators to detect the presence of POME final discharge in river water.



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Dr. Norhayati Ramli
Group Researcher

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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



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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 (BOD₅) 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 serve 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 trophic 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.

Hidayah Ariffin
Group Researcher



International Journal of Biological Macromolecules 114 (2018) 54–63



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Isolation and characterization of nanocrystalline cellulose from roselle-derived microcrystalline cellulose

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ABSTRACT

Roselle fiber is a renewable and sustainable agricultural waste enriched with cellulose polysaccharides. The isolation of Nanocrystalline cellulose (NCC) from roselle-derived microcrystalline cellulose (MCC) is an alternative approach to recover the agricultural roselle plant residue. In the present study, acid hydrolysis with different reaction time was carried out to degrade the roselle-derived MCC to form NCC. The characterizations of isolated NCC were conducted through Fourier Transform Infrared Ray (FTIR), Transmission Electron Microscopy (TEM), Field Emission Scanning Electron Microscopy (FESEM), Atomic Force Microscopy (AFM), Dynamic Light Scattering (DLS), Energy Dispersive Spectroscopy (EDS), X-ray Diffraction (XRD), Thermogravimetric Analysis (TGA) and Differential Scanning Calorimetry (DSC). As evaluated from the performed morphological investigations, the needle-like shape NCC nanostructures were observed under TEM and AFM microscopy studies, while irregular rod-like shape of NCC was observed under FESEM analysis. With 60 min hydrolysis time, XRD analysis demonstrated the highest NCC crystallinity degree with 79.5%. In thermal analysis by TGA and DSC, the shorter hydrolysis time tended to produce NCC with higher thermal stability. Thus, the isolated NCC from roselle-derived MCC has high potential to be used in application of pharmaceutical and biomedical fields for nanocomposite fabrication.

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PhD Student



Cellulose (2018) 25:3853–3859

<https://doi.org/10.1007/s10570-018-1859-3>



CrossMark

ORIGINAL PAPER

Superheated steam pretreatment of cellulose affects its electrospinnability for microfibrillated cellulose production

Mohd Nor Faiz Norrrahim · Hidayah Ariffin · Tengku Arisyah Tengku Yasim-Anuar · Ferial Ghaemi · Mohd Ali Hassan · Nor Azowa Ibrahim · Janet Lim Hong Ngee · Wan Md Zin Wan Yunus

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Abstract In this study, oil palm mesocarp fiber (OPMF) was pretreated with (1) superheated steam (SHS) and (2) potassium hydroxide (KOH) to remove hemicellulose. Both SHS-OPMF and KOH-OPMF underwent delignification step to isolate the cellulose and dissolved in selected ionic liquid and its co-solvent before being electrospun to obtain microfibrillated cellulose (MFC). FE-SEM images showed that SHS-OPMF cellulose produced discontinuous MFC fiber with diameter ranging from 100 to 500 nm, of

with sizes larger than 200 nm. The differences in fiber size and continuity of fiber produced were due to incomplete removal of hemicellulose from SHS-OPMF sample that inhibited fiber re-coalescence and resulted in interruption in fiber formation.

Keywords Microfibrillated cellulose · Hemicellulose · Superheated steam · Electrospinning



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Dr. Norhayati Ramli
Group Researcher

Applied Microbiology and Biotechnology
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ENVIRONMENTAL BIOTECHNOLOGY



Seeking key microorganisms for enhancing methane production in anaerobic digestion of waste sewage sludge

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Abstract

Efficient approaches for the utilization of waste sewage sludge have been widely studied. One of them is to use it for the bioenergy production, specifically methane gas which is well-known to be driven by complex bacterial interactions during the anaerobic digestion process. Therefore, it is important to understand not only microorganisms for producing methane but also those for controlling or regulating the process. In this study, azithromycin analogs belonging to macrolide, ketolide, and lincosamide groups were applied to investigate the mechanisms and dynamics of bacterial community in waste sewage sludge for methane production. The stages of anaerobic digestion process were evaluated by measuring the production of intermediate substrates, such as protease activity, organic acids, the quantification of bacteria and archaea, and its community dynamics. All azithromycin analogs used in this study achieved a high methane production compared to the control sample without any antibiotic due to the efficient hydrolysis process and the presence of important fermentative bacteria and archaea responsible in the methanogenesis stage. The key microorganisms contributing to the methane production may be *Clostridia*, *Cladilinea*, *Planctomycetes*, and *Alphaproteobacteria* as an accelerator whereas *Nitrosomonadaceae* and *Nitrospiraceae* may be suppressors for methane production. In conclusion, the utilization of antibiotic analogs of macrolide, ketolide, and lincosamide groups has a promising ability in finding the essential microorganisms and improving the methane production using waste sewage sludge.

Keywords Macrolide · Ketolide · Lincosamide · Sewage sludge · Methane · Microbial community



IMPACT FACTOR: 3.098 (Q2)

PUBLISHED

Nur Fatin Athirah Ahmad Rizal
Master Student



Article

Combination of Superheated Steam with Laccase Pretreatment Together with Size Reduction to Enhance Enzymatic Hydrolysis of Oil Palm Biomass

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Abstract: The combination of superheated steam (SHS) with ligninolytic enzyme laccase pretreatment together with size reduction was conducted in order to enhance the enzymatic hydrolysis of oil palm biomass into glucose. The oil palm empty fruit bunch (OPEFB) and oil palm mesocarp fiber (OPMF) were pretreated with SHS and ground using a hammer mill to sizes of 2, 1, 0.5 and 0.25 mm before pretreatment using laccase to remove lignin. This study showed that reduction of size from raw to 0.25 mm plays important role in lignin degradation by laccase that removed 38.7% and 39.6% of the lignin from OPEFB and OPMF, respectively. The subsequent saccharification process of these pretreated OPEFB and OPMF generates glucose yields of 71.5% and 63.0%, which represent a 4.6 and 4.8-fold increase, respectively, as compared to untreated samples. This study showed that the combination of SHS with laccase pretreatment together with size reduction could enhance the glucose yield.

Keywords: oil palm biomass; physical pretreatment; biological pretreatment; lignin removal; lignocellulosic biomass

PUBLISHED


IMPACT FACTOR: 3.098 (Q2)

Nur Fatin Athirah Ahmad Rizal
Master Student



Review

Pre-treatment of Oil Palm Biomass for Fermentable Sugars Production

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Abstract: Malaysia is the second largest palm oil producer in the world and this industry generates more than 80 million tonnes of biomass every year. When considering the potential of this biomass to be used as a fermentation feedstock, many studies have been conducted to develop a complete process for sugar production. One of the essential processes is the pre-treatment to modify the lignocellulosic components by altering the structural arrangement and/or removing lignin component to expose the internal structure of cellulose and hemicellulose for cellulases to digest it into sugars. Each of the pre-treatment processes that were developed has their own advantages and disadvantages, which are reviewed in this study.

Keywords: lignocellulosic biomass; fermentation; pre-treatment; palm oil process flow

PUBLISHED



IMPACT FACTOR: 3.098 (Q2)

Norlailiza Ahmad
Master Student



Article

Subcritical Water-Carbon Dioxide Pretreatment of Oil Palm Mesocarp Fiber for Xylooligosaccharide and Glucose Production

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Abstract: The present work aimed to investigate the pretreatment of oil palm mesocarp fiber (OPMF) in subcritical H₂O-CO₂ at a temperature range from 150–200 °C and 20–180 min with CO₂ pressure from 3–5 MPa. The pretreated solids and liquids from this process were separated by filtration and characterized. Xylooligosaccharides (XOs), sugar monomers, acids, furans and phenols in the pretreated liquids were analyzed by using HPLC. XOs with a degree of polymerization X2–X4



IMPACT FACTOR: 3.098 (Q2)

PUBLISHED

Nur Atheera Aiza Md Razali
Master Student



Article

Optimisation of Simultaneous Saccharification and Fermentation (SSF) for Biobutanol Production Using Pretreated Oil Palm Empty Fruit Bunch

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Abstract: This study was conducted in order to optimise simultaneous saccharification and fermentation (SSF) for biobutanol production from a pretreated oil palm empty fruit bunch (OPEFB) by *Clostridium acetobutylicum* ATCC 824. Temperature, initial pH, cellulase loading and substrate concentration were screened using one factor at a time (OFAT) and further statistically optimised by central composite design (CCD) using the response surface methodology (RSM) approach. Approximately 2.47 g/L of biobutanol concentration and 0.10 g/g of biobutanol yield were obtained after being screened through OFAT with 29.55% increment (1.42 fold). The optimised conditions for SSF after CCD were: temperature of 35 °C, initial pH of 5.5, cellulase loading of 15 FPU/g-substrate and substrate concentration of 5% (w/v). This optimisation study resulted in 55.95% increment (2.14 fold) of biobutanol concentration equivalent to 3.97 g/L and biobutanol yield of 0.16 g/g. The model and optimisation design obtained from this study are important for further improvement



IMPACT FACTOR: 2.766 (Q1)

PUBLISHED

Assoc. Prof. Dr. Hidayah Ariffin
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RESEARCH ARTICLE

In vitro cytotoxicity of superheated steam hydrolyzed oligo((R)-3-hydroxybutyrate-co-(R)-3-hydroxyhexanoate) and characteristics of its blend with poly(L-lactic acid) for biomaterial applications

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Abstract

In order to clarify the *in vitro* cytotoxicity effect of superheated steam (SHS) treated poly((R)-3-hydroxybutyrate-co-(R)-3-hydroxyhexanoate) (PHBHHx) for biomaterial applications, SHS-treated PHBHHx oligoester samples: P(HB-co-6%-HHx) and P(HB-co-11%-HHx) with low and high percentages of unsaturated chain ends were evaluated for their cytotoxicity effects toward the growth of mouse fibroblast cell line NIH 3T3. From the results obtained after 24 and 48 h of the growth test, the SHS-treated PHBHHx oligoesters were found to be nontoxic to the growth of mouse fibroblast NIH 3T3 cell line with cell viability percentages of more than 95%. In order to serve as a potential resorbable medical suture, PHBHHx oligoesters were blended with poly(L-lactic acid) (PLLA) with a weight ratio of PHBHHx oligoester/

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IMPACT FACTOR: 1.874 (Q3)

Prof. Dr. Suraini Abd-Aziz
Group Researcher



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<https://doi.org/10.1007/s12649-016-9745-4>



ORIGINAL PAPER

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

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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 com-

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

PUBLISHED

IMPACT FACTOR: 1.874 (Q3)

Prof. Dr. Suraini Abd-Aziz
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DOI 10.1007/s12649-017-9838-8



ORIGINAL PAPER

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

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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 with-

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



IMPACT FACTOR: 1.497 (Q3)

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Dr. Mohd Zulkhairi Mohd Yusoff
Group Researcher

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ORIGINAL ARTICLE



Pseudogene product YqiG is important for *pfkB* expression and biohydrogen production in *Escherichia coli* BW25113

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Abstract

Pseudogenes in the *Escherichia coli* genome are assumed to be non-functional. In this study, Keio collection BW25113Δ*yqiG* and YqiG-producing strain (BW25113/pCA24N-YqiG) were used to evaluate the importance of pseudogene *yqiG* in hydrogen metabolism. Our results show pseudogene protein YqiG was identified as an essential protein in the production of biohydrogen from glucose. The mutant *yqiG* decreased biohydrogen production from 37 μmol mg⁻¹ protein to 6 μmol mg⁻¹ protein compared to the wild-type strain, and glucose consumption was reduced by 80%. Through transcriptional analysis, we found that the *yqiG* mutation represses *pfkB* transcription tenfold; *pfkB* encodes pyruvate-formate lyase, one of the key enzymes in the anaerobic metabolism of *E. coli*. Moreover, production of YqiG stimulated glycolysis and increased biohydrogen productivity 1.5-fold compared to that of the wild-type strain. Thus, YqiG is important for the central glycolysis reaction and is able to influence hydrogen metabolism activity in *E. coli*.

Keywords *Escherichia coli* · Biohydrogen · Pseudogene · Pyruvate-formate lyase (PflB) · YqiG

Introduction

and protein engineering for enhancing hydrogen production (Maeda et al. 2008; Sanchez-Torres et al. 2009). However,



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Nahrul Hayawin Zainal
PhD Student

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DOI: <https://doi.org/10.21894/jopr.2018.0039>

CARBONISATION-ACTIVATION OF OIL PALM KERNEL SHELL TO PRODUCE ACTIVATED CARBON AND METHYLENE BLUE ADSORPTION KINETICS

NAHRUL HAYAWIN ZAINAL*; ASTIMAR ABDUL AZIZ*; MOHAMAD FAIZAL IBRAHIM**; JUFERI IDRIS*; MOHD ALI HASSAN**; EZYANA KAMAL BAHRIN**; NOR FAIZAH JALANI*; NUR SULIHATIMARSYILA ABDUL WAFTI* and SURAINI ABD-AZIZ**

ABSTRACT

The carbonisation-activation system was developed to produce activated carbon from oil palm kernel shell (OPKS). The OPKS was carbonised at 500°C for 3 hr in an electric vertical reactor followed by steaming at 700°C for another 3 hr in the same reactor. The process showed significant results with a high activated carbon yield of 32%, high fixed carbon content of 88.6% with Brunauer-Emmett-Teller (BET) surface area of 305.67 m² g⁻¹. The OPKS-activated carbon was further tested to remove methylene blue. It could adsorb up to 99.7% of methylene blue using only 0.6 g litre⁻¹ dosage of OPKS-activated carbon, for 24 hr of treatment time. The results have been correlated in the Freundlich isotherm which was well fitted to the experimental data over the methylene blue experimental concentration range with correlation coefficients of R²=0.992.

Keywords: oil palm kernel shell, carbonisation-activation, bioadsorbent, activated carbon.

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Khairiatul Nabilah Jansar
Master Student



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Review Article: Appropriate Hydrothermal Pretreatment of Oil Palm Biomass in Palm Oil Mill

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Abstract – Oil palm (*Elaeis guineensis* Jacq.) is one of the most planted trees in Malaysia for the palm oil production. Thus, solid biomass had been generated from this industry such as empty fruit bunch, shell, mesocarp fibre, frond and trunk produced that causes problematic to the nation and expected to escalate up to 85-110 million tonnes by 2020. Besides that, palm oil mill effluent and excessive steam also generated from the production of palm oil. *In situ* hydrothermal pretreatment means the utilisation of excessive steam produced by the oil palm mill and at the same time, generating value added product as well as reducing the biomass. Oil palm biomass is rich in lignocellulosic materials which comprised of lignin, hemicellulose and cellulose. Refinement of lignocellulosic from oil palm biomass can be utilised to form fermentable sugar, bioethanol and other potential chemicals. Recalcitrant property of lignocellulosic reduces the ability of enzymes to penetrate, thus pretreatment is required prior to

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Periodic addition of anaerobic sludge enhanced the lignocellulosic degradation rate during co-composting of oil palm biomass

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Abstract. The main objective of this work was to investigate the effects of the controlled periodic addition of anaerobic sludge during composting to increase amount of microbial DNA, which appears to be correlated to soluble sugar content which may relate to rate of lignocellulosic degradation. In this study, the composting of pressed-shredded oil palm empty fruit bunch with the periodic addition of palm oil mill effluent anaerobic sludge for moisture control in a newly designed in-vessel type composter was carried out. A control experiment was also conducted over the same period but with the periodic addition



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Multi-step pretreatment as an eco-efficient pretreatment method for the production of cellulose nanofiber from oil palm empty fruit bunch

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Abstract. Cellulose nanofiber (CNF) characteristics could be influenced by the pretreatment process during cellulose isolation, and generally pretreatment is conducted using harsh, less eco-efficiency chemical pretreatment. In this study, multi-step pretreatment method was evaluated for its eco-efficiency and compared with the conventional soda pulping method for cellulose isolation from oil palm empty fruit bunch (OPEFB). CNF developed from the celluloses pretreated by these methods were characterized. Some amount of hemicellulose residue left after the pretreatments whereby multi-step method showed higher amount of hemicellulose residue. This affected the diameter size of CNF obtained in which CNF from multi-step pretreated cellulose had smaller diameter range (13-33 nm) compared to that of soda pulping (18-52 nm). Crystallinity, thermal stability and degree of polymerization of the two CNFs are comparable. The superior characteristics of CNF obtained from multi-step pretreatment method, in addition to its eco-efficiency characteristic as evaluated based on the two key elements of eco-efficiency.



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CITED

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Environmental performance of bioethanol production from oil palm frond petiole sugars in an integrated palm biomass biorefinery.

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Characteristics of cellulose from oil palm mesocarp fibres extracted by multi-step pretreatment methods

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Abstract. Characteristics of cellulose isolated from oil palm mesocarp fiber (OPMF) using multi-step pretreatment methods were determined in this study. It was postulated that the succession of pretreatment steps for cellulose extraction from lignocellulosic biomass may affect the cellulose properties. Pretreatment steps involved in cellulose extraction were

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Properties of Cellulose Extract from Different Types of Oil Palm Biomass

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Abstract. This study focuses on the characteristics of cellulose extracts from different oil palm biomass namely oil palm mesocarp fiber (OPMF), oil palm empty fruit bunch (OPEFB) and oil palm frond (OPF). Cellulose was obtained from these biomass through soda pulping process followed by a totally chlorine free (TCF) bleaching step using peracetic acid solution. It was found that the cellulose extract for OPMF, OPEFB and OPF had 88.8%, 93.0% and 94.6% purity. Further analyses on the properties of cellulose in terms of morphology, thermal stability and crystallinity



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CITED

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One-pot nanofibrillation of cellulose and nanocomposite production in a twin-screw extruder

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The Wood and Biofiber International Conference (WOBIC 2017) IOP Publishing
IOP Conf. Series: Materials Science and Engineering **368** (2018) 012033 doi:10.1088/1757-899X/368/1/012033

Characterization of cellulose nanofiber from oil palm mesocarp fiber produced by ultrasonication

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Abstract. Oil palm mesocarp fibre (OPMF) is one of the major biomass generated from palm oil industry and it is currently inefficiently burnt at palm oil mill for energy and as a mean of disposal. With the growing concern on environmental sustainability and finite supply of non-renewable resources, particular attention has been given to produce value-added materials from OPMF, such as biocomposite and biocompost. Since OPMF contains mainly cellulose, there is high potential for the production of cellulose nanofiber (CNF) from OPMF. In this study, cellulose was obtained from OPMF by chemical extraction. OPMF-cellulose obtained was then

CITED

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Start-up treatment of palm oil mill effluent (POME) final discharge using Napier Grass in wetland system

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Abstract. Average of about 53 million m³ POME is being produced yearly in Malaysia. The

CITED

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ICAMME 2017 IOP Publishing
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Physical properties of coir and pineapple leaf fibre reinforced polylactic acid hybrid composites

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Abstract. This study examined the physical behaviour of Coir fibres (CF) /Pineapple leaf fibres (PALF) /Poly lactic acid (PLA) composites. In this research, coir and PALF reinforced PLA hybrid composites were fabricated by hand lay-up process and hot press. The aim of this



Impact Factor: 3.553 (Q3)

IN-PRESS

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IN THE FIELD

Energy Science & Engineering

Simultaneous saccharification and fermentation of sago hampas into biobutanol by *Clostridium acetobutylicum* ATCC 824

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Funding information: Fundamental Research Grant Scheme

Abstract

Simultaneous saccharification and fermentation (SSF) by *Clostridium acetobutylicum* ATCC 824 was conducted to produce biobutanol from sago hampas. Sago hampas is a waste generated from the processing of sago starch. This waste is composed of 54.6% starch and 31.7% of cellulose and hemicellulose, with only 3.3% of lignin. In order to fully utilize the starch and cellulosic materials, saccharification using a mixture of amylase (Dextrozyme) and cellulase (Acremonium cellulase) was conducted using 0.09 g/mL sago hampas, producing 67.0 g/L of fermentable sugar. The SSF and delayed SSF (DSSF) were conducted using 0.07 g/mL sago hampas with the optimized enzyme loading of Dextrozyme amylase (71.4 U/g_{substrate}) and Acremonium cellulase (20 FPU/g_{substrate}). The SSF of sago hampas generated 6.12 g/L of solvents with biobutanol concentration of 3.81 g/L and the yield of 0.11 g-biobutanol/g-sugar. In order to improve biobutanol concentration and productivity, DSSF was introduced. In DSSF, the inoculum was introduced into the system after 24 hour of fer-



Impact Factor: 2.476 (Q2)

IN-PRESS

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Microbes Environ. Vol. 00, No. 0, 000-000, 2019
<https://www.jstage.jst.go.jp/browse/jsme2> doi:10.1264/jsme2.ME18104



Dynamics of Microbial Populations Responsible for Biodegradation during the Full-Scale Treatment of Palm Oil Mill Effluent

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Despite efforts to address the composition of the microbial community during the anaerobic treatment of palm oil mill effluent (POME), its composition in relation to biodegradation in the full-scale treatment system has not yet been extensively examined. Therefore, a thorough analysis of bacterial and archaeal communities was performed in the present study using MiSeq sequencing at the different stages of the POME treatment, which comprised anaerobic as well as facultative anaerobic and aerobic processes, including the mixed raw effluent (MRE), mixing pond, holding tank, and final discharge phases. Based on the results obtained, the following biodegradation processes were suggested to occur at the different treatment stages: (1) *Lactobacillaceae* (35.9%) dominated the first stage, which contributed to high lactic acid production; (2) the higher population of *Clostridiaceae* in the mixing pond (47.7%) and *Prevotellaceae* in the holding tank (49.7%) promoted acetic acid production; (3) the aceticlastic methanogen *Methanosaeataceae* (0.6–0.8%) played a role in acetic acid degradation in the open digester and closed reactor for methane generation; (4) *Syntrophomonas* (21.5–29.2%) appeared to be involved in the degradation of fatty acids and acetic acid by syntrophic cooperation with the hydrogenotrophic methanogen, *Methanobacteriaceae* (0.6–1.3%); and (5) the phenols and alcohols detected in the early phases, but not in the final discharge phase, indicated the successful degradation of lignocellulosic materials. The present results contribute to a better understanding of the biodegradation mechanisms involved in the different stages of the full-scale treatment of POME.

Key words: bacterial community, methanogenic archaea, palm oil mill effluent, biodegradation, wastewater treatment

EB GROUP ATTACHMENT 2018 (OUTBOUND)

Participants	Program	Research Theme	Host/Location	Duration	Sponsor
Nur Sharmila Sharip	JASSO	Nanocellulose Composite	Kyutech	4 months	JASSO
Izza Nadira Abu Bakar	Research Attachment	Bioactive Compounds in Pegaga (<i>Centella asiatica</i> L.)	Chulalongkorn University	3 Months	UPM
Nur Aina Natasha bt Mohd Asmadi	Sakura Science Programme	Biosurfactant	Kyutech	2 weeks	Sakura Science Programme
Noor Shaidatul Lyana bt Mohamad Zainal	Sakura Science Programme	Bacterial Community	Kyutech	3 weeks	Sakura Science Programme
Nurhasliza bt Zolkefli	JASSO	Molecular Indicator	Kyutech	2 months	JASSO

EB GROUP ATTACHMENT 2018 (INBOUND)

Participants	Program	Research Theme	Host/Location	Duration	Sponsor
Mahathir Nur Muhamad	Attachment	Biomass and Bioenergy	Biorefinery Complex	1 month	NONE
Nada Zulmy Mayora	Attachment	Biomass and Bioenergy	Biorefinery Complex	1 month	NONE
Reno Susanto	Attachment	Biomass and Bioenergy	Biorefinery Complex	1 month	NONE
Yasinta Lola	Attachment	Biomass and Bioenergy	Biorefinery Complex	1 month	NONE
Nadhela Fahira Faradisha	Attachment	Biomass and Bioenergy	Biorefinery Complex	1 month	NONE
Kazuo Yamamoto	Mobility Exchange Student	Microbial Biotechnology	Biotech UPM	1 month	KYUTECH

CONSULTANCY

Research Theme	Clients/Industrial Partner	Duration	Project Leader
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	Dr. Zulkhairi Mohd Yusoff
Start-up Co-composting of Palm Oil Empty Fruit Bunch and Palm Oil Mill Effluent Anaerobic Sludge in Semi Commercial Plant	Kemaman Palm Oil Mill	Sept 2017 - March 2018	Assoc. Prof. Mohd Rafein Zakaria
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	Prof. Dr. Suraini Abd. Aziz
Research Study on the Acceleration of Composting Process from Spent Rice Huck with Chicken Manure	Novozymes Malaysia Sdn Bhd	February 2018 - May 2019	Dr. Ahmad Muhaimin Roslan
The Future of Renewable Energy and Palm Oil Industry in Malaysia	Mitsubishi Heavy Industries Asia Pacific PTE. LTD.	June 2018 - June 2019	Assoc. Prof. Dr. Hidayah Ariffin
Collaborative Research on The Use of Hydrothermal Carbonization Technology for Treatment of Oil Palm Biomass to be Used in Composting: Part 1-Preliminary Study	Mitsubishi Heavy Industries Asia Pacific PTE. LTD.	November 2018 – November 2019	Assoc. Prof. Dr. Hidayah Ariffin

AWARD



Prof. Dr Mohd Ali Hassan received Akademia Putra Special Award during Majlis Gemilang Akademia Putra (MGAP) 2017, Universiti Putra Malaysia (UPM)



Dr. Nahrul Hayawin Zainal received Gold Medal MVP Doctor of Philosophy Award 2018 during 42th UPM Convocation Ceremony



Prof. Dr Suriani Abd. Aziz received the Top Research Scientists Malaysia (TRSM) Awards 2018 from Academy Science of Malaysia



Prof. Datuk Dr. Mohd Ali Hassan received Anugerah Darjah Kebesaran Datuk Paduka Mahkota Selangor (DPMS) during Hari Keputeraan Sultan Selangor, Sultan Sharafuddin Idris Shah Ke-73

NEWSPAPER CUTTING

Acknowledgements Received

18 **Mega sains** f mega sains dan teknologi

Saintis UPM cemerlang penyelidikan biomas

Oleh AQILAH MIOR KAMARULRAID
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SUMBANGAN yang tidak ternilai selama 37 tahun dalam bidang bioteknologi alam sekitar dan biomas termasuk menghasilkan pelbagai penyelidikan serta penerangan menjadi faktor utama Ketua Unit Saringan Industri dan Masyarakat, Fakulti Bioteknologi dan Sains Molekul, Universiti Putra Malaysia (UPM), Prof. Dr. Mohd. Ali Hassan merangkul anugerah utama, Anugerah Kelas Akademia Putra 2017 anjuran



SULTAN SHARAFUDDIN IDRIS



DR. MOHD. ALI HASSAN

dari 2011 hingga 2014 selain merupakan Naib Presiden, Persekutuan Bioteknologi Asia (AFOB) dan juga Presiden AFOB Cawangan Malaysia sejak 2014.

Lebih meribunkan, Mohd. Ali Hassan menerbitkan lebih daripada 180 kertas kerja dalam jurnal berimpak Scopus dan mempunyai tujuh paten.

Ketukahan beliau mendapat pengiktirafan antarabangsa melalui Anugerah Pertukaran Penyelidikan dari Persekutuan Bioteknologi Korea dan Bioindustri pada 2013 selain menerima Anugerah Saintis Penyelidikan pada 2015 dan Peto Akademi Sains Malaysia (ASM).

Pada tahun lalu, beliau menerima dua anugerah lain iaitu Anugerah Malaysia Bioteknologi 2017 dan Anugerah Bintang Penyelidikan Malaysia 2017.

Pengalaman dan kepakaran beliau sebagai seorang ahli akademik membawa kepada peltantikan dalam pelbagai jawatannya akademik, penyelidikan dan pengurusan pada peringkat universiti, kebangsaan dan antarabangsa.

Dalam masa sama beliau terlibat dalam pengubalan Strategi Nasional Biomas 2020, iaitu hasil penyelidikan dan paten beliau dijadikan sebagai salah satu projek utama.

Beliau juga adalah ahli senat UPM dan Ahli Lembaga Pengarah Universiti.

Ms. 18

Selasa, 11 Disember 2018 BH

HARI KEPUTERAAN

Tengku Puan Panglima Perlis dikurnia anugerah tertinggi Selangor

Panglima ATM, Peguam Cara Negara II turut terima darjah kebesaran



Tengku Puteri Nor Zehan



Zulkifli Zainal Abidin



Siti Zubrah Amirah

Ketua Deputi Pasukan Singapura (Gala Sultan Selangor), Teo Hock Seng, Dekan Fakulti Komunikasi HELP University, Dr. Khairuddin Othman, Ketua Pegawai Eksekutif Pendidikan dan Peragaan Kesihatan Kumpulan Sunway, Dr. Lee Weng Keng dan Pengarah Eksekutif Teknikal dan Peragamaan Nestle Philippines, Adnan Hisham Pawanter.

Oleh Norazmira Che Noh
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Klang

Tengku Puan Panglima Perlis, Tengku Puteri Nor Zehan Sultan Selangor dan Abdul Aziz Shah, menerima anugerah tertinggi Selangor, Darjah Kerabat Yang Amat Dihormati (DK) sempena Hari Keputeraan

tin Paduka Zauyah bte T Loth Khan dan Pengarah Urusan Khazanah Nasional Bhd, Datuk Shahri Ridza Ibrahim.

Darjah Kebesaran Datuk Setia Sultan Sharafuddin Idris Shah (SSIS) yang membawa gelaran Datuk Setia kepada lelaki dan Datuk

Datuk tingi lelaki dan Datuk Paduka bagi wanita.

Mereka ialah Hakim Mahkamah Tinggi Shah Alam, Datuk Mohamad Zahidin Mohd Dzak; Panglima Tentara Laut, Laksamana Datuk Mohd Reza Mohd Sany; Panglima 11 Briod ATM, Briged Jeneral Dr

teknologi dan Sains Biomolekul UPM, Prof Dr Mohd Ali Hassan.

Panglima Pasukan Khas Laut (PAKAL), Laksamana, Restoran Anuar Alias, Pengerusi Antara Holiday Villas 5dr Bhd, Tan Sri Azman Shah Datuk Haron, Ketua Eksekutif Cancer Research Malay

UPM staff get top science awards

EDUCATION

Sunday, 4 Nov 2018



FIVE scientists and researchers from Universiti Putra Malaysia (UPM) have been chosen to receive the Top Research Scientists Malaysia (TRSM) Awards 2018 while four more were selected as Academy of Sciences Malaysia (ASM) fellows.

They received their awards from Prime Minister Tun Dr Mahathir Mohamad at a ceremony on Thursday, said UPM in a statement.



Balai Rungseri



NEWSPAPER CUTTING

Nanocellulose From Oil Palm



Nanoselulosa mesra alam, boleh diperbaharui

Sekumpulan penyelidik dari UPM telah menghasilkan nanoselulosa daripada biomass sawit yang dapat meringkaskan ciri ketahanan sesuatu produk.

MALAYSIA merupakan salah satu negara pengeluar vitamin E yang tertinggi di dunia. Dua tahun lalu, kawasan pertanian pokok kelapa sawit di Malaysia dianggarkan seluas 1.7 juta hektar. Derivatif jumlah penanaman pokok kelapa sawit itu, berjuta-juta meter padu biomass sawit boleh dihasilkan. Biomass sawit terdiri daripada batang pokok, pelepah dan tunas kelapa sawit yang boleh menjadi sumber alternatif untuk penghasilan produk-produk lain. Kebolehan yang ada pada biomass sawit ini telah mendorong seumpulan penyelidik dari Universiti Putra Malaysia (UPM) untuk menghasilkan nanoselulosa daripada biomass sawit. Nanoselulosa secara amnya dipaparkan sebagai bahan yang berkesan untuk meningkatkan ciri ketahanan sesuatu produk. Ketua Penyelidik, Prof. Madya, Dr. Hidayah Ariffin berkata, nanoselulosa boleh dihasilkan daripada bahan-bahan beranorganik seperti biomass tumbuhan serta kapas. Menurutnya, nanoselulosa Malaysia merupakan sebuah negara yang kaya dengan pokok kelapa sawit dan banyak biomass yang bererti daripada tumbuhan itu yang boleh digunakan di pusat-pusat pemprosesan minyak kelapa sawit maka ia berpotensi untuk menghasilkan nanoselulosa. "Nanoselulosa adalah bahan yang sangat stabil dalam persekitaran, sekali pun tidak ditapis dengan dengan aplikasinya. Ia secara semula jadi memiliki sifat yang ketahanan tinggi ke atas suhu, kelembapan, meringkaskan luas permukaan spesifik yang



berkelulus dalam suhu malar antara 100 nanometor (atau skala nanang), sama ada dari segi diameter atau panjang. Pada masa ini, teknologi nano merupakan antara teknologi terbaru dan maju secara global. Mengeksploitasi kemajuan teknologi nano dan pemrosesannya yang membolehkan membuat kepada manusia, Hidayah beranjan penyelidik yang lain telah membangunkan produk nanoselulosa daripada biomass sawit. **Produk bernilai** Penyelidikan itu bermula sejak lima tahun lalu. Selain Hidayah, penyelidik lain yang terlibat dalam kajian tersebut ialah Prof. Dr. Mohd. Ali Hassan, Mohd. Nor-Fairi Norvazirah, Tengku Arsyah Tunjung, Hasni Anwar, Lianna Noor Muzaffar, serta dua



Hidayah (kanan) bersama penyelidik yang lain berbincang tentang nanoselulosa yang dihasilkan.

CONFERENCES AND WORKSHOPS

DATE	EVENT	VENUE	PARTICIPANT
18-19/12/18	Workshop Anaerobic Digester on Food Waste 2018	TNB Renewables Sdn Bhd, Selangor	Dr. Mohd Zulkhairi Mohd Yusoff
15-16/12/18	Conference: UPM-Kyutech International Symposium of Applied Engineering and Sciences (SAES) 2018	Kyutech Tobata	Prof. Dato' Dr. Mohd Ali Hassan Assoc. Prof. Dr. Hidayah Ariffin Assoc. Prof. Dr. Mohd Rafein Zakaria Dr. Mohd Zulkhairi Mohd Yusoff Dr. Ahmad Muhaimin Roslan Dr. Norhayati Ramli Nor Farhana Aziz Ujang Liana Noor Megashah Nur Atiqah Osman
6-8/12/2018	The Second International Conference on Applied Microbiology (ICAM 2018)	National Chung Cheng University, Chiayi, Taiwan	Prof. Dr. Suraini Abd Aziz Dr. Mohamad Faizal Ibrahim
26-30/11/2018	Workshop on Biorefinery Enzymes for Renewable Chemicals: From Discovery to Industrial Applications	Thailand Science Park, Pathum Thani, Thailand	Prof. Dr. Suraini Abd Aziz Mohd Azwan Jenol
12-14/11/2018	RNA Seq Data Analysis Workshop	UMBI, PPUKM	Nurhazliza Zolkefli
25/9/2018	Workshop on Thermogravimetric-Infrared (TG-IR)	INTROP, UPM	Siti Shazra Shazleen Shamsudin
10-14/9/2018	The 12th Korea-Asean Joint Symposium 2018	Korea University, Seoul, Korea	Prof. Dr. Suraini Abd Aziz Dr. Mohamad Faizal Ibrahim
22-24/8/2018	Summer Forum 2018	Songdo, Incheon, Korea	Prof. Dr. Suraini Abd Aziz
18 - 21/08/2018	Conference: Asian Federation of Biotechnology Malaysia Chapter International Symposium (AFOBMCIS) 2018	Kuching, Sarawak	Prof. Dato' Dr. Mohd Ali Hassan Prof. Dr. Suraini Abd Aziz Dr. Mohd Zulkhairi Mohd Yusoff Dr. Mohamad Faizal Ibrahim Mohd Azwan Jenol Nur Fariza Abdul Rahman
24 - 25/07/2018	International Conference on Safe Biodegradable Packaging	Cyberjaya, Malaysia	Mohd Nor Faiz Norrrahim
16/5/2018	Workshop on Introduction to SAS for Data Science 2018	Institute of Mathematics Research, UPM	Nurhazliza Zolkefli Noor Shaidatul Lyana Mohamad Zainal
19-20/04/18	Workshop on X-Ray Diffraction	Faculty Science, UPM	Liana Noor Megashah
2018/03/29	Nanoindentation Workshop	Universiti Malaya (UM)	Nur Sharmila Sharip



UPM
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BERILMU BERBAKTI

ENVIRONMENTAL BIOTECHNOLOGY

RESEARCH GROUP



2018

EB STUDENTS

Research Summary

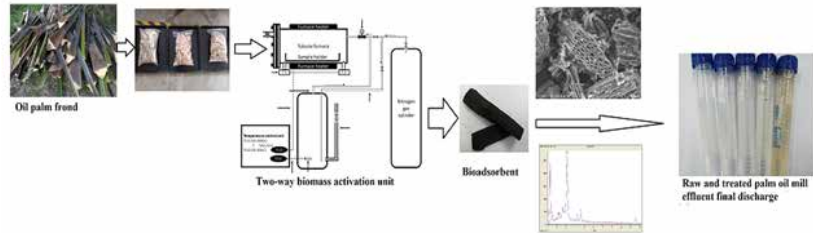


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Production and evaluation of adsorption properties of oil palm frond derived bioadsorbent for removal of organic and toxic contaminants

Adsorption is one of the simplest processes employed for wastewater purification due to the strong affinity of organic pollutants to adsorbents. Carbon-based adsorbents are the most widely employed form of sorbents and it is receiving attention due to the diverse nature of its precursors. Recently, there have been growing research interest to substitute coal with biomass as precursors for production of bioadsorbents partly due to environmental concern and cost. The extend of adsorption depends on the nature of bioadsorbent, contaminant and adsorption medium. Hence, producing bioadsorbent with adsorption properties that interact positively with target contaminant require selection of suitable biomass feedstock and optimum production process. Considering the heterogeneity of contaminants in palm oil mill effluent final discharge, this study selects oil palm frond due to its high porosity. A two-way biomass activation unit was also designed to optimize production process (Figure 1).



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Microbial community shift and their roles in biodegradation during the treatment of palm oil mill effluent

This study aimed to assess the microbial community dynamics during POME treatment and its relation to biodegradation of POME, as well as to compares the microbial community in POME final discharges from different palm oil mills. To achieve these objectives, the flow cytometry was applied to assess the functional status of bacterial community, meanwhile culture-independent approaches such as PCR-Denaturing Gradient Gel Electrophoresis (DGGE) and 16S rRNA gene sequencing on Illumina MiSeq platform were applied to assess the microbial community composition. Interestingly, the proposed bioindicators, the Alcaligenaceae and Chromatiaceae families were found to be present in all the four final discharges despite the different characteristics of the mills and the different biotreatment processes used by them.

Publications:

1. Mohd-Nor, D., Ramli, N., Sharuddin, S.S., Hassan, M.A., Mustapha, N.A., Amran, A., Sakai, K., Shirai, Y. and Maeda, T. 2018. Alcaligenaceae and Chromatiaceae as reliable bioindicators present in palm oil mill effluent final discharge treated by different biotreatment processes. Ecological Indicators 95: 468-473.
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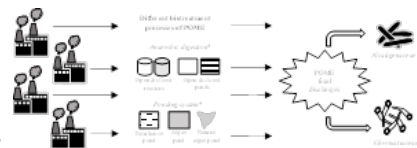


Figure 1. Schematics diagram of the proposed bioindicators the *Alcaligenaceae* and *Chromatiaceae* families were found in different full-scale biotreatment of four typical palm oil mills.

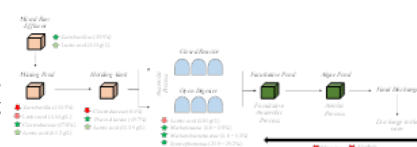
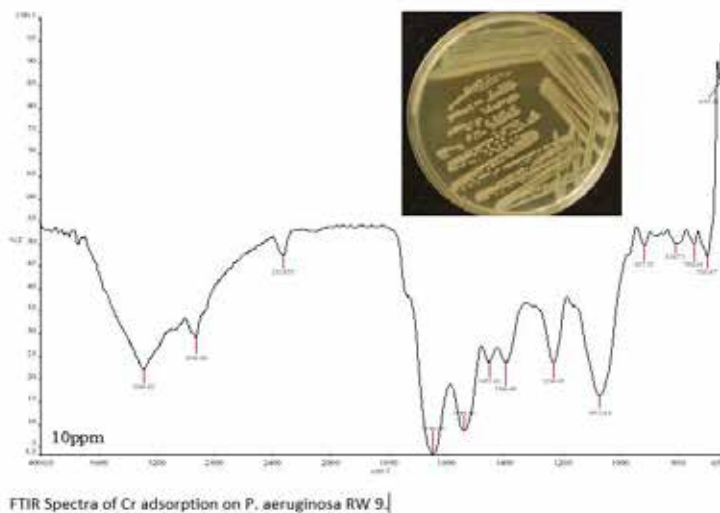


Figure 2. Schematic flow process diagram of biodegradation in the different stages during the treatment of palm oil mill effluent (POME) catalysed by bacteria and archaea populations.



Role of *Pseudomonas aeruginosa* RW 9 for Hexavalent Chromium Remediation in Selected Wastewater

The present study is designed to evaluate hexavalent chromium, Cr (VI), removal mechanism by biosurfactant producing local strain, *Pseudomonas aeruginosa* RW 9 for bioremediation of hexavalent chromium contaminated wastewater. The Cr (VI) tolerance of the strain is assessed first by supplementing various concentration of Cr (VI) to nutrient broth. Later, experiments are conducted to determine Cr (VI) removal mechanisms which are intracellular, intercellular, cell wall adsorption and metabolites (biosurfactant and reductase) production. Next, the distribution of Cr and its speciation are explored to assess the reducing mechanism of the biosurfactant released by the strain and its interaction with Cr (VI) in terms of metal complex formation. In addition, the expression of several target genes that responsible for biosurfactant production is also determined. Finally, performance test is conducted by introducing the strain to palm oil mill effluent for bioremediation.



Sustainable Treatment Methods for Nanocellulose Production from Oil Palm Biomass

Nanocellulose has become of interest in many applications such as in biocomposites, textiles, 3D bio-printing, thickening agents, cosmetics and etc. In brief of this study, upstream process is the main focus in producing nanocellulose. Oil palm biomass (OPB) was used as raw material, and extraction of cellulose by non-halogenated chemical was conducted prior to the production of cellulose nanofiber (CNF). Cellulose was extracted from OPB by introducing sustainable pretreatments methods using the combination of superheated steam, enzyme and totally chlorine-free chemicals. The cellulose pulp produced was then ground using a wet disc mill (WDM) for CNF production. Improvement in CNF production was achieved by further treating the cellulose with superheated steam and cellulase enzyme pretreatments prior to CNF production, which resulted in higher productivity CNF processing. This improvement would be beneficial and useful in scale-up process.

Publications:

1. Megashah, L N, H Ariffin, M R Zakaria, and M A Hassan. 2018. IOP Conference Series: Materials Science and Engineering 368: 012049.
2. Megashah, L N, H Ariffin, M R Zakaria, and Ando Y. 2018. IOP Conference Series: Materials Science and Engineering 368: 012001
3. Megashah, L N, H Ariffin, M R Zakaria, and M A Hassan. 2018. Asia Pacific Journal of Molecular Biology and Biotechnology. 26(2): 1–8.

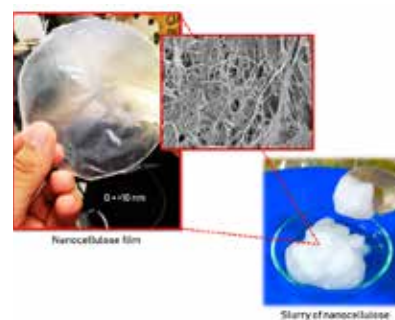


Figure 1. Nanocellulose film obtained from oil palm biomass nanocellulose



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Waste to Watts: 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 it 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. Microbial fuel cell setup for bioelectricity generation using dual chamber system

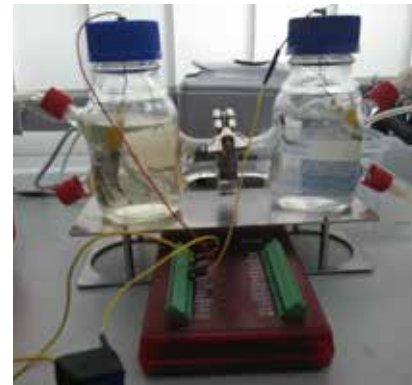


Figure 2. DNS analysis for total reducing sugar concentration.



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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.

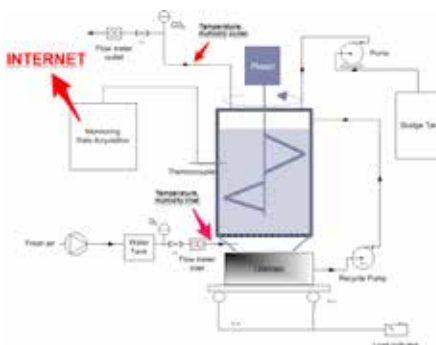


Figure 1: Composter Schematic Diagram



Figure 2: Composter



Figure 3: Temperature and Humidity Sensor with Datalogger



Figure 4: Compost



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.

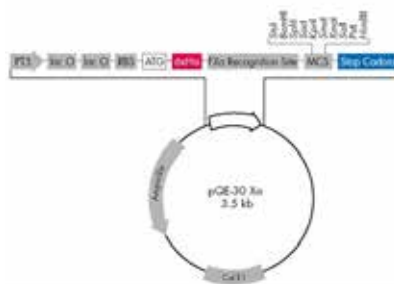


Figure 1. Schematic representation of the expression vector (pQE-30 Xa)

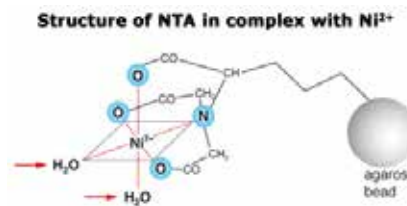


Figure 2. Structure of NTA in complex with Ni²⁺ for Ni NTA column



Lemongrass Leaves as Potential Substrate for Ferulic and p-Coumaric Acids Extraction using Ionic Liquid

Agricultural biomass particularly lemongrass leaves is among one of the highest waste produced in Malaysia yet the report on the valorisation of the leaves is still limited. Lemongrass leaves is famously known for its extracted essential oil, however, information on the phenolic content of the leaves specifically ferulic acid and p-coumaric acid are still inadequate knowing that it could be an excellent feedstock for the acids. Ferulic acid and p-coumaric acids display relevant properties in the food, health, cosmetic and pharmaceutical fields. Besides that, both acids are potential precursors in the biocatalytic production of aromatic natural products such as vanillin and p-hydroxybenzaldehyde, which could be found in vanilla. Extraction of phenolic compounds from biomass are oftenly conducted using conventional method, which involved the use of volatile and hazardous organic solvent. Based on this shortcoming, the use of ionic liquid (IL) which is a liquid salt at room temperature that consist of organic cation and organic/inorganic anion, is explored in this study as an alternative to organic

solvent. IL is considered as green solvent because of its outstanding properties such as thermal stability, negligible volatility and non-flammability allowing for green extraction of wide variety of interest compounds.



Figure 1. Unutilized lemongrass leaves at lemongrass farm in Beranang, Negeri Sembilan



Figure 2. Cut lemongrass leaves ready for grinding



Figure 3. Extraction of phenolic acids from lemongrass leaves using ionic liquid



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Development of Ultra High Molecular Weight Polyethylenel / Nanofibrillated Biocomposite for Tibial Inserts Potential Application

Ultra-high molecular weight polyethylene (UHMWPE) has been long used for components of artificial joint replacement (arthroplasty) such as tibial inserts. Yet the longevity of this material is limited by abrasion and fatigue due to rolling and sliding of metal components on its surface under external load. These wear effects cause generation of wear debris which in the end leads to inflammation, osteolysis and failure.

Therefore, this research focuses on implementing cellulose nanofibrils (CNF) as filler in UHMWPE polymer matrix. Besides possessing good biocompatibility, CNF as a nature-based material bears an excellent mechanical properties, tailorable surface chemistry, good flexibility and elasticity. Considering higher aspect ratio materials can be more effective in improving hardness and modulus of UHMWPE, focus on research using CNF, a high aspect ratio organic materials would be beneficial to the field. Accordingly, the use of CNF in UHMWPE could produce a material with good biocompatibility as arthroplasty components.



Figure 1: UHMWPE as component of total knee arthroplasty



Figure 2: The UHMWPE/CNF nanocomposite and neat UHMWPE



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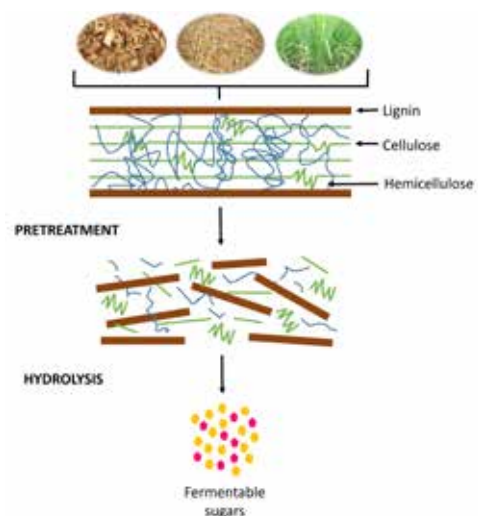
PhD Student

Pretreatment of oil palm empty fruit bunch using lignocellulolytic enzymes 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) was tough 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-products and it give low yield of fermentable sugars. In this study, the OPEFB was treated biologically using lignocellulolytic enzymes due to environmental concern. The OPEFB is subjected to enzymatic hydrolysis by crude lignocellulolytic enzymes to produce fermentable sugars. Hence, the biological approach for pretreatment and saccharification process is expected to result in high lignin removal and consequently produces high fermentable sugars concentration.



Figure 1. *Pycnoporus sanguineus* UPM4



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Development of Biorefinery Process for the Production of Bioethanol from Oil Palm Frond

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 Sand bath reactor system



Figure 2 Pretreated oil palm frond

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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 - Show yield of project compost at oil palm plantation after 5 year in FELDA Serting Hilir Negeri Sembilan



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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. coli*, 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 1. Aquatic organism (*D. magna*)



Figure 2. POME final discharge pond



Figure 3. POME final discharge sample A and B



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Pineapple Peels as an Alternative Substrate for the Production of Bacterial Nanocellulose

Production of bacterial nanocellulose (BNC) is becoming increasingly popular owing to its environmentally friendly properties. BNC may have applications in a variety of contexts, such as in the textile industry, nonwoven cloth, paper, food, pharmaceuticals, waste treatment, broadcasting, mining, and refineries. However, culture medium to produce BNC occupies approximately 30% of the total cost. Therefore, one important and challenging aspect of the fermentation process to produce BNC is the identification of a new cost-effective culture medium that can facilitate the production of high yields within short periods of time, thereby improving BNC production and permitting application of BNC in the biotechnological, medical, pharmaceutical, and food industries. Since Malaysia is blessed with abundant agricultural wastes such as oil palm biomass, sago wastes, rice straw, pineapple wastes and etc, utilization of this raw material could generate extra benefit to the related industries while at the same time developing new culture medium for BNC production. This study aims to utilize the

pineapple peels as potential substrate for the production of BNC (prior to pretreatment for fermentable sugar release). The BNC produced were then subjected as raw materials for food specifically for the production of Nata de pina (from pineapple fruits).

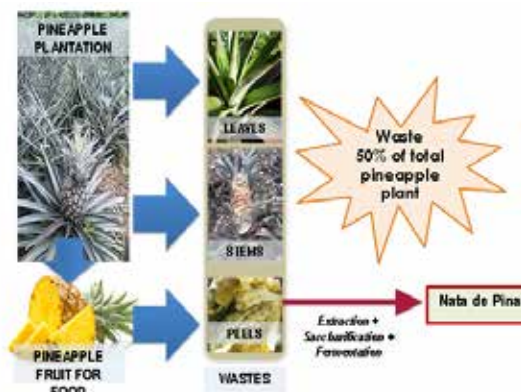


Figure 1: Big picture of the study.

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Biological Pretreatment of Oil Palm Empty Fruit Bunch using Local Isolate 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 local isolate fungus has a great potential to convert the OPEFB into value-added products.



Figure 1. Culture of local isolate on agar plate



Figure 2. Water extractive analysis

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Evaluation on The Use of Cellulose Nanofibers and Lignocellulose Nanofibers in Papermaking Process and Paper Performance

This study was conducted to investigate the effect of lignin content in the papermaking process and paper characteristics with the aim to improve the drainage time rate and mechanical performance; tensile strength and tear strength. Cellulose nanofibers (CNF) and lignocellulose nanofibers (LCNF) were reinforced into two types of cellulose pulps; bleached (without lignin) and unbleached (with lignin). The runnability of the papermaking process was evaluated in term of drainage time rate while characteristics of the resulted paper were evaluated in terms of physical and mechanical properties. Findings from this study are expected to provide better understanding on the presence of lignin in papermaking process and its effect on the performance of the paper.



Figure 1.0: Cellulose Nanofibers (CNF)



Figure 2.0: Unbleached and Bleached Pulp



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Fortified Biocompost to Enhance Bioactive Compounds in Pegaga (*Centella asiatica* L.)

The present study was designed to formulate the fortified biocompost from Oil Palm Empty Fruit Bunch (OPEFB) for the enhancement of bioactive compounds in Pegaga (*Centella asiatica* L.). Different formulation and ratio of biocompost will be formulated and fortified with biochar with the addition of fertilizers. The fortified biocompost will then be used as a medium to plant the Pegaga. Once the planting and cultivation is done, the Pegaga will be analyzed to determine whether the fortified biocompost were able to enhance the bioactive compounds in Pegaga known for its medicinal, nutraceutical and pharmaceutical properties.

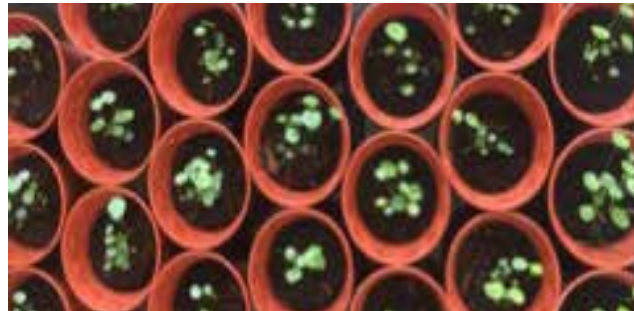


Figure 1: Planting pots of Pegaga with different ratios of fortified biocompost



Figure 2: Total Phenolic Content Analysis



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Elucidation of Uncharacterized Pseudogene is important in Hydrogen Metabolism

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 oxidizes 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 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. 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



Molecular Cloning and Heterologous Expression of β -glucosidase Gene from *Trichoderma* sp. for Enzymatic Characterization

The present study was constructed to characterize a glycosyl hydrolase (GH) family 1 β -glucosidase isolated from local *Trichoderma* sp., for possible glucose tolerance, allowing for utilization in cellulose breakdown with minimal glucose end product inhibition, for subsequent downstream applications. Work first proceeded with total RNA template, obtained following induction in submerged state fermentation, used with sequential degenerate and specific primers designed for PCR and RACE PCR, for isolation of coding sequences. Subsequent analysis was conducted on the deduced amino acid sequence for homologous proteins, predicted localization, structure, function and phylogeny. Codon optimization, cloning and transformation was then conducted for expression into heterologous host, with the resultant protein visualized via SDS-PAGE, characterized via enzyme activity, over a range of glucose concentrations and compared to other known glucose tolerant β -glucosidases.

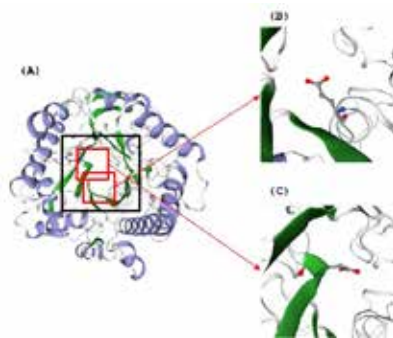


Figure 1. (A) Predicted tertiary structure of isolated β -glucosidase with (B) & (C) as highlighted key active site residues

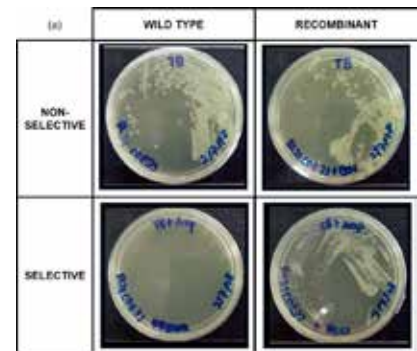


Figure 2. Growth of wild type and transformant bacterial hosts in presence and absence of antibiotic for selection



Inactivation and Survivability of Bacterial Community in the River Water Induced by Palm Oil Mill Effluent (POME) Final Discharge and Post-Zero Emission System

This study aimed to assess the factors that caused the bacterial community inactivation and survivability in correlation with the changes of physicochemical properties of POME. Several factors will be tested including temperature, pH, concentration of total suspended solids and UV irradiation. In addition, a lab-scale river water system will be set up to assess the bacterial community shift after the implementation of zero-emission system. The changes in functional status of bacteria including the total cell concentration, the viability of bacterial cells and the nucleic acid contents will be assessed by using nucleic acid double staining assay based on flow cytometry. Meanwhile, the changes on the composition of bacterial community will be analyzed by using Illumina MiSeq.



Figure 1 Sampling point of POME Final Discharge



Figure 2 Flow Cytometer BD Accuri C6 machine will be used to analyze functional status of bacterial community



Figure 3 Bacterial community composition will be analyzed using Illumina MiSeq machine



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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 and some gases such as CH₄, SO₂ and NH₃. 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, POME will be treating 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 fewer side effects as compared to the biological and chemical approach.



Figure 1. Collection of POME final discharge



Figure 2. Wetland system in biorefinery



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Biosurfactant Production from Sludge Pit Oil by *Pseudomonas* strain.

Most surfactants used are only partially and slowly biodegradable; hence it contributes to environmental pollution. Therefore, new approach in biotechnology research on the production of microbial surfactant or known as biosurfactants. It has high potential for becoming the next generation of biosurfactants. It contains of one or two sugar unit linked to one or two B-hydroxy fatty acids, which mainly known to be produced by *Pseudomonas* strain. This study was conducted to optimize and characterize the production of biosurfactant grown on sludge pit oil as substrate.

The bacterial strain *Pseudomonas* was inoculated in mineral salt medium with different types of carbon sources, concentrations of carbon source, types of nitrogen sources and concentration of nitrogen sources. The 1L fermentation was conducted supplemented with the optimized conditions. The biosurfactant were extracted and purified prior characterization. Thus, these biologically produced molecules reported to

have lower impact on the environmental and better in biodegradability and less toxicity as conventional surfactant.



Figure 1 *Pseudomonas* strain for biosurfactant production



Figure 2 Fermentation on the production of biosurfactant



Figure 3 The extraction method of biosurfactant



Biohydrogen production from biodiesel derived crude glycerol using engineered Escherichia coli strain

This study will attempt to increase biohydrogen production by dark fermentation using the engineered strain and crude glycerol as the substrate. This is because increasing interest in biodiesels has caused significant increase in crude glycerol production; a major by-product of this industry that is underutilized and considered as waste. The use of genetically engineered E. coli in this study to preferentially transform crude glycerol into hydrogen and ethanol will allow for a zero waste process stream, leading to an increase in the economic viability of biofuels and bioenergy industry. Next, since the rate and yield of biohydrogen produced is influenced by several factors such as zpH, nitrogen source, and hydrogen partial pressure, this study will attempt to optimize these parameters to further increase the biohydrogen production more effectively. In addition, fermentation experiments conducted under non-sterile conditions will also give an indication of the feasibility of biohydrogen production using crude glycerol for industrial application.

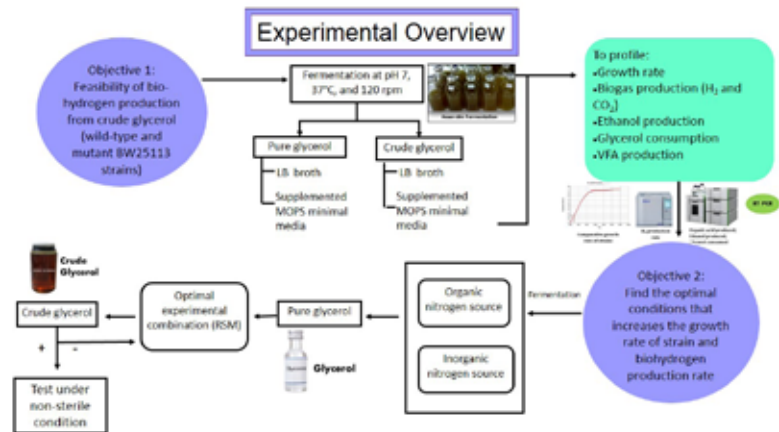
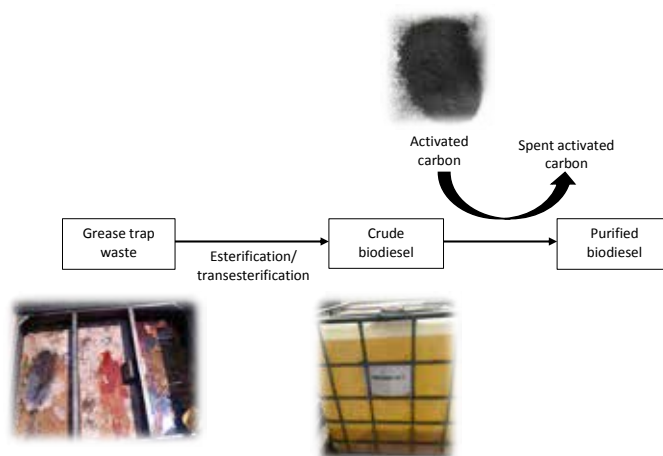


Figure 1: Experimental design



An improved purification method using biomass derived adsorbents for biodiesel purification from grease trap waste

Recently, the global energy demand is increasing due to the fast industrialization and population growth and also; the main energy resources like gas, oil and coal are decreasing from day to day. Biodiesel has attracted numerous researchers worldwide and it was found that it is the best alternative fuels that could reduce both energy and environmental deterioration. Biodiesel is a diesel fuel substitute derived from the transesterification reaction of triglycerides with alcohol in the presence of catalyst. In this study, grease trap waste will be used as feedstock for the biodiesel production and further purification to remove impurities will be achieved by using activated carbon derived from oil palm biomass. The purified biodiesel will be analysed for the methanol content, free fatty acid content, water content, free glycerine content, triglyceride and potassium content in order to meet the European Biodiesel Standards (EN 14214).





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Quantification of the Functional Gene Amplification in Palm Oil Mill Effluent Biodegradation for the Development of Molecular-based Indicator

This research is attempted as a fundamental study to establish a complementary molecular based monitoring system for the currently adapted physicochemical evaluation in determining river pollution caused by palm oil mill effluent (POME). At the earlier stage of this study, metagenomics sequencing was done by Illumina MiSeq to confirm the unique presence of bacterial family/order in POME. Through the understanding of biodegradation pathways involved in POME, significant genes were conventionally screened by polymerase chain reactions (PCR). Advanced high throughput RNA sequencing was also done to get the overall profiling of the genes expressed in POME. Further confirmation will be done by real-time PCR where the expression of selected genes is relatively quantified and compared between the POME source and the receiving waterway.

(2017). Bacterial community shift revealed Chromatiaceae and Alcaligenaceae as potential bioindicators in the receiving river due to palm oil mill effluent final discharge. *Ecological Indicators*, 82, 526-529.



Figure 1: Palm oil mill effluent mixing pond

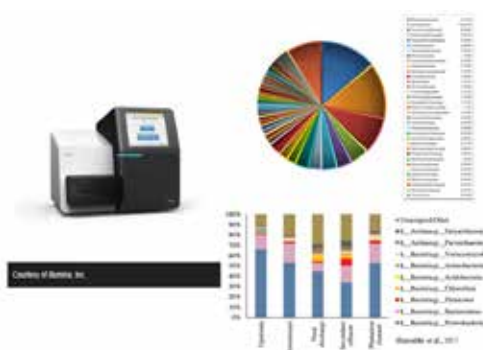


Figure 2: Bacterial community analyses by Illumina MiSeq

Reference:

Sharuddin, S. S., Ramli, N., Hassan, M. A., Mustapha, N. A., Amran, A., Mohd-Nor, D., Sakai, K., Tashiro, Y., Shirai, Y., & Maeda, T.



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Bio-sugar Production from Napier Grass Grown on Palm Oil Mill Effluent Final Discharge

Napier grass (*Pennisetum purpureum*), also known as “elephant grass” was first introduced in Malaysia in the 1920’s from East Africa. There are a few of Napier grass varieties, namely common Napier, red Napier, and Australian dwarf. Like every other biomass, Napier grass is made of lignocellulosic materials, which is a promising feedstock for renewable biofuel production. In a parallel study, Napier grass has shown the capability to phytoremediate polluted waters. However, the effect of those polluted waters towards the Napier grass and its further use is unknown. Therefore, this study attempts to evaluate the physical characteristic of Napier grass supplied with POME final discharge in a constructed wetland system. In addition, this study also attempts to determine the effect of POME final discharge towards the concentration of biosugar in the Napier grass constructed wetland after saccharification. The untreated and treated Napier grass will be pressed using a sugarcane pressing machine, and the dried pressed-biomass will be ground into 2.0 mm size using a hammer mill. The chemical composition of

biomass was observed together with elemental composition, ash and moisture content. The structural composition was determined using acid hydrolysis. Saccharification of untreated and treated biomass will be carried out using enzyme cocktail of 10 FPU *Acremonium cellulase* per gram of biomass.



Figure 1. Napier grass's juice according to the cultivars and treatment



Figure 2. Grinded sample (Above from left: Common control stem, Common treatment stem, Common control leaves, Common treatment leaves; Below from left: Red control stem, Red treatment stem, Red control leaves, Red treatment leaves)

Master Student

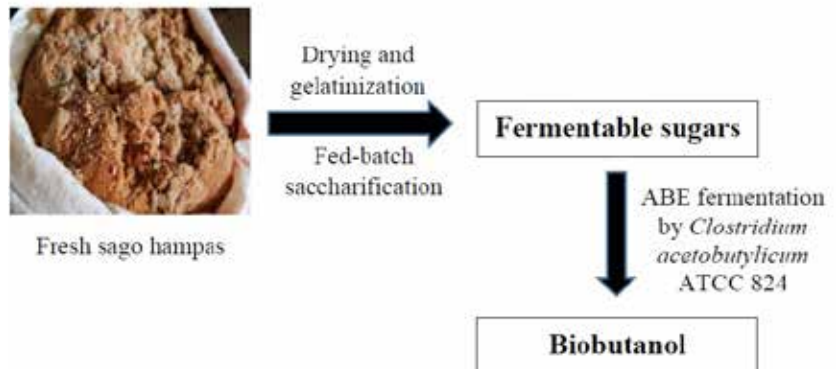
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Fed-batch Saccharification of Sago Hampas into Fermentable Sugars for Biobutanol Production

The recent increase in energy demand and crisis on depletion of fossil fuel worldwide have diverted attention among researchers all around the world towards the utilisation of renewable sources for bio-based fuels. Current bio-based components for biofuel production are agricultural waste after the crisis of food crops were used. The sago agricultural waste or better known as sago hampas is a starchy, lignocellulosic residue that has produced from sago starch processing industries. It has been recognized as one of the alternative raw materials due to its availability, free and abundantly found in Sarawak. The high content of starch (58-60%) and lignocellulosic components (35.9%) in sago hampas can contribute to environmental problem without a proper treatment. Therefore, sago hampas will be used in this study as a substrate for saccharification process to produce fermentable sugars in order to be consumed by *Clostridium acetobutylicum* ATCC 824 for biobutanol production. Fed-batch type of saccharification along with optimization study will be conducted in this study as to improve

and enhance the concentration of sugar yield as well as to generate high concentration of biobutanol.



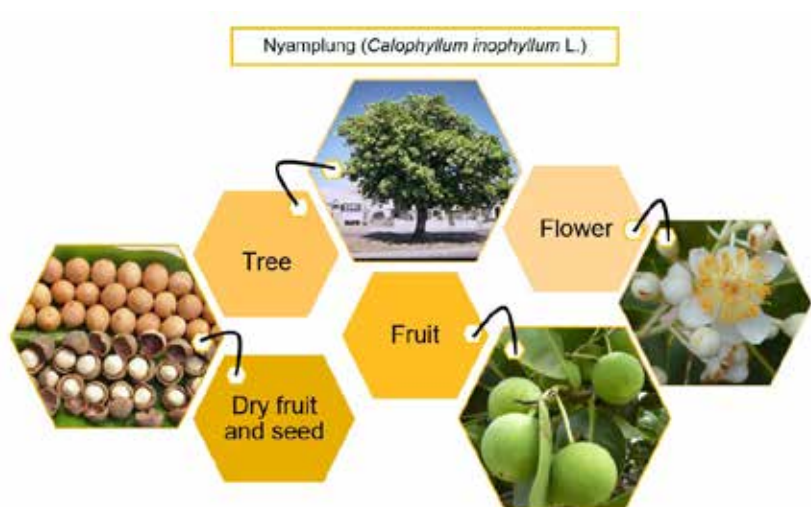
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The Potential Use of Nyamplung (*Calophyllum inophyllum* L.) Seed Oil and Waste Cooking Oil Mixture as Environmentally friendly Biolubricant

Nyamplung (*Calophyllum inophyllum* L.) is one of the most potential plants for biodiesel feedstock because of its high oil content. Mechanical extraction using screw press is one method to get oil from nyamplung seed. The future prospect the uses of lubricant petroleum on the vehicle's engine is predicted to have a bad prospect. Thus, began research to identify suitable materials to replace petroleum-based lubricants. It can produce from vegetable oils and animal oils by chemical modification. But, bio-lubricant properties are easily damaged, so research to improve the shelf life of the bio-lubricant must be done to improve the characteristics such as addition of biolubricant additive or mixture of bio-oil. With the collaboration with Universitas Indonesia, the project objectives are to characterize the nyamplung oil and waste cooking oil properties for the formulation of biolubricant and to optimize the formulation of biolubricant properties to replace the petroleum-based lubricants.





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Production of Biosurfactant from Biodiesel Side Stream Glycerine by *Pseudomonas aeruginosa*

The growth and production of rhamnolipid by *Pseudomonas aeruginosa* using waste glycerol from biodiesel production as a carbon source are carried in this study. The optimization is conducted in laboratory scale and will be tested in a pilot- scale. Majority of the surfactants present these days are derived from petrochemical sources, that might lead to environmental issues because of their low biodegradability and derived from non-renewable resources. Due to that, some of the surfactant usages currently has already replaced by biosurfactant which can be utilized in many fields. Even though there are numerous studies exhibited the advantages of biosurfactants over synthetic surfactants, large-scale production and application of these compounds are still not widely implemented because of the high production costs when compared to synthetic surfactants. This study aims to produce rhamnolipid at a laboratory and pilot- scale with low production cost.



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Cellulose Nanofibers (CNF) as Nucleating Agent for Poly (3-hydroxybutyrate-co-3-hydroxyhexanoate) (PHBHHx) and Polylactic Acid (PLA) Nanocomposites

This study is conducted to investigate the effect of cellulose nanofibers (CNF) as nucleating agent for poly(3-hydroxybutyrate-co-3-hydroxyhexanoate) (PHBHHx) and polylactic acid (PLA) biopolymer with the aim to improve its crystallization behaviors such as crystallization rate and crystal nucleation density. Optimization of CNF and compatibilizer content (1 – 5 %wt) is done to determine the best composition for PHBHHx and PLA nanocomposites. The nanocomposites produced will be characterized and compared with control samples which are neat biopolymer in terms of mechanical, morphological, thermal and barrier properties.



Figure 1: Nanocellulose used in this study



Figure 2: Preparation of PLA/CNF nanocomposite using internal mixer (Brabender)



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Title of Project: Cellulose nanofiber and nanocomposite production from OPMF

Former Supervisor:
Assoc. Prof. Dr. Hidayah Ariffin



Dr. Mohd Nor Faiz Norrahim

Title of Project:
Nanofiber and nanocomposite production from super-heated steam

Former Supervisor:
Assoc. Prof. Dr. Hidayah Ariffin



Dr. Noor Farisha Abd Rahim

Title of Project:
Synthesis of Versatile Bio-based Copolyesters from Long-Chain Unsaturated Fatty Acids

Former Supervisor:
Assoc. Prof. Dr. Hidayah Ariffin



Dr. Nahrul Hayawin Zainal

Title of Project:
Development of Carbonisation-Activation System for Production of Biochar and Activated Carbon from Oil Palm Kernel Shell

Former Supervisor:
Prof. Dr. Suraini Abd Aziz



Muhammad Azman Zakaria

Title of Project:
E. coli pseudogene in hydrogen production

Former Supervisor:
Dr. Mohd Zulkhairi Mohd Yusoff



Khairatul Nabilah Jansar

Title of Project:
Production of glucose from mixed oil palm biomass

Former Supervisor:
Prof. Dato' Dr. Mohd Ali Hassan



Hazwani Husin

Title of Project:
Biobutanol production from sago hampas using *C. acetobutylicum*

Former Supervisor:
Dr. Mohamad Faizal Ibrahim

ALUMNI 2018



Mohd Hafif Samsudin

Title of Project:
Co-composting of kitchen waste and sawdust with addition of biochar

Former Supervisor:
Prof. Dato' Dr. Mohd Ali Hassan



Nur Atheera Aiza Md Razali

Title of Project:
Biobutanol production through simultaneous saccharification and fermentation

Former Supervisor:
Prof. Dr. Suraini Abd Aziz



Norlailiza Ahmad

Title of Project:
Production of xylooligosaccharide and biosugars from oil palm mesocarp fibre

Former Supervisor:
Dr. Mohd Rafein Zakaria



Nurhajirah Mohamed Biran

Title of Project:
Production of polyhydroxyalkanoates from engineered *E. coli*

Former Supervisor:
Dr. Mohd Zulkhairi Mohd Yusoff



Nur Fatin Athirah Ahmad Rizal

Title of Project:
Effect of pretreatment of oil palm biomass for fermentable sugars production

Former Supervisor:
Dr. Mohamad Faizal Ibrahim



Azam Fikri Taifor

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

Former Supervisor:
Dr. Mohd Rafein Zakaria

LIST OF ALUMNI (2007-2017)

Year	Alumni	Current work place	Current position	Highest qualification with EB group	Former supervisor
2007	Dr. Cheong Weng Chung	Ministry of Science, Technology and Innovation (MOSTI)	Principal Assistant Secretary	PhD	Prof. Dr. Mohd Ali Hassan
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2008	Assoc. Prof Dr Tengku Elida Tengku Zainal Mulok	Faculty of Applied Sciences, UiTM Shah Alam	Associate Professor	PhD	Prof. Dr. Mohd Ali Hassan
	ZulKarami Berahim	Institute of Tropical Agriculture & Food Security, UPM	Research Officer	PhD	Prof. Dr. Suraini Abd Aziz
2009	Assoc. Prof. Dr. Norjan Yusof	Faculty of Science & Mathematics, Universiti Pendidikan Sultan Idris (UPSI)	Associate Professor	PhD	Prof. Dr. Yoshihito Shirai
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	Dr. Meisam Tabatabaei	Agricultural Biotechnology Research Institute of Iran (ABRII), Iran.	Assistance Professor	PhD	Prof. Dr. Mohd Ali Hassan
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2010	Dr. Khanom Simarani	Faculty of Sciences, UM	Senior Lecturer	PhD	Prof. Dr. Yoshihito Shirai
	Dr. Azahari Samsu Baharuddin	Faculty of Engineering, UPM	Senior Lecturer	PhD	Prof. Dr. Mohd Ali Hassan
	Dr. Alawi Sulaiman	Faculty of Plantation and Agrotechnology, Universiti Teknologi MARA (UiTM), Shah Alam	Senior Lecturer	PhD	Prof. Dr. Mohd Ali Hassan
	Dr. Mohd Zulkhairi Mohd Yusoff	Faculty of Biotechnology and Biomolecular Sciences, UPM	Senior Lecturer	MSc	Prof. Dr. Mohd Ali Hassan
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	Halimatus Saadiah Hafid	Faculty of Biotechnology and Biomolecular Sciences, UPM	PhD student	MSc	Assoc. Prof. Dr. Nor'Aini Abdul Rahman
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	Lim Siong Hock	Self employed	Self employed	MSc	Prof. Dr. Mohd Ali Hassan
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	Dr. Ahmad Amiruddin Mohd Ali	KYUTECH, Japan.	Postdoctoral Researcher	PhD	Prof. Dr. Yoshihito Shirai
	Dr. Nurul Asyifah Mustapha	KYUTECH, Japan.	Postdoctoral Researcher	MSc	Prof. Dr. Suraini Abd Aziz
	Dr. Mohd Rafein Zakaria	Faculty of Biotechnology and Biomolecular Sciences, UPM	Senior Lecturer	MSc	Prof. Dr. Mohd Ali Hassan
	Mohd Najib Ahmad	Malaysia Palm Oil Board	Research Officer	MSc	Prof. Dr. Mohd Ali Hassan

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Year	Alumni	Current work place	Current position	Highest qualification with EB group	Former supervisor
2013	Dr. Mior Ahmad Khushairi Mohd Zahari	Universiti Malaysia Pahang (UMP), Pahang.	Senior Lecturer	PhD	Prof. Dr. Mohd Ali Hassan
	Dr. Mohamad Faizal Ibrahim	Faculty of Biotechnology and Biomolecular Sciences, UPM	Senior Lecturer	PhD	Prof. Dr. Suraini Abd Aziz
	Dr. Ezyana Kamal Bahrin	Centre of Foundation Studies for Agricultural Science, UPM	Senior Lecturer	PhD	Prof. Dr. Suraini Abd Aziz
	Dr. Mohd Zulkhairi Mohd Yusoff	Faculty of Biotechnology and Biomolecular Sciences, UPM	Senior Lecturer	PhD	Assoc. Prof. Dr. Toshinari Maeda
	Fairouz Jahaan Mohd Aanifah	Malaysian Qualifications Agency (MQA), Selangor.	Assistant Director	MSc	Prof. Dr. Suraini Abd Aziz
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	Sheril Norliana Suhaimi	Segi University Kota Damansara, Selangor.	Junior Lecturer	MSc	Assoc. Prof. Dr. Phang Lai Yee
	Mohamad Nafis Abdul Razak	Johor Bahru District Office, Johor.	Admin Executive	MSc	Prof. Dr. Suraini Abd Aziz
	Mohd Azwan Jenol	Biorefinery and Biomass Laboratory, UPM	PhD student	MSc	Prof. Dr. Suraini Abd Aziz
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	Dr. Mohd Huzairi Mohd Zainudin	Institute of Tropical Agriculture & Food Security, UPM	Research Officer	PhD	Prof. Dr. Mohd Ali Hassan
	Dr. Sharifah Sopliah 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., Pahang.	Lab Analysts	MSc	Assoc. Prof. Dr. Hidayah Ariffin
	Mohd Rahimi Zakaria @ Mamat	Malaysia Rubber Board, Selangor.	Research Officer	MSc	Assoc. Prof. Dr. Hidayah Ariffin
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	Dr. Rozaimi Abu Samah	Faculty of Chemical & Natural Resources Engineering, Universiti Malaysia Pahang	Senior Lecturer	PhD	Prof. Dr. Suraini Abd Aziz
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	Nur Sharmila Sharip	Environmental Biotechnology Laboratory, Biotech 3, Faculty of Biotechnology & Biomolecular Sciences, UPM	PhD student	MSc	Assoc. Prof. Dr. Hidayah Ariffin
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	Dr. Dhurga Devi Rajaratanam	Self employed	Self employed	PhD	Assoc. Prof. Dr. Hidayah Ariffin
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	Zulnaim Dzulkurnain	Biocon Sdn Bhd	QCA Trainee	MSc	Prof. Dato' Dr. Mohd Ali Hassan
	Aisyah Zulkarnain	Institut Penyelidikan Halal, UPM	Research Assistant	MSc	Prof. Dr. Suraini Abd Aziz
	Iffah Nabilah Mohd Ariff	Biocon Sdn Bhd	QCA Sr. Associate	MSc	Prof. Dr. Suraini Abd Aziz
	Siti Suhailah Sharuddin	Research Instruments Sdn Bhd	Sales Executive	MSc	Dr. Norhayati Ramli

EB ALUMNI WALL OF FAME

Dr. Juferi Idris



After obtaining his first degree in Bachelor of Engineering (Hons) in Chemical from Universiti Teknologi MARA (UiTM) Shah Alam in 2003, he started his career as a planning engineer (onshore) for Brooke Dockyard Corporation. In 2005, he pursued his Master Science degree in Chemical Engineering in UiTM Shah Alam and graduated in the year 2007.

After that, he started his academic career as a lecturer in the Faculty of Chemical Engineering, UiTM Shah Alam. As he is a passionate lecturer, he was soon appointed as Head of Program for Chemical Engineering programme in UiTM Sarawak in 2008, and remain in that position until he pursued his PhD at Kyushu Institute of Technology (Kyutech) Japan in 2011. During his PhD journey, he was mainly supervised by Prof. Dr. Yoshihito Shirai and Prof. Dr. Mohd Ali Hassan, and published several manuscripts in high impact factor journals before he graduated in 2015.

When he returned to Malaysia, he was appointed as a Coordinator in Research Innovation Business Unit (RIBU) for UiTM Sarawak. His main role is to assist the management, technology transfer and commercialization of the university intellectual properties (IP), as well as involving in the university creativity and promotional activities. Therefore, he is actively engaged with the industry to bridge the knowledge from the university to the people.

His work is well recognised locally and internationally with awards from various competition such as Archimedes 2008 (Silver medal), British Invention Show (Gold medal), International Trade Fair 2010 (Silver), i-INOVA 2016 (Gold) as well as Invention, Innovation and Design Exposition 2017 (Gold). Due to his contribution, Dr Juferi was also honoured with the Research and Development Achievement Award during the Sarawak Maal Hijrah celebration in 2017.

We are proud to have Dr. Juferi as one of EB Group Alumni and wishing him the best in his future path.







EB group
Eid Al Fitr
celebration
Tuesday 26/6/2018
Seminar room



ACTIVITIES 2018



COLLABORATORS

NATIONAL



INTERNATIONAL





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