CONTENTS

PhD Students

Nur Ain Zamzuri 40
One-step biotransformation of ferulic acid into biovanillin using genetically engineered Escherichia coli

Elmy Nahida Othman
Towards controlled depolymerization of polyhydroxyalkanoates by steam hydrolysis

Muhammad Yusuf Hassan
Co-composting oil palm empty fruit bunch and anaerobic sludge palm oil mill effluent with enrichment of urea

Noor Farisha Abd Rahim
Design of Functionalized Polyester from Long-Chain Fatty Acids

Nik Ida Mardiana Nik Pa
Expression, purification and characterization of codon optimized recombinant cyclodextrin glycosyltransferase from Escherichia coli

Ruqayyah Masran
Development and optimization of lignocellulolytic enzyme cocktail for fermentable sugars production from oil palm empty fruit bunch

Dhurga Devi Rajaratnam
Controlled Depolymerization of Poly(3-hydroxybutyrate-co-3-hydroxyhexanoate) by Superheated Steam for Oligoester Production

Diana Mohd Nor
Microbial community adaptation and its community changes in different stages of palm oil mill effluent treatment

Siti Suliza Selamat
The Use of Oil Palm Empty Fruit Bunch and Palm Oil Mill Effluent Compost in Oil Palm Plantations as a Nutrient Recycling System for Oil Palm Industry

Mohd Nor Faiz Norrrahim
Nanofiber and Nanocomposite Production from Super Heated Steam Treated Oil Palm Biomass

Mohd Azwan Jenol
Bioelectricity production from oil palm empty fruit bunch hydrolysate by Clostridium butyricum A1 using microbial fuel cell

Yuya Hashiguchi
Evaluation of Toxicity and Identification of Toxic compounds in Palm Oil Mill Effluent

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

Nahrul Hayawin Zainal
Simultaneous carbonization and activation of palm kernel shell for activated carbon production

Nur Fariza Abdul Rahman
Pineapple crown and lemongrass leaves as potential precursors for flavor enhancer

Master Students

Iffah Nabilah Mohd Ariff 40
Production of cellulolytic cnzymes via solid state fermentation of spent mushroom substrate by Trichoderma Asperellum UPM 1

Aisyah Zulkarnain
Alkaline hydrolysate of oil palm empty fruit bunch as potential substrate for biovanillin production via two-step bioconversion

Zulnaim Dzulkurnain
Co-composting of Municipal Sewage Sludge and Landscaping Waste by Pilot Plant Scale and The Application of Compost to an Ornamental Plant, Tagetes erecta

Nurhajirah Mohamed Biran
Production of Polyhydroxyalkanoates from an Engineered Escherichia Coli through Molecular Biotechnology Approach

Muhammad Nazmir Mohd Warid
Optimization of Oil Palm Biomass Superheated Steam Treatment Improving Fiber Characteristic and Biocomposite Performance

Mohamad Farhan Mohamad Sobri
Molecular cloning of β-Glucosidase gene into Saccharomyces cerevisiae for enhancement of bioethanol production from oil palm empty fruit bunch hydrolysate

Mohammed Abdillah Ahmad Farid
Utilization of Biomass-Derived Activated Carbon as Catalyst Support and Bio-Adsorbent in Biodiesel Production using Waste Cooking Oil as Feedstock

Mohd Ezreeza Mohamed Yusoff
Bioadsorbent produced from oil palm decanter cake by carbonization and steam activation

Mohd Hafif Samsudin
Co-composting of Kitchen Waste and Sawdust with Addition of Biochar

Nur Atheera Aiza Md Razali
Optimization of biobutanol production through simultaneous saccharification and fermentation from oil palm empty fruit bunch

Nurul Hanisah Md. Badrul Hisham Biosurfactant production from used cooking oil by local isolates for heavy metals removal

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

Hazwani Husin
Optimization of simultaneous saccharification and fermentation for biobutanol production from sago hampas

Muhammad Siddiq Mohamed Salleh
In situ recovery of biobutanol produced from simultaneous saccharification and fermentation using gas stripping-distillation techniques

Nur Fatin Athirah Ahmad Rizal
Effect of physico-chemical and biological pretreatment of oil palm biomass for fermentable sugars production

Siti Suhailah Sharuddin
Assessment of physicochemical and community profiles in bacterial ecology of palm oil mill effluent final discharge and polluted river water

Nurshazana Mohamad
Enzyme-assisted extraction of essential oil from pineapple peels using cellulase

Tengku Arisyah Tengku Yasim Anuar Utilization of oil palm mesocarp fiber for the production of cellulose nanofiber and nanocomposite.

Norlailiza Ahmad
Production of xylooligosaccharides from oil palm mesocarp fiber using hydrothermal pretreatment

Khairiatul Nabilah Jansar
Development of Robust Hydrothermal Pretreatment to Produce Glucose from Oil Palm Biomass

Marahaini Md Mokhtar
Elucidation of Uncharacterized Pseudogene is Important in Hydrogen Metabolism

Enis Natasha Noor Arbaain
Biological pretreatment of oil palm empty fruit bunch (OPEFB) using indigenous fungus for fermentation feedstock

Nor Farhana Aziz Ujang
Treatment for Pome Final Discharge using Wetland System

Liana Noor Megashah
Non-chlorinated, Eco-friendly Cellulose Nanofiber Production Production from Oil Palm Biomass

CATCH SOME NEWS IN

INTRODUCTION TO BIOREFINERY COMPLEX

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. Biochar, biocompost, biodiesel and biogas pilot plants are developed based on our extensive research for 20 years in environmental biotechnology. Pilot plants are majorly equipped with solid biomass processing machines and instrument for generation of lignocellulosic based products. The pilot plants consist of biocompost machinery including biocompost reactor, mechanical compost turner, grinder, wood chipper as well as other machines such as steam blasting and biodiesel reactor. Serdang Biomass Town launched in January 2012 was a breakthrough project for EB group in collaboration with MPSJ, MARDI, KyuTech (Japan), FELDA, AIST (Japan) and KPKT. Through this project, we promoted zero discharge concept for Serdang community by converting selected biomass into valuable biomaterials.

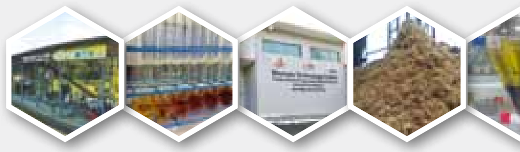
Biorefinery complex also includes Biomass Technology Centre (BTC) for analytical purposes to attain research and development requirement. This year, EB Group is proudly marks the second anniversary of BTC. BTC located near to University Agricultural Park (TPU) and UPM golf course, was operated last year starting from January 2014. The whole area of BTC covers 1075 m2 features laboratories, postgraduate students room which accommodates 30 students, researcher rooms, meeting room and seminar room. The seminar room can accommodate a maximum of 100 people at a time for meetings and presentations. The laboratory of this centre comprises of a chemical room, a culture room, a bioreactor room, an analysis room and a cold room. These rooms are fully equipped with instruments for environmental biotechnology research such as biomass pretreatment, fermentation process, bioalcohol detection and wastewater characteristics.

INTRODUCTION to 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 14 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. The laboratory is equipped with (2L & 7L), incubator shaker, freeze-dryer, glass tube oven for pyrolysis, gas-chromatography with Flame Ionization Detector (GC-FID), gel permeation chromatography (GPC) with UV and RI detectors, high performance liquid chromatography (HPLC) with UV and RI detectors, phase-contrast microscope and UV-VIS spectrophotometer.

Environmental Biotechnology (Molecular) Lab on the other hand is a laboratory dedicated for molecular work focusing on environmental samples. The laboratory is equipped with equipment for molecular analyses such as thermal cycler, RT-PCR thermal cycler, Denaturing Gradient Gel Electrophoresis (DGGE) machine, NanoDrop and Gel Documentation system.

MESSAGE FROM THE EB GROUP LEADER



PROFESSOR DR. MOHD ALI HASSAN

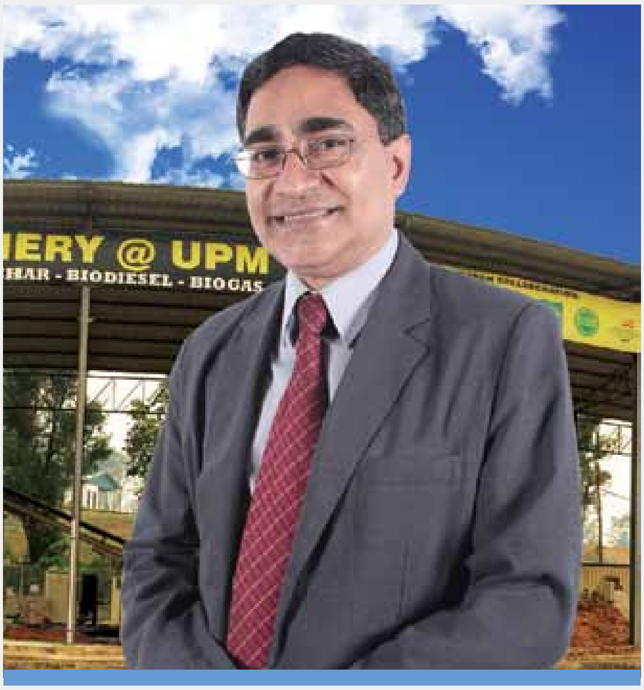
In The Name of ALLAH, Most Gracious, Most Merciful.

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 2016.

- We have two sub-groups; comprising of EB1 - Biomass and Biorefinery, and EB2 – Bioenergy and Biobased Chemicals.
- We have 9 academic staff members, 1 post-doctorate researcher and associate researchers.
- Our current student enrolment are PhD, MS and undergraduate students. In addition we also have students on the PhD Double-Degree and students on the Split-PhD program with Kyushu Institute of Technology, Japan.
- In 2016, PhD students and MS students graduated from our laboratory.

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

- We managed to secure the JICA-JST SATREPS International Grant for the period 2013-2017, with a matching grant from The Ministry of Education Malaysia, 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.
- In terms of output, we successfully published research papers in 2016, with in Quartile 1 (Q1) and 9 in Quartile 2 (Q2), with a total of Impact Factors.

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

Thank you. Wassalam.

Professor Dr. Mohd Ali Hassan

EB GROUP

BIG PICTURE

SERDANG BIOMASS

TOWN BIG PICTURE

SATREPS

BIG PICTURE

EB GROUP

Researcher

Professor Dr. Mohd Ali Hassan

Specialization:
Bioprocess Engineering and Environmental Biotechnology

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

***h*-index:** 35

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Academic Qualification:

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

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

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

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

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

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

Selected Publications:

Sharifah Soplah Syed Abdullah, Yoshihito Shirai, Ahmad Amiruddin Mohd Ali, Mahfuzah Mustapha, Mohd Ali Hassan (2016). Case study: Preliminary assessment of integrated palm biomass biorefinery for bioethanol production utilizing non-food sugars from oil palm frond petiole. Energy Conversion and Management 108: 233-242

Juferi Idris, Yoshihito Shirai, Yoshito Andou, Ahmad Amiruddin Mohd Ali, Mohd Ridzuan Othman, Izzudin Ibrahim, Akio Yamamoto, Nobuhiko Yasuda and Mohd Ali Hassan (2016). Successful scaling-up of self-sustained pyrolysis of oil palm biomass under pool-type reactor Waste Management & Research, 34(2): 176-180.

Ahmad Amiruddin Mohd Ali, Mohd Ridzuan Othman, Yoshihito Shirai, Mohd Ali Hassan (2015). Sustainable and integrated palm oil biorefinery concept with value-addition of biomass and zero emission system, Journal of Cleaner Production 91, 96-99.

Sharifah Soplah Syed Abdullah, Yoshihito Shirai, Ezyana Kamal Bahrin, Mohd Ali Hassan (2015). Fresh oil palm frond juice as a renewable, non-food, non-cellulosic and complete medium for direct bioethanol production, Industrial Crops and Products 63, 357-361.

Mior Ahmad Khushairi Mohd Zahari, Hidayah Ariffin, Mohd Noriznan Mokhtar, Jailani Salihon, Yoshihito Shirai, Mohd Ali Hassan (2015). Case study for a palm biomass biorefinery utilizing renewable non-food sugars from oil palm frond for the production of poly (3-hydroxybutyrate) bioplastic, Journal of Cleaner Production 87, 284-290.

Juferi Idris, Yoshihito Shirai, Yoshito Andou, Ahmad Amiruddin Mohd Ali, Mohd Ridzuan Othman, Izzudin Ibrahim, Mohd Ali Hassan (2015). Self-sustained carbonization of oil palm biomass produced an acceptable heating value charcoal with low gaseous emission Journal of Cleaner Production 89, 257-261.

Juferi Idris, Yoshihito Shirai, Yoshito Anduo, Ahmad Amiruddin Mohd Ali, Mohd Ridzuan Othman, Izzudin Ibrahim, Rafidah Husen, Mohd Ali Hassan (2015). Improved yield and higher heating value of biochar from oil palm biomass at low retention time under self-sustained carbonization Journal of Cleaner Production 104, 475-479.

Seminars Presented 2016:

Invited Speaker. JST SATREPS Joint Symposium. Kobe, Japan 15th March 2016.

Invited Speaker. UPM Delegates to Sejong University for 2nd Sejong University-UPM Joint Biotechnology Symposium. Seoul, Korea. 14th -15th April 2016.

Invited Speaker. 68th The Society for Biotechnology (SBJ), Japan Annual Meeting. Toyama, Japan. 28th September 2016.

Invited Speaker. Symposium on Applied Engineering Sciences (SAES2016) Kyutech, Tobata Campus. 17th-18th December 2016.




EB GROUP

Researcher

Professor Dr. Suraini Abd-Aziz

Specialization:
Biochemical Engineering/Enzyme Technology

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

***h*-index:** 20
Citation: 1236

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Academic Qualification:

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

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

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

Selected Publications:

Ruqayyah Masran, Zuraidah Zanirun, Ezyana Kamal Bahrin, Mohamad Faizal Ibrahim, Phang Lai Yee, Suraini Abd-Aziz. (2016). Harnessing the potential of ligninolytic enzymes for lignocellulosic biomass pretreatment. Applied Microbiology and Biotechnology. 100(12), 5231-5246.

Nahrul Hayawin Zainal, Astimar Abdul Aziz, Juferi Idris, Ropandi Mamat, Mohd Ali Hassan, Ezyana Kamal Bahrin , Suraini Abd-Aziz. (2016). Microwave-assisted pre-carbonisation of palm kernel shell produced charcoal with high heating value and low gaseous emission. Journal of Cleaner Production. ONLINE FIRST. DOI 10.1016/j.jclepro.2016.10.176.

Aisyah Zulkarnain, Ezyana Kamal Bahrin, Norhayati Ramli, Phang Lai Yee, Suraini Abd-Aziz. (2016). Alkaline hydrolysate of oil palm empty fruit bunch as potential substrate for biovanillin production via two-step bioconversion. Waste and Biomass Valorization. ONLINE FIRST. DOI 10.1007/s12649-016-9745-4.

Zuraidah Zanirun, Ezyana Kamal Bahrin, Lai Yee Phang, Mohd Ali Hassan, Suraini Abd-Aziz. (2015). Enhancement of fermentable sugars production from oil palm empty fruit bunch by ligninolytic enzymes mediator system. International Biodeterioration & Biodegradation. 105, 13-20.

Mohamad Faizal Ibrahim, SurainiAbd-Aziz, Mohd. Ezreeza Mohamed Yusoff, Phang Lai Yee and 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.

Seminars Presented 2016:

Oral Speaker. Asian Federation of Biotechnology Regional Symposium. Hue City, Vietnam. January 28-30, 2016.

Chairman. UPM Delegates to Sejong University for 2nd Sejong University-UPM Joint Biotechnology Symposium. Seoul, Korea. April 14-15, 2016.

Invited Speaker: 2016 AFOB International Symposium and AFOB Board Meeting. Gyeongju, Korea. April 21-22, 2016.

Chairman. UPM Delegates to Chulalongkorn University for Biotechnology of Biomass Utilization for ASEAN Development. Bangkok, Thailand. September 5-8, 2016.

Invited Speaker: Biotechnology International Congress (BIC 2016). Bangkok, Thailand. September 20-23, 2016.

EB GROUP

Researcher

Associate Professor Dr Hidayah Ariffin

Specialization:
Bioprocess Engineering, Environmental Biotechnology and Biomaterials.

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

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

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

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

Selected Publications:

Nur Sharmila Sharip, Hidayah Ariffin, Mohd Ali Hassan, Haruo Nishida and Yoshihito Shirai. (2016). Characterization and Application of Bioactive Compounds in Oil Palm Mesocarp Fiber Superheated Steam Condensate as an Antifungal Agent. RSC Advances. 6 (88), 84672-84683.

Muhammad Nazmir Mohd Warid, Hidayah Ariffin, Mohd Ali Hassan and Yoshihito Shirai. (2016). Optimization of Superheated Steam Treatment to Improve Surface Modification of Oil Palm Biomass Fiber. Bioresources. 11(3), 5780-5796.

Dhurga Devi Rajaratanam, Hidayah Ariffin, Mohd Ali Hassan and Haruo Nishida. (2016). Changes in diad sequence distribution by preferential chain scission during the thermal hydrolysis of poly(3-hydroxybutyrate-co-3-hydroxyhexanoate). Polymer Journal. 1-4.

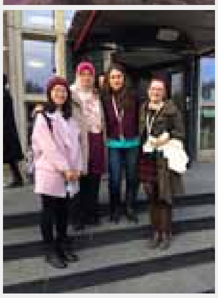
Kubra Eksiler, Yoshito Andou, Farouk Yilmaz, Yoshihito Shirai, Hidayah Ariffin, Mohd Ali Hassan. (2016). Dynamically controlled fibrillation under combination of ionic liquid with mechanical grinding. Journal of Applied Polymer Science. In press.

Chern Chiet Eng, Nor Azowa Ibrahim, Norhazlin Zainuddin, Hidayah Ariffin, Wan Md Zin Wan Yunus. (2016). Chemical modification of oil palm mesocarp fiber by methacrylate silane: Effects on morphology, mechanical, and dynamic mechanical properties of biodegradable hybrid composites. BioResources. 11, 861-872.

Selected seminars / conferences (2014-2016):

Hidayah Ariffin, Mohd Nor Faiz Norrrahim, Tengku Arisyah Tengku Yasim-Anuar, Mohd Ali Hassan. 2016. Nanocellulose fiber from oil palm biomass. Invited speaker. CIPST-KTAPPI Forum. Kangwon National University, Chuncheon, South Korea. 27 – 29 September 2016.

Hidayah Ariffin, Mohd Rahimi Zakaria Mamat, Nur Falia Shazana Manja Farid and Mohd Ali Hassan. 2016. Biobased Production of Crotonic Acid, a Precursor for Industrially Important Chemicals. Eco-Bio 2016, Rotterdam, The Netherlands. 6-9 March 2016.



EB GROUP

Researcher

Dr Mohd Rafein Zakaria

Selected Publications:

Zulnaim Dzulkurnain, Mohd Ali Hassan, Mohd Rafein Zakaria, Puteri Edaroyati Megat Wahab, Muhamad Yusuf Hassan, Yoshihito Shirai. Co-composting of municipal sewage sludge and landscaping waste - a pilot scale study. Accepted in Waste and Biomass Valorization.

Izzudin Ibrahim, Suraini Abd-Aziz, Yoshihito Shirai, Yoshito Andou, Mohd Ridzuan Othman, Ahmad Amiruddin Mohd Ali, Mohd Rafein Zakaria. (2017). Reduction of residual pollutants from biologically treated palm oil mill effluent final discharge by steam activated bioadsorbent from oil palm biomass. Journal of Cleaner Production. 141, 122-127

Mohd Rafein Zakaria, Satoshi Hirata, Shinji Fujimoto, Izzudin Ibrahim, Mohd Ali Hassan. (2016). Soluble inhibitors generated during hydrothermal pretreatment of oil palm mesocarp fiber suppressed the catalytic activity of Acremonium cellulase. Bioresource Technology. 200, 541-547.

Mohd Rafein Zakaria, Satoshi Hirata, Shinji Fujimoto, Mohd Ali Hassan. (2015). Combined pretreatment with hot compressed water and wet disk milling opened up oil palm biomass structures resulting in enhanced enzymatic digestibility. Bioresource Technology. 193, 128-134.

Mohd Rafein Zakaria, Mohd Nor Faiz Norrrahim, Satoshi Hirata, Mohd Ali Hassan. (2015). Hydrothermal and wet disk milling pretreatment for high conversion of biosugars from oil palm mesocarp fiber. Bioresource Technology. 181, 263-269.

Mohd Rafein Zakaria, Satoshi Hirata, Mohd Ali Hassan. (2015). Hydrothermal pretreatment enhanced enzymatic hydrolysis and glucose production from oil palm biomass. Bioresource Technology. 176, 142-148.

Specialization:
Environmental Biotechnology, Biomass Valorization, Hydrothermal Pretreatment

Current research interest:
Biomass valorization in biorefinery concept

***h*-index:** 8

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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)

EB GROUP

Researcher

Dr Norhayati Ramli

Specialization:
Microbial Biotechnology, Environmental Microbiology

Current research interest:
Microbial community study related to ecological functions; Strain improvement and utilization of biomass for the production of enzymes, bioproducts and bioethanol

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Academic Qualification:

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

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

Selected Publications:

Aisyah Zulkarnain, Ezyana Kamal Bahrin, **Norhayati Ramli**, Phang Lai Yee, Suraini Abd-Aziz. (2016). Alkaline hydrolysate of oil palm empty fruit bunch as potential substrate for biovanillin production via two-step bioconversion. Waste and Biomass Valorization, 1-11. ONLINE FIRST. DOI 10.1007/s12649-016-9745-4.

Norhayati Ramli, Suraini Abd-Aziz, Noorjahan Banu Alitheen, Mohd Ali Hassan, Toshinari Maeda. (2013). Improvement of cyclodextrin glycosyltransferase gene expression in Escherichia coli by insertion of regulatory sequences involved in the promotion of RNA transcription. Molecular Biotechnology, 54, 961-968.

Seminars Presented:

Norhayati Ramli, Siti Suhailah Sharuddin, Diana Mohd Nor, Mohd Ali Hassan, Yoshihito Shirai, Toshinari Maeda, Yukihiro Tashiro, Kenji Sakai (2016). Compositional and functional shifts in microbial communities: An approach to assess pollution due to palm oil mill effluent. 33rd Symposium of the Malaysian Society for Microbiology 2016. Malacca, Malaysia.

Norhayati Ramli, Siti Suhailah Sharuddin, Diana Mohd Nor, Mohd Ali Hassan, Yoshihito Shirai, Toshinari Maeda, Yukihiro Tashiro, Kenji Sakai (2016). Analysis of bacterial community structure and function as a tool in assessing the pollution due to palm oil mill effluent. 68th The Society for Biotechnology (SBJ), Japan Annual Meeting. Toyama, Japan.

Norhayati Ramli, Mohamad Farhan Mohamad Sobri, Suraini Abd-Aziz (2016). Potential of recombinant yeast strain for enhancement of cellobiose degradation and subsequent bioethanol production from oil palm biomass. Seminar on Biotechnology of Biomass Utilization for ASEAN Development. Chulalongkorn University, Thailand.

Norhayati Ramli, Mohd Ali Hassan, Kenji Sakai, Yukihiro Tashiro, Yoshihito Shirai. (2015). Molecular analysis of bacterial community structure in the palm oil mill effluent treatment in Malaysia. AFOB Regional Symposium 2015 (ARS2015). Universitas Indonesia, Depok, Indonesia.

Kenji Sakai, Yukihiro Tashiro, **Norhayati Ramli**, Mohd Ali Hassan, Charles S. Vairappan (2015). Microbial diversity analysis as a tool for monitoring environmental impact and biodiversity toward sustainability of Sabah, Malaysia. Asian Congress on Biotechnology 2015 (ACB2015). Istana Hotel, Kuala Lumpur, Malaysia.

EB GROUP

Researcher

Dr Mohd Zulkhairi Mohd Yusoff

Selected Publications:

Hironaga Akita, Zen-ichiro Kimura, **Mohd Zulkhairi Mohd Yusoff**, Nobutaka Nakashima, Tamotsu Hoshino. (2016). Draft Genome Sequence of Burkholderia sp. Strain CCA53, Isolated from Leaf Soil. Genome Announcements. 4(4), 00630-00616.

Hironaga Akita, Zen-ichiro Kimura, **Mohd Zulkhairi Mohd Yusoff**, Nobutaka Nakashima, Tamotsu Hoshino. (2016) . Isolation and characterization of Burkholderia sp. strain CCA53 exhibiting ligninolytic potential. SpringerPlus. 5, 596.

Mumtazah Ibrahim, Norjan Yusof, **Mohd Zulkhairi Mohd Yusoff**, Mohd Ali Hassan. (2015). Enrichment of anaerobic ammonium oxidation (anammox) bacteria for short start-up of the anammox process: a review. Desalination and Water Treatment. 1-21.

Minh Tuan Nguyen, Toshinari Maeda, **Mohd Zulkhairi Mohd Yusoff**, Hiroaki Ogawa. (2014). Effect of azithromycin on enhancement of methane production from waste activated sludge. Journal of Industrial Microbiology & Biotechnology. 41(7), 1051-1059.

Mohd Zulkhairi Mohd Yusoff, Anyi Hu, Cuijie Feng, Toshinari Maeda, Yoshihito Shirai, Mohd Ali Hassan, Chang-Ping Yu. (2013). Influence of pretreated activated sludge for electricity generation in microbial fuel cell application, Bioresource Technology. 145, 90-96.

Specialization:
Environmental biotechnology, Bioprocess technology and Molecular biotechnology

Current research interest:
Biomass utilization for biohydrogen production, bioenergy, biocomposting, microbial fuel cells, molecular biotechnology applications

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Academic Qualification:

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

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

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

EB GROUP

Researcher

Dr Mohamad Faizal Ibrahim

Specialization:
Enzyme Technology, Fermentation Technology, Microbial Biotechnology

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

***h*-index:** 5

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Academic Qualification:

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

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

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

Selected Publications:

Ruqayyah Masran, Zuraidah Zanirun, Ezyana Kamal Bahrin, **Mohamad Faizal Ibrahim**, Phang Lai Yee, Suraini Abd-Aziz. (2016). Harnessing the potential of ligninolytic enzymes for lignocellulosic biomass pretreatment. *Applied Microbiology and Biotechnology.* 100(12), 5231-5246.

Mohamad Faizal Ibrahim, SurainiAbd-Aziz, Mohd. Ezreeza Mohamed Yusoff, Phang Lai Yee and 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.

Mohd Azwan Jenol, **Mohamad Faizal Ibrahim**, Phang Lai Yee, Madihah Md Salleh, Suraini Abd-Aziz. (2014). Sago biomass as a sustainable source for biohydrogen production by *Clostridium butyricum* A1. *BioResources*. 9(1), 1007-1026.

Mohamad Faizal Ibrahim, Mohamad Nafis Abdul Razak, Phang Lai–Yee, Mohd Ali Hassan and Suraini Abd–Aziz. Crude cellulase from oil palm empty fruit bunch by *Trichoderma asperellum* UPM1 and *Aspergillus fumigatus* UPM2 for fermentable sugars production. *Applied Biochemistry and Biotechnology.* 170,1320–1335.

Mohamad Nafis Abdul Razak, **Mohamad Faizal Ibrahim**, Phang Lai Yee, Mohd Ali Hassan, and Suarini Abd–Aziz. (2013). Statistical optimization of biobutanol production from oil palm decanter cake hydrolysate by *Clostridium acetobutylicum* ATCC 824. *BioResources.* 8(2), 1758–1770.

Attended Seminars, Conferences and Trainings:

Post-Doctoral Training, Department of Chemical and Biological Engineering, Korea University, Seoul, South Korea. 1 March 2016 – 28 February 2017.

Speaker. Implementation of readily available technology for bromelain extraction and purification from pineapple wastes for value-added to pineapple plantation industry. *International Conference on Knowledge Transfer 2015* (ICKT2015), Putrajaya, Malaysia. 1-3 December 2015.

Participant. *Asian Congress on Biotechnology 2015* (ACB2015), Kuala Lumpur, Malaysia.15-19 November 2015.

Sepaker. Biofuels production through simultaneous acetone-butanol-ethanol fermentation using oil palm empty fruit bunch as substrate. *AFOB Regional Symposium 2015* (ARS2015), Jakarta, Indonesia. 27-30 May 2015.

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Nahrul Hayawin Zainal, Astimar Abdul Aziz, Juferi Idris, Ropandi Mamat, Mohd Ali Hassan, **Ezyana Kamal Bahrin**, Suraini Abd-Aziz. (2016). Microwave-assisted pre-carbonisation of palm kernel shell produced charcoal with high heating value and low gaseous emission. *Journal of Cleaner Production*. ONLINE FIRST. DOI 10.1016/j.jclepro.2016.10.176.

Aisyah Zulkarnain, **Ezyana Kamal Bahrin**, Norhayati Ramli, Phang Lai Yee, Suraini Abd-Aziz. (2016). Alkaline hydrolysate of oil palm empty fruit bunch as potential substrate for biovanillin production via two-step bioconversion. *Waste and Biomass Valorization.* ONLINE FIRST. DOI 10.1007/s12649-016-9745-4.

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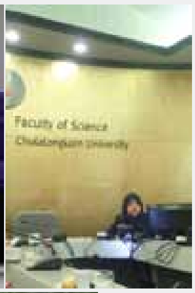
Seminars Presented:

Speaker. UPM Delegates to Chulalongkorn University for Biotechnology of Biomass Utilization for ASEAN Development. Bangkok, Thailand. September 5-8, 2016.

Speaker. Lignin as a barrier in biological pretreatment of lignocellulosic biomass Asian Federation of Biotechnology Regional Symposium, 27-30 May 2015, Depok, Indonesia.



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Meor Ahmad Khushairi Mohd Zahari, Sharifah Soplah Syed Abdullah, **Ahmad Muhaimin Roslan**, Hidayah Ariffin, Yoshihito Shirai, Mohd Ali Hassan. (2014). Efficient utilization of oil palm frond for bio-based products and biorefinery. *J. Journal of Cleaner Production. 65, 252-260.*

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Selected seminar/conferences:

Ahmad Muhaimin Roslan (2016). Superheated steam treatment to improve biosugars yield from oil palm frond petiole. Sejong Univ-UPM Biotechnology Joint Symposium, Sejong University, Gwanggaetto-gwan.

Ahmad Muhaimin Roslan, Izzudin Ibrahim, Mohd Ali Hassan, Yoshihito Shirai. (2014). Wet disk milling as an appropriate treatment for sugar recovery from oil palm frond biomass. AFOB Regional Symposium, Kuala Lumpur, Malaysia. (PB052)

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- Q1: **9**
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Soluble inhibitors generated during hydrothermal pretreatment of oil palm mesocarp fiber suppressed the catalytic activity of *Acremonium* cellulase

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HIGHLIGHTS

- Oil palm mesocarp fiber was pretreated at isothermal and non-isothermal conditions.
- Enzymatic hydrolysis of both pretreated slurry and solids were performed.
- Inhibitors generated from hydrothermal pretreatment of OPMF were identified.
- Xylooligosaccharide and tannic acid are the most severe inhibitors to cellulase.
- Activated carbon from OPMF is suitable adsorbent for tannic acid removal.

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Oil palm mesocarp fiber
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Acremonium cellulase inhibition

ABSTRACT

Oil palm mesocarp fiber was subjected to hydrothermal pretreatment under isothermal and non-isothermal conditions. The pretreated slurries were separated by filtration, pretreated liquids and solids were characterized. An enzymatic digestibility study was performed for both pretreated slurries and solids to understand the effect of soluble inhibitors generated during the pretreatment process. The highest glucose yield obtained from pretreated slurries was 70.1%, and gradually decreased with higher pretreatment severities. The highest glucose yield obtained in pretreated solids was 100%, after pretreatment at 210 °C for 20 min. In order to study the inhibitory effects of compounds generated during pretreatment with cellulase, technical grade solutions that mimic the pretreated liquid were prepared and their effect on *Acremonium* cellulase activity was monitored using Avicel. Xylo-oligomers and tannic acid were identified as powerful inhibitors of *Acremonium* cellulase, and the lowest hydrolysis rate of Avicel of 0.18 g/g-glucose released/L/h was obtained from tannic acid.

Published

Q1 IMPACT FACTOR 4.801

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Case study: Preliminary assessment of integrated palm biomass biorefinery for bioethanol production utilizing non-food sugars from oil palm frond petiole

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ABSTRACT

In this case study, a preliminary assessment on the bioethanol production from oil palm frond (OPF) petiole sugars within an integrated palm biomass biorefinery was carried out. Based on the case study of 4 neighbouring palm oil mills, approximately 55,600 t/y of fermentable sugars could be obtained from OPF petiole. The integrated biorefinery will be located at one of the 4 mills. The mill has potential excess energy comprising 3.64 GW h/y of electricity and 177,000 t/y of steam which are sufficient to run the biorefinery. With 33.9 million litres/y of bioethanol production, the specific production cost of bioethanol is estimated at $ 0.52/l bioethanol, compared to $ 0.31–0.34/l bioethanol produced from sugarcane and $ 0.49–0.60/l bioethanol from other lignocellulosics. The net energy ratio of 7.48 for bioethanol production from OPF provides a promising alternative for OPF utilization as a non-food sugar feedstock.

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PhD student

Q2 IMPACT FACTOR 3.376

Published

Appl Microbiol Biotechnol
DOI 10.1007/s00253-016-7545-1

MINI-REVIEW

Harnessing the potential of ligninolytic enzymes for lignocellulosic biomass pretreatment

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Abstract Abundant lignocellulosic biomass from various industries provides a great potential feedstock for the production of value-added products such as biofuel, animal feed, and paper pulping. However, low yield of sugar obtained from lignocellulosic hydrolysate is usually due to the presence of lignin that acts as a protective barrier for cellulose and thus restricts the accessibility of the enzyme to work on the cellulosic component. This review focuses on the significance of biological pretreatment specifically using ligninolytic enzymes as an alternative method apart from the conventional physical and chemical pretreatment. Different modes of biological pretreatment are discussed in this paper which is based on (i) fungal pretreatment where fungi mycelia colonise and directly attack the substrate by releasing ligninolytic enzymes and (ii) enzymatic pretreatment using ligninolytic enzymes to counter the drawbacks of fungal pretreatment. This review also discusses the important factors of biological pretreatment using ligninolytic enzymes such as nature of the lignocellulosic biomass, pH, temperature, presence of mediator, oxygen, and surfactant during the biodelignification process.

Keywords Biological pretreatment · Ligninolytic enzymes · Laccase · Lignocellulosic biomass · Mediator · Lignin degradation

Introduction

Lignocellulosic biomass is abundantly generated by various industries and is often regarded as an unwanted waste with zero market value. The U.S. Department of Energy has reported that lignocellulosic biomass is generated at 60 billion tonnes per year (Christopher et al. 2014). Lignocellulosic biomass comes from forest and wood waste resources (such as poplar) and agriculture residues (such as rice straw, wheat straw, and corn stover). From 341 million tonnes of lignocellulosic biomass produced in 2012, agriculture residues contribute about 70 % and the other 30 % is generated from forest residues (Balan 2014). Conventionally, the lignocellulosic biomass is used to generate electricity required for mill operation, processed into animal feed, and used as mulching agent in plantation area. Some of the remaining lignocellulosic biomass are burned or left to decompose naturally which will take years. Nevertheless, most of the lignocellulosic biomass generated from the agriculture sectors is not fully utilised and systematically disposed of. A lot of issues arise due to the improper biomass waste management. An appropriate method of disposal by employing recent innovation and technology for the remaining lignocellulosic biomass is required to produce value-added products such as biofuel.

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Master student

Q2 IMPACT FACTOR 3.289

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Characterization and application of bioactive compounds in oil palm mesocarp fiber superheated steam condensate as an antifungal agent†

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Lignocellulosic degradation products from superheated steam (SHS) pretreatment of oil palm mesocarp fiber (OPMF) at 190 °C to 240 °C for 1 hour were recovered as a condensate. Compositional analysis of the condensate was carried out and subsequently its potential application as an antifungal agent was investigated. GCMS analysis revealed a total of 62 compounds in the condensate sample from SHS pretreatment at 240 °C, which were identified and classified into ten different groups of aromatic phenolics, furans, pyrans, dioxoles; and open chains ketones, esters, alcohols, aldehydes, alkenes and alkanes. The presence of carboxylic acids was identified by HPLC and the condensate contained acetic, formic, levulinic and succinic acids at concentrations of 1671 mg L^{-1}, 12 320 mg L^{-1}, 831 mg L^{-1} and 435 mg L^{-1}, respectively. Complete suppression of *Ganoderma boninense* UPM13 mycelial growth was observed in the agar dilution test, while spore germination of *Aspergillus fumigatus* UPM2 and *Trichoderma asperellum* UPM1 was completely inhibited in the spore germination test. The growth suppression of *G. boninense*, a fungal causing basal stem rot (BSR) disease in oil palm plantation shows the condensate potential benefit to combat the disease.

Published

Q1 IMPACT FACTOR 3.249

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Research paper

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

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ABSTRACT

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

Published

Q2 IMPACT FACTOR 1.866

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Journal of Applied Polymer Science

Dynamically controlled fibrillation under combination of ionic liquid with mechanical grinding

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ABSTRACT: Combination of mortar grinder mill (MG) and ionic liquid (IL) treatment was employed in order to fibrillate fibers from oil palm mesocarp fiber (OPMF) in one-step. The structural changes of OPMF before and after the treatment were examined by Thermogravimetric analysis (TGA), Fourier transformed infrared (FT-IR) spectra, Wide-angle X-ray diffraction (WAXD), Dynamic light scattering (DLS) and Scanning electron microscopy (SEM). Compared with the only use of 1-butyl-3-methylimidazolium tetrafluoroborate (BMIM[BF_4]), combination of MG and IL helped to remove hemicellulose and lignin components partially from OPMF, and also fibrillated OPMF fibers at average particle diameter of 127 nm. Afterwards, the fibrillated fibers were utilized as reinforcement material for the purpose of enhancement of mechanical properties of poly(ε-caprolactone)(PCL). The addition of OPMF treated with the combined method led to a 64% increase in tensile strength in comparison with that of untreated OPMF. These results indicate that the combined method enables effective fibrillation. J. Appl. Polym. Sci. **2016**, *133*, 44469.

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NOTE

Changes in diad sequence distribution by preferential chain scission during the thermal hydrolysis of poly(3-hydroxybutyrate-*co*-3-hydroxyhexanoate)

Dhurga Devi Rajaratanam[1,2], Hidayah Ariffin[1,3], Mohd Ali Hassan[1] and Haruo Nishida[2]

Polymer Journal (2016) **48,** 839–842; doi:10.1038/pj.2016.28; published online 16 March 2016

INTRODUCTION

Polyhydroxyalkanoates (PHAs) are microbial polyesters produced by many types of bacteria as an intracellular energy reserve material under substrate limiting conditions and in the presence of excessive carbon sources.[1] Poly((*R*)-3-hydroxybutyrate) (PHB), the most commonly used microbial polyester, was the first member of the PHA family to be discovered, and more than 150 other monomer units have been reported to date.[2,3] Poly((*R*)-3-hydroxybutyrate-*co*-(*R*)-3-hydroxyhexanoate) (PHBHHx) is a copolymer in the PHA family that consists of randomly distributed (*R*)-3-hydroxybutyrate (HB) and (*R*)-3-hydroxyhexanoate (HHx) units.[4] This type of copolymer exhibits improved mechanical properties and processability compared with those of PHB and poly((*R*)-3-hydroxyvalerate) (PHBV).[5] PHBHHx copolymers are currently produced on a large scale and have proven to be biocompatible in clinical studies using mouse fibroblasts cells, and rabbit articular cartilage-derived chondrocytes.[6] PHBHHx is a highly favorable copolymer of the PHB family due to its biodegradability, flexible mechanical properties and good melt processability.

Because PHBHHx has potential applications in various fields, the degradation properties of PHBHHx must be determined, especially those related to thermal degradation and hydrolysis, which causes substantial changes in the mechanical properties after melt-processing. Previously, degradation studies on members of the PHA family have mainly focused on enzymatic degradation,[7,8] thermal degradation[9–10] and hydrothermal degradation,[11] as well as acid and alkaline hydrolysis.[12] The resulting degradation products are dependent on the degradation mechanisms. The thermal degradation of PHB occurs through random chain scissions via β-elimination, resulting in final products with an unsaturated chain end. In the hydrothermal degradation of PHB, homogeneous and random degradation occur via bulk erosion at high temperature (180–300 °C) and high pressure, which result in the formation of water-soluble monomers and oligomers.[11]

Previously, studies on the hydrolysis of PHBHHx have shown that hydrolysis occurs preferentially at the amorphous phase, rather than the crystalline phase.[13–15] However, the effects of HHx units in the 3HB unit sequence on the hydrothermal degradation of PHBHHx have not yet been determined. To evaluate the effect of HHx units on hydrothermal degradation, super-heated steam (SHS) hydrolysis was introduced as an alternative method for the hydrolysis of PHBHHx. SHS uses unsaturated steam produced by the addition of heat to saturated steam, which enables the steam's temperature to exceed its boiling point.[16] SHS is widely applicable because it is operable at atmospheric pressure,[17] allows steam to homogeneously diffuse into PHBHHx, and specifically degrades ester bonds without any dissolving out of hydrolysates into a liquid solvent, which interrupts quantitative analysis of degradation behavior.[18]

In the present study, the effects of HHx units on the hydrothermal degradation of PHBHHx with 6% HHx were investigated and compared with that of PHB, with a focus on changes in the diad sequence distribution after SHS hydrolysis. The diad sequence distribution for PHBHHx has been determined in previous studies;[13–14] however, to date changes in diad sequence distribution during degradation, that is, the effects of HHx on the sequence during hydrolysis, remain unknown. To clarify these effects, changes in the first-order structure of PHBHHx during SHS hydrolysis were monitored by precise structural analyses, including size-exclusion chromatography (SEC), and proton (^{1}H) and carbon (^{13}C) nuclear magnetic resonance (NMR) spectroscopies. Moreover, the reaction mechanism was validated by performing a lowest-unoccupied molecular orbital (LUMO) analysis on model compounds.

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Chemical Modification of Oil Palm Mesocarp Fiber by Methacrylate Silane: Effects on Morphology, Mechanical, and Dynamic Mechanical Properties of Biodegradable Hybrid Composites

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Effects of modifying oil palm mesocarp fibers (OPMF) by methacrylate silane on polylactic acid (PLA)/ polycaprolactone (PCL)/clay/OPMF hybrid composites were investigated. The composites were prepared by a melt blending technique and characterized by dynamic mechanical analysis (DMA) and scanning electron microscopy (SEM). The silane-treated OPMF hybrid composites showed better tensile strength, tensile modulus, and elongation at break than unmodified OPMF hybrid composites. DMA analysis showed an increase in storage modulus when silane-treated OPMF was added to a hybrid composite. The loss modulus curve showed that the incorporation of silane-treated OPMF into a hybrid composite shifted the two glass transition temperatures (T_g) of composites closer to each other. The low tan *δ* peak indicated good fiber/matrix adhesion for the silane-treated OPMF hybrid composites. SEM micrographs revealed that silane-treated OPMF hybrid composites showed better fiber/matrix adhesion than unmodified OPMF hybrid composites because of absence of gap between silane-treated OPMF and the matrix in the composite.

Keywords: Oil palm mesocarp fiber; Chemical modification; Silane coupling agent; Hybrid composites

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Short Communication

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Successful scaling-up of self-sustained pyrolysis of oil palm biomass under pool-type reactor

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Abstract
An appropriate technology for waste utilisation, especially for a large amount of abundant pressed-shredded oil palm empty fruit bunch (OFEFB), is important for the oil palm industry. Self-sustained pyrolysis, whereby oil palm biomass was combusted by itself to provide the heat for pyrolysis without an electrical heater, is more preferable owing to its simplicity, ease of operation and low energy requirement. In this study, biochar production under self-sustained pyrolysis of oil palm biomass in the form of oil palm empty fruit bunch was tested in a 3-t large-scale pool-type reactor. During the pyrolysis process, the biomass was loaded layer by layer when the smoke appeared on the top, to minimise the entrance of oxygen. This method had significantly increased the yield of biochar. In our previous report, we have tested on a 30-kg pilot-scale capacity under self-sustained pyrolysis and found that the higher heating value (HHV) obtained was 22.6–24.7 MJ kg^{-1} with a 23.5%–25.0% yield. In this scaled-up study, a 3-t large-scale procedure produced HHV of 22.0–24.3 MJ kg^{-1} with a 30%–34% yield based on a wet-weight basis. The maximum self-sustained pyrolysis temperature for the large-scale procedure can reach between 600 °C and 700 °C. We concluded that large-scale biochar production under self-sustained pyrolysis was successfully conducted owing to the comparable biochar produced, compared with medium-scale and other studies with an electrical heating element, making it an appropriate technology for waste utilisation, particularly for the oil palm industry.

Keywords
Biochar, self-sustained pyrolysis, oil palm biomass, charcoal

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PEER-REVIEWED ARTICLE

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Optimization of Superheated Steam Treatment to Improve Surface Modification of Oil Palm Biomass Fiber

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Superheated steam (SHS) pretreatment is an effective method for hemicellulose removal from oil palm biomass (OPB) fiber, which leads to the surface modification of the fiber. However, the current SHS pretreatment is conducted at a high temperature and has a long retention time, which causes the removal of cellulose, which is an important component for biocomposite production. This study was conducted to optimize the SHS treatment temperature and retention time so that hemicellulose but not cellulose was removed. Three types of OPB fibers were used: oil palm mesocarp fiber (OPMF), oil palm empty fruit bunch (OPEFB), and oil palm frond (OPF). The chemical composition data was analyzed using a type of response surface methodology (RSM), *i.e.*, central composite design (CCD). The optimal SHS treatment temperature and retention time were 265 °C/5 min, 280 °C/5 min, and 300 °C/9 min for OPMF, OPEFB, and OPF, respectively. The removal of hemicellulose at these temperatures was in the range of 60% to 70%, while the cellulose degradation was maintained below 5%. Statistical analysis showed that the optimal SHS treatment time can be shortened to 5 min to 9 min, which is 18 to 20 times shorter than previously reported methods.

Keywords: Oil Palm Biomass Fiber; Pretreatment; Superheated steam; Surface modification; Optimization

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RESEARCH **Open Access**

Isolation and characterization of *Burkholderia* sp. strain CCA53 exhibiting ligninolytic potential

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

Abstract
Microbial degradation of lignin releases fermentable sugars, effective utilization of which could support biofuel production from lignocellulosic biomass. In the present study, a lignin-degrading bacterium was isolated from leaf soil and identified as *Burkholderia* sp. based on 16S rRNA gene sequencing. This strain was named CCA53, and its lignin-degrading capability was assessed by observing its growth on medium containing alkali lignin or lignin-associated aromatic monomers as the sole carbon source. Alkali lignin and at least eight lignin-associated aromatic monomers supported growth of this strain, and the most effective utilization was observed for *p*-hydroxybenzene monomers. These findings indicate that *Burkholderia* sp. strain CCA53 has fragmentary activity for lignin degradation.
Keywords: 16S rRNA gene sequencing, *Burkholderia*, Lignin-associated aromatic monomer, Lignin-degrading bacterium

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Group researcher

Cited

AMERICAN SOCIETY FOR MICROBIOLOGY genomeAnnouncements

Draft Genome Sequence of *Burkholderia* sp. Strain CCA53, Isolated from Leaf Soil

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***Burkholderia* sp. strain CCA53 was isolated from leaf soil collected in Higashi-Hiroshima City in Hiroshima Prefecture, Japan. Here, we present a draft genome sequence of this strain, which consists of a total of 4 contigs containing 6,647,893 bp, with a G+C content of 67.0% and comprising 9,329 predicted coding sequences.**

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The genus *Burkholderia* contains Gram-negative, non-spore-forming β-proteobacteria (1). This genus was separated from the former *Pseudomonas* rRNA homology group II, and more than 80 *Burkholderia* species have been reported to date (1). Based on phylogenetic analyses of the sequences of their 16S rRNA, *acdS*, *gyrB*, *recA*, and *rpoB* genes, as well as their genome sequences, *Burkholderia* species have been classified into two major clusters and several subgroups (2). Group A comprises plant-associated and saprophytic species, while group B contains opportunistic pathogens that infect animals, humans, and plants (2). *Burkholderia* sp. strain CCA53 was recently isolated from leaf soil and classified into group B (3). An important limitation of industrial host microorganisms, such as *Escherichia coli* and *Saccharomyces cerevisiae*, is an inability to assimilate lignin as a carbon source, but *Burkholderia* sp. CCA53 has this ability (3). Because of that, it is anticipated that *Burkholderia* sp. CCA53 could be a useful strain for industrial production of second-generation biofuels (3), as lignin is a widely distributed raw material on Earth (4). To enable gene engineering of *Burkholderia* sp. CCA53 for industrial applications, we determined its draft genome sequence.

ing Kit P6 version 2 (Pacific Biosciences), yielding the sequencing template. The concentration of the sequencing templates was calculated using Binding Calculator version 2.3.1.1 (Pacific Biosciences), after which the templates were bound to MagBeads using a MagBead Kit (Pacific Biosciences) and loaded onto single-molecule real-time (SMRT) Cell 8 Pac V3 (Pacific Biosciences). The sequencing was performed using PacBio RS II (Pacific Biosciences). The raw data were 65,150 reads at 138-fold coverage and were assembled *de novo* using SMRT Analysis version 2.3.0 (Pacific Biosciences) (5) to filter the subreads. The genome sequence was 6,647,893 bp, and the G+C content was 67.0%. The assembly generated 4 contigs with an N_{50} contig size of 3,558,923 bp. Genome annotation was performed using CRITICA (6) and Glimmer2 (7), and 9,329 predicted coding sequences were identified. In addition, 65 tRNA genes and 15 rRNA genes were identified using tRNAscan-SE (8) and BLASTN (9), respectively.

Nucleotide sequence accession numbers. The nucleotide sequence and annotation data for the *Burkholderia* sp. CCA53 draft genome have been deposited in DDBJ/EMBL/GenBank under accession numbers BDDJ01000001 to BDDJ01000004.

Cited

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SciMedCentral
JSM Biotechnology & Biomedical Engineering

Short Communication

Isolation of *Pseudomonas* sp. Strain CCA1 from Leaf Soil and Preliminary Characterization Its Ligninolytic Activity

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- *Pseudomonas*
- Lignin-associated aromatic monomer
- Lignin-degrading bacterium

Abstract

Here we describe the screening and characterization of a lignin-degrading bacterium from an environmental sample. The bacterium was isolated from leaf soil and identified as *Pseudomonas* sp. strain CCA1 based on 16S rRNA gene sequencing. Although identified as able to degrade lignin in our screen, the ligninolytic activityof this strain was weak. Nonetheless, assessment of its utilization of lignin-associated aromatic monomers revealed that *Pseudomonas* sp. strain CCA1 assimilated at least ten lignin-associated aromatic monomers.

Cited

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Enhancement of Tensile Properties of Surface Treated Oil Palm Mesocarp Fiber/Poly(butylene succinate) Biocomposite by (3-aminopropyl)trimethoxysilane

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Keywords: (3-aminopropyl)trimethoxysilane; Biocomposites; Oil palm Mesocarp Fiber; Poly(butylene succinate); Tensile Properties

Abstract. The issue related to relatively poor interfacial adhesion between hydrophilic natural fiber and hydrophobic thermoplastic remain as an obstacle in natural fiber/thermoplastic biocomposites. Consequently, surface treatment of fiber is of important to impart adhesion. The present work used consecutive superheated steam-alkali treatment to treat the oil palm mesocarp fiber (OPMF) prior to biocomposite fabrication. The biocomposites made up of 70 wt% treated OPMF and 30 wt% poly(butylene succinate) (PBS) were prepared by melt blending technique in a Brabender internal mixer followed by hot-press moulding into 1 mm sheets. A silane coupling agent of (3-aminopropyl)trimethoxysilane (APTMS) was also added to the biocomposite during the process of compounding to promote interfacial adhesion and enhance the properties of biocomposites. The results showed that the biocomposite containing 2 wt% APTMS showed maximum enhancement in tensile strength (89%), tensile modulus (812%) and elongation at break (52%) in comparison to that of untreated OPMF/PBS biocomposite. The SEM observation of the tensile fracture surface revealed that APTMS improved the interfacial adhesion between treated OPMF and PBS. It can be deduced that the presence of APTMS can improve the adhesion between hydrophilic fiber and hydrophobic thermoplastic, and thus increased the tensile properties of the biocomposite.

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In Press

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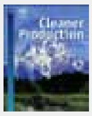

Short communication

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

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A B S T R A C T

Treatment of wastewater using bioadsorbent has gained interest as one of the tertiary treatment methods. Bioadsorbents from peat, coconut shell, fruit stones and oil palm biomass have been produced but the bioadsorbent ability in removing pollutants from biologically treated palm oil mill effluent final discharge is scarcely reported. This research attempts to treat biologically treated palm oil mill effluent final discharge using steam activated oil palm mesocarp fiber bioadsorbent without the use of chemicals as activating agents. Oil palm mesocarp fiber was carbonised at 600 °C for 30 min and later activated using steam at same temperature for another 30 min. The Brunauer-Emmett-Teller (BET) surface area of the bioadsorbent was found to be 494 m^2/g. Bioadsorbent produced was then used to treat biologically treated palm oil mill final discharge by mixing both bioadsorbent and the wastewater into a conical flask and shaken at 150 rpm for 24 h. At 10 g/L dosage, the bioadsorbent reduced the chemical oxygen demand and suspended solid of biologically treated palm oil mill effluent final discharge from 395 mg/L and 117 mg/L down to 303 mg/L and 14 mg/L, respectively. Consecutive treatments at 10 g/L dosage resulted in higher removal of the chemical oxygen demand and suspended solids up to 122 mg/L and 7 mg/L, respectively, which meets the river water quality, making the final wastewater suitable as recycled water for the zero-emission system in the palm oil mill.

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In Press

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

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Microwave-assisted carbonisation
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Waste utilisation

A B S T R A C T

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

In Press

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PEER-REVIEWED ARTICLE *bioresources.com*

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

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

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

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In Press

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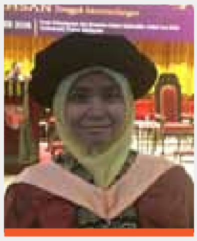

PEER-REVIEWED ARTICLE *bioresources.com*

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

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

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

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Q4 IMPACT FACTOR 0.915

In Press

Waste Biomass Valor
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CrossMark

ORIGINAL PAPER

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

Zulnaim Dzulkurnain[1] · Mohd Ali Hassan[1,2] · Mohd Rafein Zakaria[1,3] · Puteri Edaroyati Megat Wahab[4] · Muhamad Yusuf Hasan[2,5] · Yoshihito Shirai[6]

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

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

Introduction

Compost is a product that is produced from the degradation of organic materials under controlled conditions by biological treatment [1, 2]. Compost can be produced from various types of biomass, including municipal solid waste, agricultural waste and others with the addition of bulking

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ORIGINAL PAPER

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

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Received: 27 July 2016 / Accepted: 14 October 2016

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

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

Introduction

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

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

EB GROUP ATTACHMENT 2016 (OUTBOUND)

Participants	Program	Research Theme	Host/Location	Duration	Sponsor
Noor Farisha Abd Rahim	Research Attachment	Design of Functionalized Polyester from Palm Oil's Fatty Acids	Kyushu Institute of Technology (KYUTECH), Japan	15th September 2015 - 29th February 2016	JASSO
Norlailiza Ahmad	Research Attachment	Production of xylooligosaccharides from mesocarp fiber using hydrothermal pretreatment	National Institute of Advanced Industrial Science and Technology (AIST), Japan	18th April 2016 - 14th October 2016	JICA
Marahaini Md Mokthar	Research Attachment	Elucidate the *ydfw* protein role during hydrogen production by using RT-PCR	Kyushu Institute of Technology (KYUTECH), Japan	16th July 2016 - 6th August 2016	Sakura Science Programme
Azam Fikri Taifor	Research Attachment	Application of metabolically engineered *E.coli* strains for production of biohydrogen from POME	Kyushu Institute of Technology (KYUTECH), Japan	17th July 2016 - 13th January 2016	JASSO
Khairiatul Nabilah Jansar	Research Attachment	Enhancement of glucose production from combined oil palm biomass using robust pretreatment of hot compressed water	National Institute of Advanced Industrial Science and Technology (AIST), Japan	19th July 2016 - 16th September 2016	JICA
Mohd Nor Faiz Norrahim	Research Attachment	Characterization of nanofiber	Kyushu Institute of Technology (KYUTECH), Japan	15th August 2016 - 20th January 2017	JICA
Tengku Arisyah Tengku Yasim Anuar	Research Attachment	Optimization, production and characterization of nanocomposite	Kyushu Institute of Technology (KYUTECH), Japan	15th August - 10th March 2017	JICA
Siti Suliza Salamat	Research Attachment	Analysis of samples using the next-generation DNA Sequencer	Kyushu Institute of Technology (KYUTECH), Japan	15th August - 13th October 2016	JICA
Diana Mohd Nor	Research Attachment	Analysis of microbial community structure using MiSeq and bioinformatics tools	Kyushu Institute of Technology (KYUTECH), Japan	15th August - 16th September	JICA
Siti Suhailah Shaharuddin	Research Attachment	Analysis of microbial community structure using MiSeq and bioinformatics tools	Kyushu Institute of Technology (KYUTECH), Japan	15th August - 16th September	JICA

EB GROUP ATTACHMENT 2016 (INBOUND)

Participants	Program	Research Theme	Host/Location	Duration	Sponsor
Yuya Hashiguchi	PhD Student	Toxicity Identification Evaluation of Palm Oil Mill Effluent	KYUTECH & Biorefinery and Biomass Laboratory, UPM	21th Jun 2014 - 21st Jun 2017	JASSO
Omar Hisham Mohamed Hamed	Postgraduate Student	Snythesis of starch/ nanocellulose/ ZnO biocomposites for antimicrobial food packaging	Biorefinery and Biomass Laboratory, UPM	20th July 2016 -12th September 2016	The American University, Cairo
Keita Kubo	Postgraduate Student	Inhibition of methane using the phosphoric gum, palm oil industrial waste	Biorefinery and Biomass Laboratory, UPM	6th October 2016 - 17th November 2016	JASSO

Consultancy

Reserach Theme	Clients/Industrial Partner	Duration
Research Study on the Effectiveness of Biofertilizer Pellets for Landscape Palnts	Indah Water Konsurtium Sdn Bhd	September 2015 - March 2017
Collaborative Work to Study The Prodection of Solid Fuel from Oil Palm Empty Fruit bunch Biomass	Mitsubishi Heavy Industries Asia Pacific PTE. LTD.	June 2016 - December 2016
Biofertilizer and Biochar Pellets for Landscape Plants and Biofuel	CJ Bio Malaysia Sdn Bhd	15 Mei 2016 - 30 April 2017
Collaborative Work to study the Production of Biogas from Empty Fruit Bunch and Palm Oil Mill Effluent	Renagen South East Asia Sdn Bhd	August 2016 - Nonember 2016

MoA between UPM and Chulalongkorn University, Thailand

DR. MAD NASIR SAMSUDIN (dua kiri) bertukar dokumen dengan Polkit Sangvanich (dua kanan) selepas menandatangani memorandum perjanjian jaringan penyelidik bioteknologi antara kedua-dua universiti di UPM, Serdang, Selangor, semalam. - UTUSAN/MOHD. NOOR MAT AMIN

MoA jalin kerjasama bioteknologi

KUALA LUMPUR 17 Ogos - Universiti Putra Malaysia (UPM) hari ini menandatangani memorandum perjanjian (MoA) dengan Universiti Chulalongkorn, Thailand untuk memulakan jaringan antara penyelidik kedua-dua universiti itu dalam bidang berkaitan bioteknologi ke arah memantapkan penyelidikan bersama.

MoA itu merangkumi pertukaran kakitangan akademik dan pelajar termasuk pelajar ijazah dan pasca siswazah, pembangunan program pengajian di luar negara dan penyeliaan bersama untuk pelajar pasca siswazah.

Timbalan Naib Canselor Akademik dan Antarabangsa UPM, Prof. Datuk Dr. Mad Nasir Samsudin menandatangani MoA itu bagi pihak Fakulti Bioteknologi dan Sains Biomolekul universiti itu manakala Dekan Fakulti Sains, Prof. Madya Polkit Sangvanich mewakil lalongkorn.

Bercakap dala selepas itu, Ma kerjasama itu t galakkan pertul antara kedua-du mengaplikasi sis kredit dan kursu pelajar Malaysia

Katanya, ini : pertukaran lima demik dan 10 p pelajar ijazah da dalam tempoh s

"Universiti Chulalongkorn merupakan antara universiti terbaik dan kerjasama ini diharap dapat mendedahkan pelajar dengan proses pembelajaran di luar

DR Mad Nasir Samsudin (kiri) dan Dr Polkit memerhatikan MoA, semalam.

UPM hantar pelajar, staf ke Thailand

Serdang: Universiti Putra Malaysia (UPM) akan menghantar pelajar dan kakitangannya ke Universiti Chulalongkorn, Thailand bagi memantapkan lagi penyelidikan berkaitan bidang bioteknologi.

Program pertukaran itu adalah hasil memorandum perjanjian (MoA) yang ditandatangani antara UPM dan universiti terbabit, semalam.

Timbalan Naib Canselor (Akademik dan Antarabangsa) Profesor Datuk Dr Mad Nasir Samsudin berkata, MoA berkenaan merangkumi pertukaran kakitangan akademik dan pelajar peringkat ijazah sarjana, pasca siswazah serta pembangunan program pengajian luar negara.

Katanya, untuk permulaan, seramai 10 pelajar dan lima kakitangan akan terbabit dalam program pertukaran itu bermula semester baharu tidak lama lagi.

"Usaha sama ini membolehkan kedua-dua universiti memulakan jaringan hubungan dalam bidang berkaitan sains dan bioteknologi.

"Ini kerana, sebagai salah satu universiti penyelidikan terkemuka di Malaysia, UPM sentiasa memberi keutamaan dalam mengenal pasti penyelidik pada masa depan dan gembira dapat menjalin kerjasama dengan salah sebuah universiti terbaik di rantau Asia" katanya pada sidang media selepas majlis MoA itu, di sini, semalam.

Pada majlis itu, UPM diwakili Mad Nasir sendiri manakala Dekan Fakulti Sains Profesor Madya Dr Polkit Sangvanich mewakili Universiti Chulalongkorn.

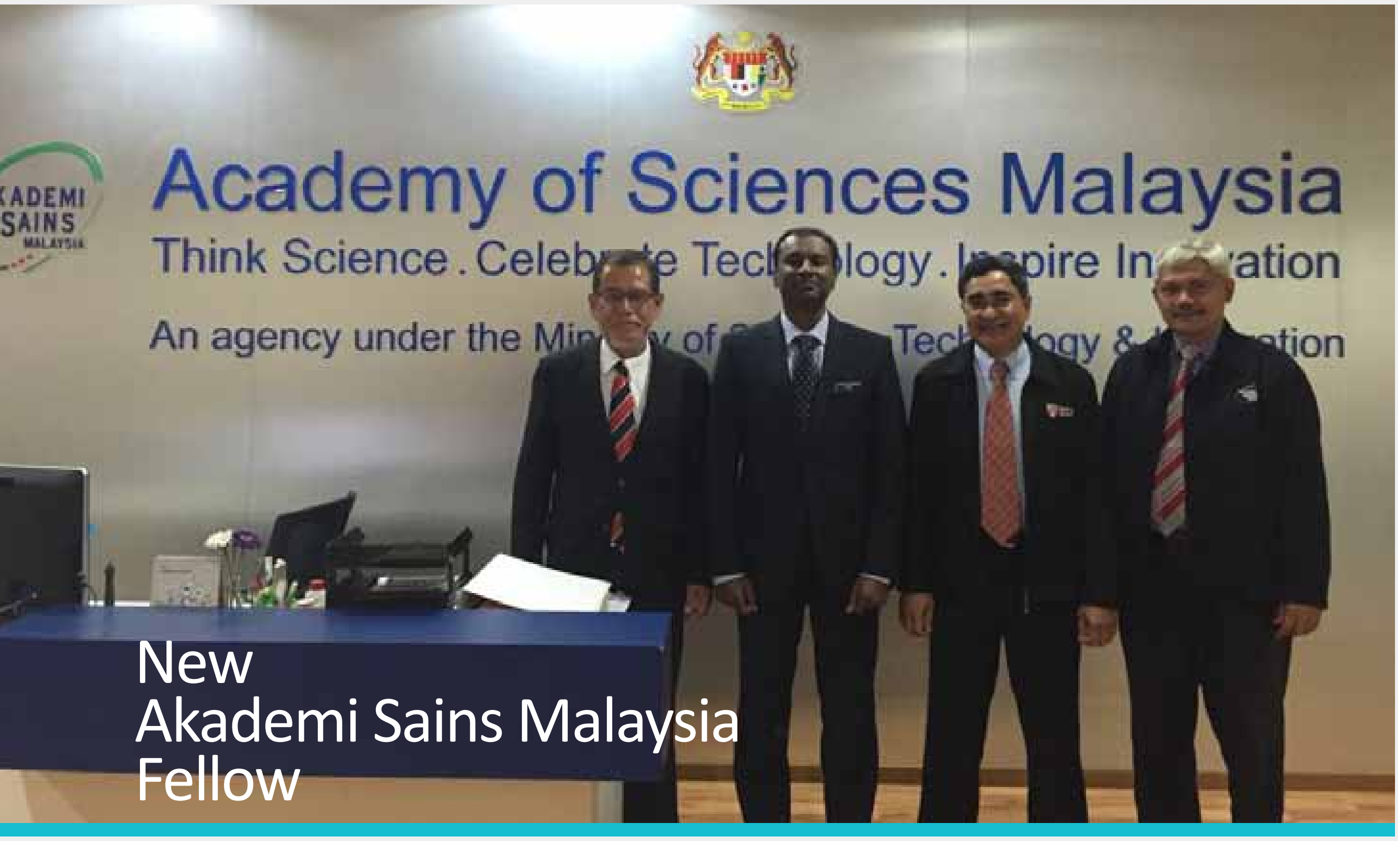
Menurut Mad Nasir lagi, pelajar yang terpilih mengikuti program pertukaran itu akan mengikuti pengajian di universiti berkenaan selama satu semester.

Kata beliau, program itu tidak akan menjejaskan tempoh pengajian kerana pelajar boleh melakukan pemindahan kredit mata pelajaran.

"Selain untuk tujuan pelajaran, usaha sama seperti ini juga mampu membantu memberi pendedahan kepada pelajar kita mengenai budaya dan gaya pembelajaran di luar negara.

"Pengalaman seperti ini mampu memantapkan lagi pelajar dalam mencari pekerjaan selepas mereka tamat pengajian kelak," katanya.

NEWSPAPER CUTTING



New Akademi Sains Malaysia Fellow

BH ONLINE

SEMASA

Akademi Sains Malaysia umum 25 felo baharu

CONFERENCES AND WORKSHOPS

Event name	Date	Venue	Name of participant
Asian Federation of Biotechnology Regional Symposium 2016	28th – 30th January 2016	Hue City, Vietnam	Prof. Dr. Suraini Abd Aziz
Biobased Production of Crotonic Acid, a Precursor for Industrially Important Chemicals	6th – 9th March 2016	Eco-Bio 2016, Rotterdam, The Netherlands	Assoc. Prof. Dr. Hidayah Ariffin
JST SATREPS Joint Symposium	15th March 2016	Kobe, Japan	Prof. Dr Mohd Ali Hassan
Workshop on Nanocellulose Material 2016	21st - 22nd March 2016	Universiti Putra Malaysia	Assoc. Prof. Dr Hidayah Ariffin Mohd Nor Faiz Norrahim Mohammed Abdillah Ahmad Farid Muhammad Nazmir Mohd Warid Nur Sharmila Sharef Tengku Arisyah Tengku Yasim Anuar Dhurga Devi Rajaratanam
The Second Sejong-UPM Biotechnology Joint Symposium 2016	14th -15th April 2016	Sejong University, Korea	Prof. Dr Mohd Ali Hassan Prof. Dr Suraini Abd-Aziz Dr Mohd Rafein Zakaria Dr Ahmad Muhaimin Roslan Dr Mohamad Faizal Ibrahim Dr Ahmad Amiruddin Mohd Ali Mohd Mohd Azwan Jenol Mohammed Abdillah Ahmad Farid
2016 AFOB International Symposium and AFOB Board Meeting	21st -22nd April 2016	Gyeongju, Korea	Prof. Dr. Suraini Abd Aziz
Research Association for Feedstock Recycling of Plastics Japan (FSRJ) 2016	1st - 2nd September 2016	Kyushu Institute of Technology, Tobata, Kitakyushu, Japan	Tengku Arisyah Tengku Yasim Anuar Mohd Nor Faiz Norrahim
Biotechnology of Biomass Utilization for ASEAN Development	5th - 8th September 2016	Chulalongkorn University, Bangkok, Thailand	Prof. Dr Suraini Abd Aziz Dr Norhayati Ramli Dr Ezyana Kamal Bahrin Dr Mohd Rafein Zakaria Nahrul Hayawin Zainal Ruqqayah Masran Mohd Azwan Jenol
Biotechnology International Congress (BIC 2016)	20th - 23th September 2016	Bangkok, Thailand	Prof. Dr Suraini Abd-Aziz
International Symposium for Realization of Ultra-low Carbon Society and Design of Environmental Technology to Bridge of Asian Area 2016	26th - 28th September 2016	Kyushu Institute of Technology, Wakamatsu, Kitakyushu, Japan	Tengku Arisyah Tengku Yasim Anuar Mohd Nor Faiz Norrahim Azam Fikri Taifor Siti Suliza Salamat
Nanocellulose fiber from oil palm biomass	27th - 29th September 2016	Kangwon National University, Chuncheon, South Korea	Assoc. Prof. Dr Hidayah Ariffin

CONFERENCES AND WORKSHOPS

Event name	Date	Venue	Name of participant
68th The Society for Biotechnology (SBJ) Japan Annual Meeting	28th - 30th September 2016	Toyama, Japan.	Prof. Dr. Mohd Ali Hassan Dr. Norhayati Ramli Dr Mohd Zulkhairi Mohd Yusoff
Real-Time Quantitative PCR Workshop	4th – 5th October 2016	Universiti Putra Malaysia	Marahaini Mokhtar
Bioreactor Operation & Fermentation Data Analyses	1st - 4th November 2016	Universiti Putra Malaysia	
Advanced Material Conference 2016	5th -6th December 2016	Langkawi, Malaysia	Noor Farisha Abd Rahim
33rd Symposium of the Malaysian Society for Microbiology 2016	14th - 17th December 2016	Ramada Plaza, Malacca, Malaysia	Prof. Dr. Mohd Ali Hassan Dr. Norhayati Ramli Dr Ezyana Kamal Bahrin Dr Mohd Rafein Dr Ahmad Muhaimin Roslan
Special Session for AFOB and SATREPS at MSM2016	16th December 2016	Ramada Plaza, Malacca, Malaysia	EB group members
Symposium of Applied Engineering and Sciences (SAES 2016)	17th - 18th December 2016	Kyushu Institute of Technology, Tobata, Kitakyushu, Japan	Prof. Dr. Mohd Ali Hassan Assoc. Prof. Dr Hidayah Ariffin Dr Mohd Zulkhairi Mohd Yusoff Tengku Arisyah Tengku Yasim Anuar Mohd Nor Faiz Norrahim Azam Fikri Taifor

EB STUDENTS

Research Summary

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Supervisor : Prof. Dr. Suraini Abd Aziz

Phd Student

One-step biotransformation of ferulic acid into biovanillin by recombinant *Escherichia coli*

Vanillin is an important flavouring agent in the industry of food and personal products. Natural vanillin extracted from vanilla pods has a very high price and limited supply. The current market demand for vanillin is fulfilled by the chemically synthesized vanillin which is not recognized as a natural product. Therefore, the investigation of other biotechnological routes like microbial transformations hoped towards a sustainable and environmental friendly process. The aim of this study is to produce biovanillin from the ferulic acid by recombinant E. coli through one step pathway without further oxidation of vanillin into vanillic acid. Potential isolate, Pseudomonas sp. AZ10 UPM was used to isolate the functional genes for biovanillin production. The recombinant E. coli is expected to be able to produce biovanillin in one step fermentation.

Publication

Zamzuri, N.A. and Abd-Aziz, S. 2013. Biovanillin from agro wastes as an alternative food flavour. Journal of Science of Food and Agriculture 93(3): 429-438.

Zamzuri, N.A., Abd-Aziz, S., Rahim, R.A., Phang, L.Y., Alitheen, N.B. and Maeda, T. 2014. A rapid colorimetric screening method for vanillic acid and vanillin-producing bacterial strains. Journal of Applied Microbiology 116(4): 903-910.

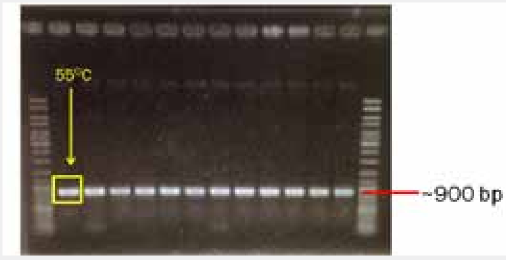


Figure 1. PCR optimization to amplify each gene

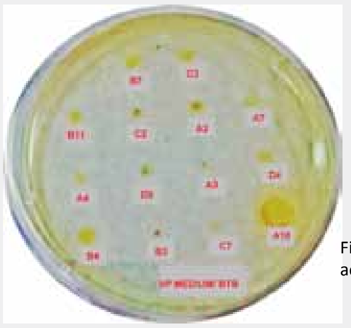
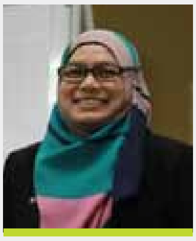


Figure 2. Rapid screening of vanillic acid producing strain



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Phd Student

Towards controlled depolymerization of polyhydroxyalkanoates by steam hydrolysis

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

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

Figure 2. PHB disks arrangement prior to steam hydrolysis

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

Phd Student

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Co-composting oil palm empty fruit bunch and anaerobic sludge palm oil mill effluent with enrichment of urea

Enrichment of urea in co-composting of oil palm empty fruit bunch and sludge palm oil mill effluent has been deploying. 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 of quantify microbes and lignocellulosic degradation able to determine detail of compost stage process. 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 factors 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.

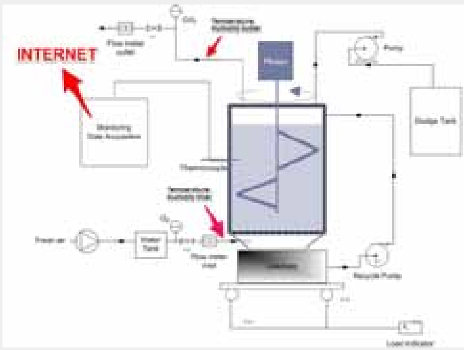

Figure 1. Composter Schematic Diagram

Figure 2. Composter

Figure 3. Temperature and Humidity Sensor with Datalogger

Phd Student

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Design of Functionalized Polyester from Long-Chain Fatty Acids

Bio-based polymers derived from renewable resources have received increasing attention from industrial sector and researchers. Plant oil, particularly palm oil is one of the interesting renewable resources that can be found abundantly in Malaysia. Therefore, in this study, in order to provide greener materials with high potentials, we propose the reaction method and combination with useful counterparts for higher efficient green products using fatty acids from plant oil. The synthesis of greener polyester using dicarboxylic acid monomer derived from metathesis of unsaturated fatty acids, was tested by condensation polymerization with aliphatic and aromatic diol in the presence of Lipase N435 and isopropyl titanate. Subsequently, in order to introduce a new reactive group and useful properties with wide use in a variety of applications, a simple and efficient method of chemical modification called olefin epoxidation was applied in the original monomers and resulted polymeric material. Characteristics of the polyester produced are varied depending on the type of precursors used during polymerization. Last but not least, the functionality of the polyester will be determined by chemical modification. Further evaluation and combination of the properties of greener and hybrid polyester will be needed in order to clarify the potential as practical useful material.

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

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

Figure 3. Unsaturated dicarboxylic acids from metahesis of oleic acid

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Expression, Purification and Characterization 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. This enzyme is a member of α-amylase family or glycosidase hydrolase family 13, which forms circular α-(1, 4)-linked oligosaccharide substrates via a covalent intermediate. Currently, the productivities of CGTases from wild-type strains are relatively low with mixtures of α-, β- and γ-CDs in different ratios and taking longer incubation time for maximum CGTase production, resulting in high costs for cyclodextrin production. Hence, the overexpression of cgt gene using Escherichia coli expression system offers a great advantage in the enhancement of the product yield and provide a straightforward way of satisfying the anticipated expansion of the cyclodextrin market. In this study, the cgt gene was constructed in E. coli expression system and placed in frame with 6x His tag for ease of protein purification and detection. Then, the optimization of codon usage and inducer supplementation were carried out to enhance the expression of CGTase.

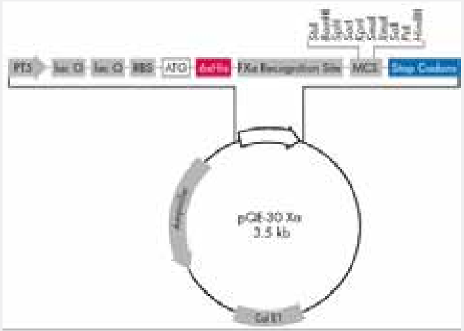

Figure 1. Schematic representation of the expression vector (pQE-30 Xa)

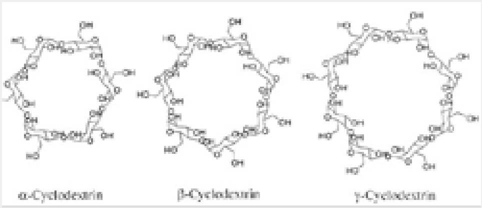

Figure 2. Schematic diagram of cyclodextrins

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Development and Optimization of Lignocellulolytic Enzymes Cocktail for Fermentable Sugars Production from Oil Palm Empty Fruit Bunch

To date, Malaysia rank in the second place as a global palm oil producer. However, a non-systematic biomass management system despite the rapid growth of oil palm plantation in Malaysia contributes a lot to biomass accumulation in huge amount. Oil palm empty fruit bunch (OPEFB) can be categorized as one of the toughest lignocellulosic biomass to be degraded naturally due to its complexity in structure. The 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 the green concept, chemical treatment is no longer suitable to be practiced because it produce harmful by-product and it gives a low yield of fermentable sugars. In this study, the OPEFB was treated biologically using crude enzyme extract due to environmental concern. The OPEFB is subjected to enzymatic hydrolysis by crude lignocellulolytic enzymes to produce fermentable sugars. Hence, the biological approach for delignification and saccharification process is expected to result in high lignin removal and consequently produces high fermentable sugars concentration.

Publication

Masran, R., Zanirun, Z., Bahrin, E. K., Ibrahim, M. F., Yee, P. L., & Abd-Aziz, S. 2016. Harnessing the potential of ligninolytic enzymes for lignocellulosic biomass pretreatment. *Applied Microbiology and Biotechnology,* 100(12), 5231-5246.

Figure 2. Overview of lignocellulosic biomass hydrolysis

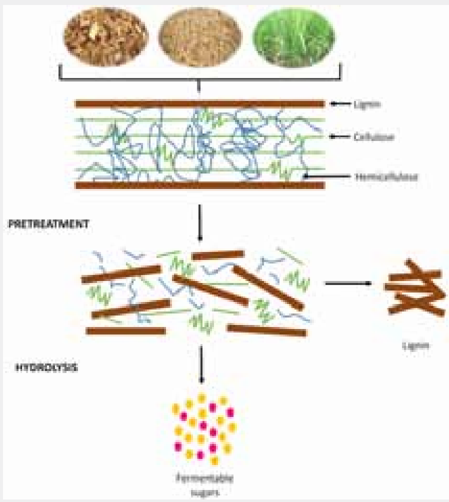

Figure 1. Pycnoporus sanguineus

Phd Student

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Controlled Depolymerization of Poly (3-hydroxybutyrate-co-3-hydroxyhexanoate) By Superheated Steam for Oligoester Production

PPolyhydroxyalkanoates (PHAs) are bacterial polymer, produced by many types of bacteria as an intracellular energy reserve material under condition of substrate limitation and in the presence of excessive carbon source. However, the intracellularly produced PHAs have high molecular weight (200 - 3000 kDa) which makes them undesirable for the production of specialty polymers that require a low, specific range of molecular weight (1 – 5 kDa). Therefore, an effective degradation method is necessary to produce oligoesters with desired molecular weight range.

In the present study, controlled degradation of PHA by superheated steam (SHS) is being studied for poly(3-hydroxybutyrate), PHB and poly(3-hydroxybutyrate-co-3-hydroxyhexanoate), PHBHHx by monitoring the mass and molecular mass changes at different treatment temperatures. Effect of SHS temperature and reaction time on the characteristics of hydrolyzed PHA was determined. Kinetic parameters and the effect of HHx unit towards the degradation mechanism were evaluated to predict the behavior of PHB and its copolymer in the aqueous medium such as human body. Currently, the SHS treated PHA degradation products are being evaluated for its biocompatibility. The finding of this research is foreseen to aid controlled depolymerization of PHA in a green route via superheated steam (SHS) hydrolysis, for various packaging and medical applications.

Publication

Rajaratanam, D.D., Ariffin, H., Hassan, M.A., and Nishida, H. (2016). Changes in diad sequence distribution by preferential chain scission during the thermal hydrolysis of poly(3-hydroxybutyrate-co-3-hydroxyhexanoate). 48, 839-842. *Polymer Journal.* (Impact Factor: 1.629)

Figure 1. Hot-pressed PHA films for superheated steam (SHS) treatment (a=PHB, b=PHB-co-6%HHx and c=PHB-co-11%HHx)

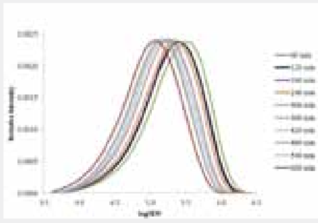

Figure 2. Changes in size-exclusion chromatography (SEC) profile of PHB-co-6%HHx during superheated steam hydrolysis at 130°C for 600 min

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Microbial Community Adaptation and Its Community Changes in Different Stages of Palm Oil Mill Effluent Treatment

The growing demand for palm oil has caused a substantial increase in the generation of palm oil mill effluent (POME). POME has been known to give the adverse environmental impacts including land and aquatic ecosystem contamination and the biodiversity loss if it is not properly treated. However, the current wastewater treatment system for POME regularly fails to treat the effluent efficiently. In Malaysia, the ponding system is commonly being used to treat POME because of the low cost and less maintenance is required. To date, only a few studies have been conducted on the microbial aspects of POME and little is known about microbial diversity involved in POME treatment, either in terms of their community structure and function or their response to the environment. Therefore, this study aims to assess the microbial community dynamics during POME treatment, as well as the comparison of the microbial community in POME final discharge from different palm oil mills. To achieve these objectives, the flow cytometry will be used to assess the microbial community function, meanwhile culture-independent approaches such as PCR-Denaturing Gradient Gel Electrophoresis (DGGE) and 16S rRNA gene sequencing on Illumina MiSeq platform will be applied to assess the microbial community structure.

Figure 1. POME treatment system in palm oil mill. (Aerobic pond)

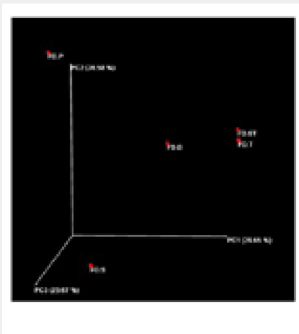

Figure 2. Principal component analysis (PCA) of bacterial community compositions for final discharge of POME different palm oil mills. FD.B: final discharge Besout, FD.P: final discharge Pasoh, FD.S: final discharge Serting, FD.ST: final discharge Sungai Tengi, FD.T: final discharge Trolak

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The Use of Oil Palm Empty Fruit Bunch and Palm Oil Mill Effluent Compost in Oil Palm Plantations as a Nutrient Recycling System for Oil Palm Industry

Fertilizers are used to enhance the growth and health of plants. Frequent and long-term application of chemical fertilizer could affect soil biodiversity. Excess fertilizer application to oil palm plantation has been practiced happen to increase oil yield. This has caused increased consumption and excessive chemical fertilizer application that could eventually lead to loss of soil biodiversity. One cycle of oil palm plantation takes around 25 years. This research is on the physical and chemical characteristic in the short and long term on plant and soil of oil palm plantation. The effect on frequent applications inorganic fertilizer on soil diversity will be elucidated. The plant physical characteristics, soil chemical composition will be correlated with the soil microbial diversity.

Figure 1. Oil Palm Plantation at Felda Serting Hilir Negeri Sembilan Malaysia.

Figure 2. Project of Oil Palm Nursery Stage between Universiti Putra Malaysia and FELDA in Ladang 10 Universiti Putra Malaysia.

Figure 3. Field work Oil Palm Plantation at FELDA Negeri Sembilan

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Phd Student

Nanofiber and Nanocomposite Production from Super Heated Steam Treated Oil Palm Biomass

In Malaysia, oil palm biomass annually generates 19.8 million tonnes of biomass on a wet basis. This provides huge resources for the conversion into value added products such as bioplastic, cellulose nanofiber (CNF) and composite. Oil palm biomass (OPB) is rich in cellulose and suitable to be used the production of CNF and composite. Current methods for isolation and nanofibrillation of cellulose involved the use of chemicals and complex processes. Therefore, alternative methods for isolation and nanofibrillation of cellulose were investigated. Moreover, the reinforcement of CNF in PP was also evaluated as to enhance the properties of PP.

A non-chemical pretreatment method by using superheated steam (SHS) was introduced prior to nanofibrillation in order to remove hemicellulose from OPB, and compared with chemical pretreatment using KOH. CNF production by electrospining and WDM were compared. In order to evaluate its mechanical properties as reinforce material for composite, produced CNF was blended with polypropylene (PP) at different proportions (1-5 wt%) of fiber through internal blending. In spite of this, one-step nanofibrillation and nanocomposite production by extrusion was also evaluated. The properties of the PP/CNF composites obtained through these two different approaches were studied.

Figure 1. Extruder

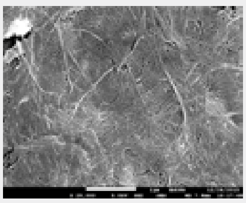

Figure 3. Nanofiber

Figure 4. Nanocomposite

Figure 2. Wet disk milling

Phd Student

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Bioelectricity Production from Oil Palm Empty Fruit Bunch Hydrolysate by *Clostridium Butyricum* A1 using Microbial Fuel Cell

Recently, microbial fuel cell (MFC) has gained attention due to its ability to transform chemical energy into electricity. MFC has been considered as an expensive technology, thus makes it challenging for commercialization in the near future. Therefore, one of the possible approaches in order to overcome the aforementioned problem is to utilize the readily available biomass as an alternative cheap substrate for MFC. The lignocellulosic biomass, such as oil palm empty fruit bunch (OPEFB) has a great potential to be utilized in MFC. The OPEFB composed of cellulose and hemicellulose that can be hydrolysed by cellulase into fermentable sugars. These fermentable sugars are possible to be used as electron donor in MFC. The fact that the potential of Clostridium sp. in MFC field has not been thoroughly documented, this study provides a fundamental knowledge in the development and better understanding for future MFC. The utilization of fermentable sugars obtained from OPEFB and local isolated Clostridium butyricum in MFC is expected to give positive and great impact in the advancement of MFC system.

Figure 1. Fermentable sugars analysis using DNS method

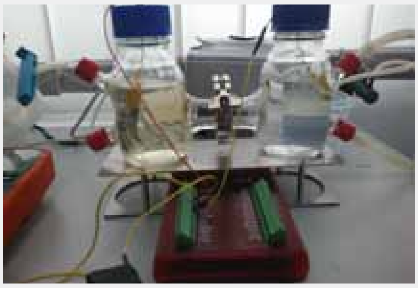

Figure 2. MFC Setup of bioelectricity generation using double chambers system

Phd Student

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Evaluation of Toxicity and Identification of Toxic compounds in Palm Oil Mill Effluent

Palm oil processing is carried out using large quantities of water in mills where oil is extracted from the palm fruits. The final discharge called Palm Oil Mill Effluent (POME) contains complex vegetative matters including high degradable organic matter. This highly polluting wastewater usually discharged into rivers and can cause harm to aquatic life and water quality if not properly treated. Even though Malaysian government already enforce the strict law on Environmental Quality Regulations 1997, which require mills to treat their effluent to safe level before discharge, none of these POME level contents were specifically checked. Toxicity content is one of the main indications for pollution. If the POME has toxicity content, this could be severely harmful to its surrounding environment. Therefore, a detail study need to be carry out to evaluate and identify the toxicity contain in POME and if it does contain, a proper adjustment should be introduce to the POME treatment before it can be discharge safely to the environment.

Figure 1. Final discharge pond in palm oil mill

Figure 2. Raw palm oil mill effluent

Figure 3. Sunlight effect experiment using POME final discharge

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Phd Student

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

Figure 3. Pretreatment oil palm frond slurry

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Simultaneous Carbonization and Activation of Palm Kernel Shell for Activated Carbon Production

This is a new concept for the production of activated carbon, which is known as two-in-one carbonisation and activation system (Figure 1). This technology has been fully developed by collaboration between Malaysian Palm Oil Board (MPOB) and Universiti Putra Malaysia (UPM). This new system successfully process two-in-one carbonisation and activation system produces efficiently high quality of activated carbon with high yield by physical activation using steam (Figure 1). The process begins with biomass waste as input and ends with three forms of product yield i.e., charcoal, wood vinegar and fuel gas. Dry palm kernel shell (PKS) was fed into the reactor, heated using a diesel burner to a set temperature and held the temperature for a period of full carbonisation to obtain carbonised products (char). Then, the carbonised products subjected to steam activation in the same reactor and hold for the activation. The flow rate of water into the perforated pipes was monitored and duration of activation can be varied to investigate the effect of activation time on the quality of activated carbons derived from the reactor (Figure 2).

Publication

Zainal, N. H., Aziz, A. A., Idris, J., Mamat, R., Hassan, M. A., Bahrin, E. K., & Abd-Aziz, S. 2016. Microwave-assisted pre-carbonisation of palm kernel shell produced charcoal with high heating value and low gaseous emission. *Journal of Cleaner Production.*

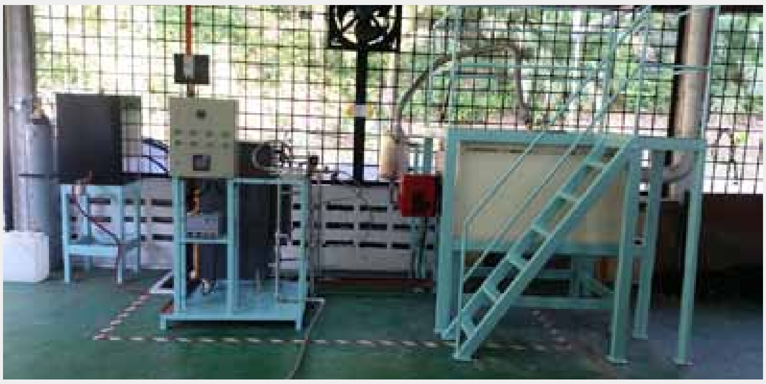

Figure 1. Two-in-one carbonisation and activation system located at MPOB-UKM, Bangi Lama

Figure 2. Activated carbon of palm kernel shell obtained using two-in-one carbonisation and activation system.

Phd Student

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Pineapple Crown and Lemongrass Leaves as Potential Precursors for Flavor Enhancer

Vanilla extract which naturally extracted from vanilla seed pod, is highly valued for its organoleptic flavor. The flavor contains almost 200 substances that contributed to complex flavor of vanilla. The two main contributors to the characteristic flavor of original vanilla are known as vanillin and p-hydroxybenzaldehyde. Since the natural vanilla extract is limited and highly priced, biotechnological approach using microorganism biotransformation has been proposed as a natural and sustainable alternative over chemically synthesized artificial vanilla. Moreover, many studies reported are focusing on producing vanillin as the targeted product however, limited studies are found on the combined production of vanillin with p-hydroxybenzaldehyde in the same media culture. In this study, vanillin and p-hydroxybenzaldehyde will be produced from pretreated pineapple crown and lemongrass leaves. Optimization studies will be carried out to obtain the optimal conditions of vanillin and p-hydroxybenzaldehyde followed by the purification and characterization of the final products.

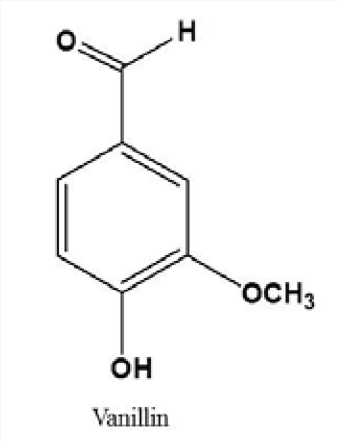

Figure 1. Vanillin

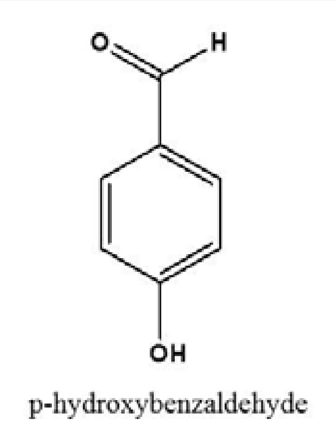

Figure 2. p-hydroxybenzaldehye

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Production of Cellulolytic Enzymes via Solid State Fermentation of Spent Mushroom Substrate by Trichoderma Asperellum UPM 1

Mushroom, fall in the class of basidiomycetes, is a fruiting part of the fungus. Over others, Pleurotus spp. has listed as the second most cultivated edible mushroom in worldwide and particularly accounted for 90% of mushroom production in Malaysia. It can be cultivated successfully on saw dust, coir waste, rice straw, olive mill waste and other lignocellulosic biomass. Its capability in secreting various degradative enzymes; ligninases, hemicellulases, and cellulases become the major key to enable them to grow on various substrates. Changes in enzyme profile are correlated with vegetative growth and fruiting body development of Pleurotus sp. To investigate the enzyme activities during fructification phase, samples from mycelia colonised substrate of P. pulmonarius and P. floridanus were taken during fruiting body formation. The result showed both strains were able to produce laccase and manganese peroxidase (MnP). The presence of laccase and manganese peroxidase at the end of cultivation period offering great potential of spent mushroom compost for various applications.

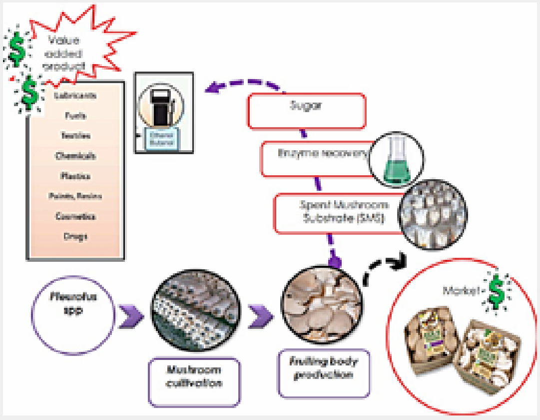

Figure 1. Schematic flowchart of enzyme recovery from mushroom cultivation

Figure 2. Oven – dried spent mushroom compost

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Master Student

Alkaline hydrolysate of oil palm empty fruit bunch as potential substrate for biovanillin production via two-step bioconversion

Vanillin is one of the most commonly used flavours in food, beverages, perfumes and pharmaceutical products which extracted from the beans of Vanilla planifolia. It is known that natural vanillin has high demand and market price than synthetic vanillin. Due to that, extensive studies are carried out on the production of biovanillin via microbial bioconversion. Aspergillus niger, Pycnoporus cinnabarinus and Phanerochaete chrysosporium are the common fungi used for the biovanillin production. Phenolic compounds such as ferulic acid, vanillic acid and eugenol or isoeugenol have been proved as precursors for biovanillin production. Instead of using synthetic biovanillin precursors, researchers now had found an alternative to use the phenolic compounds extracted from lignocellulosic biomass. In this study alkaline hydrolysate of oil palm empty fruit bunch (OPEFB) had been used as substrate for biovanillin production. Based on the composition of phenolic compounds in alkaline hydrolysate of OPEFB, there are five major phenolic compounds selected which are syringic acid, syringaldehyde, p-hydroxybenzoic acid, p-coumaric acid and ferulic acid. The interactions of those compounds are studied in order to see the significance of each phenolic compound towards vanillic acid production using two level full factorial designs.

Publication

Zulkarnain, A., Bahrin, E. K., Ramli, N., Phang, L. Y., & Abd-Aziz, S. 2016. Alkaline Hydrolysate of Oil Palm Empty Fruit Bunch as Potential Substrate for Biovanillin Production via Two-Step Bioconversion. *Waste and Biomass Valorization*, 1-11.

Figure 1. Oil palm empty fruit bunch

Figure 2. *Aspergillus niger*

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Co-composting of Municipal Sewage Sludge and Landscaping Waste by Pilot Plant Scale and The Application of Compost to an Ornamental Plant, *Tagetes erecta*

Composting process is one of effective ways of recycling biomass that been generated from natural environment since decades ago. Landscaping waste is defined as the accumulation of biodegradable waste as the result of care of landscape area. Municipal sewage sludge is the wastes generated during treatment of domestic wastewater sewage. Those biomass are examples of renewable materials that can be utilized to produce high value product with nutrient-rich organic matter such as biocompost. However, based on current research, these materials are still not being utilized completely in Malaysia. With the nutrient availability present within both materials, biocompost production can be established directly by aerobic fermentation.

This research is focusing on the co-composting process of landscaping wastes and municipal sewage sludge that been carried out using windrow and bioreactor system, which can be considered as semi-pilot scale for producing the biocompost. Compost performance was being determined using proximate and ultimate analysis of the product produced and also the maturity test of product. Besides that, this research is done to evaluate the potential of produced biocompost on the growth performance of ornamental plant, Tagetes erecta. With the information obtained from this research, the biocompost produced can be used for the ornamental plant.

Publication

Dzulkurnain, Z., Hassan, M. A., Zakaria, M. R., Megat Wahab, P. E., Hasan, M. Y., and Shirai, Y. (2016). Co-composting of Municipal Sewage Sludge and Landscaping Waste: A Pilot Scale Study. *Waste and Biomass Valorization.* doi:10.1007/s12649-016-9645-7

Figure 1. Composting site in Bio-Refinery Pilot Plant, FBSB, UPM

Figure 2. Composting bioreactor of 10 m^3 size

Figure 3. Planting trial on *Tagetes erecta*

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Production of Polyhydroxyalkanoates from an Engineered *Escherichia Coli* through Molecular Biotechnology Approach

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

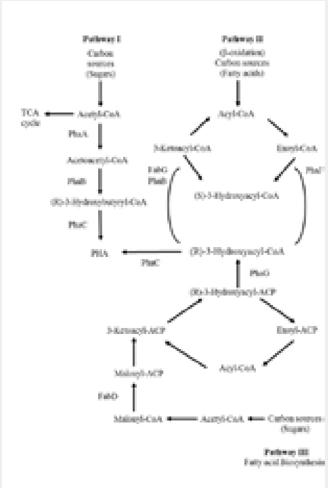

Figure 1. Pathway

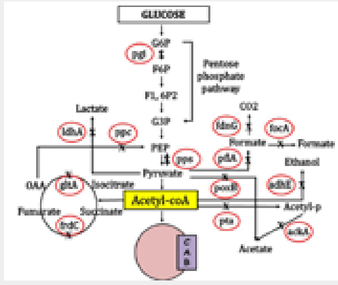

Figure 2. Metabolic pathway which lead to accumulation of PHA

Figure 3. Gas chromatography

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Optimization of Oil Palm Biomass Superheated Steam Treatment Improving Fiber Characteristic and Biocomposite Performance

Superheated steam (SHS) treatment is an effective method for hemicellulose removal from oil palm biomass (OPB) fiber to improve the compatibility of the fiber with polymer matrix in biocomposite production. Current SHS treatment is conducted at temperature around 210 - 230ºC for 60 - 180 min. The long treatment time caused degradation of cellulose resulting in fiber with reduced crystallinity; and this condition would affect biocomposite mechanical properties. This study was hence conducted with the aim to optimize the SHS treatment temperature and retention time so that only hemicellulose will be removed and not cellulose, during the treatment. In this study, the removal of hemicellulose was in the range of 60% to 70%, while the cellulose degradation was maintained below 5%. SHS treatment time can be shortened to only 5 min to 9 min, which is 18 to 20 times shorter than previously reported. Biocomposites produced had tensile strength and flexural modulus of 26 MPa and 1739 MPa respectively, which is 21 - 23% higher than those reported in the literature. In overall, optimizing the SHS treatment conditions will not only making the treatment method favorable for large scale application due to reduced treatment time, but also improved the fiber and biocomposite properties.

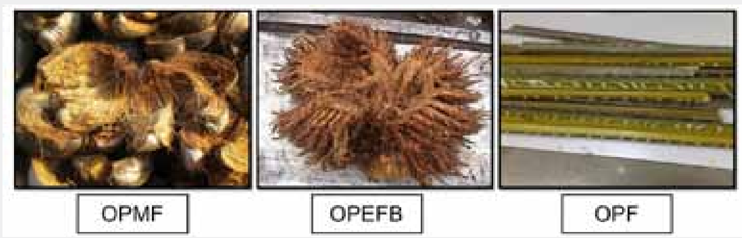

Figure 1. Different parts of oil palm biomass produced after palm oil extraction

Publication

Muhammad Nazmir Mohd Warid, Hidayah Ariffin*, Mohd Ali Hassan, Yoshihito Shirai. Optimization of Superheated Steam Treatment to Improve Surface Modification of Oil Palm Biomass Fiber. *Bioresources*, 11(3), 5780-5796. (Q1, IF=1.425)

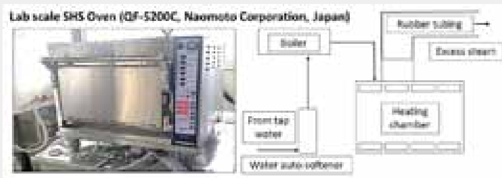

Figure 2. Lab-scale superheated steam oven used for this study

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Master Student

Molecular Cloning of β-Glucosidase Gene into *Saccharomyces cerevisiae* for Enhancement of Bioethanol Production from Oil Palm Empty Fruit Bunch Hydrolysate

Concerns on fossil fuel consumption has led to bioethanol emerging as an alternative renewable fuel. In Malaysia, abundance of oil palm waste generated including oil palm empty fruit bunch (OPEFB) offers great potential as lignocellulosic substrate. For efficient hydrolysis, high conversion rates from cellulase enzyme constituents; endoglucanase, exoglucanase, and β-glucosidase, are deemed essential. However, the common low β-glucosidase expression has resulted in cellobiose buildup, thus causing feedback inhibition. One approach to meet these challenges requires generation of a β-glucosidase expressing yeast strain capable of carrying out simultaneous saccharification and bioethanol fermentation. Previous genetic engineering efforts to achieve heterologous β-glucosidase expression in bioethanol fermenting yeast has resulted in expected increase in cellulose hydrolysis and subsequent bioethanol production. However, use of said recombinant strain for bioethanol fermentation from OPEFB hydrolysate derived cellobiose has yet proved elusive. In addition, the emergence of codon optimization for enhancement of heterologous gene expression has also yet to be demonstrated. Hence, this research aims to isolate β-glucosidase from local *Trichoderma asperellum*, and following codon optimization, express in Saccharomyces cerevisiae¸ with subsequent analysis on cell growth, enzyme production, liberated sugars concentration and bioethanol production.

Figure 1. Oil palm empty fruit bunch substrate

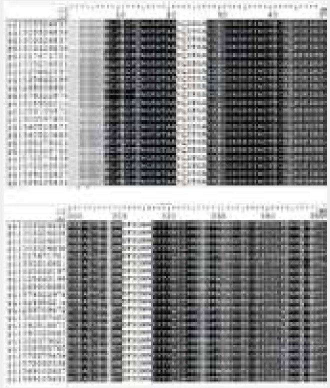

Figure 2. Conserved amino acids of β-glucosidases from several *Trichoderma asperellum*

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

With the depletion of non-renewable fossil fuels and the growing environmental awareness, biodiesel is seen as a promising substitute for the conventional diesel. Its eco-friendly properties such as being renewable, biodegradable and less carbon emission have brought new hope for a greener future. In this study, improved production of biodiesel from waste cooking oil was achieved by using a newly developed potassium phosphate tri-basic supported activated carbon catalyst. Under the optimum reaction conditions, 98 wt% of biodiesel yield was achieved, which surpassed the European Biodiesel Standard (EN 14214). The catalyst was reusable for 4 successive reaction cycles, achieving higher than 80 wt% of biodiesel yield. In addition, the oil palm biomass-derived bioadsorbent was exploited to remove impurities from the crude biodiesel. Approximately 89.7% of methanol, 81.7% of water, 80% of FFA, 26.3% of triglyceride, 98.6% of potassium and 40% of free glycerine were successfully removed, which met the European Biodiesel Standards (EN 14214). In comparison to other commercial adsorbents and conventional water washing method, purification using the biomass-derived bioadsorbent resulted in better removal of methanol, water and triglyceride impurities with only a small loss of biodiesel yield.

Figure 1. Crude biodiesel

Figure 2. Purified biodiesel

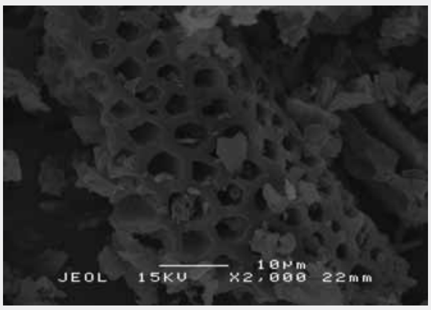

Figure 3. Oil palm biomass-derived activated carbon

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Bioadsorbent Produced from Oil Palm Decanter Cake by Carbonization and Steam Activation

Heavy metals were among the prominent hazardous wastes contain in wastewater. Due to rapid growth of population, industrial expansion, and unorganized urbanization, there is great amount of wastewater produced. Therefore, the wastewater needed to be treated adequately to meet the discharge standard. Various treatment processes were used for the treatment of heavy metals, however, adsorption process shown the most efficient treatment. Commercial activated carbon is commonly used for the treatment due to its high effectiveness but involved high cost. This study investigate the usage of oil palm decanter cake (OPDC) as a precursor for alternative activated carbon production. The OPDC will be activated by steam activation process, preceded by carbonization at 700°C and followed by steam activation at temperatures between 600°C to 800°C. The effects of activation temperatures and holding times on the characteristics of the activated carbon produced will also be investigated. Characterization of activated carbon yield, specific surface area, porousity, and heavy metals (Cu(II), Pb(II), Cd(II), Zn(II) and Cr(VI)) adsorption will be conducted. It is expected that with steam activation process, a quality activated carbon can be produced from the OPDC.

Figure 1. Reactor used for carbonization and activation

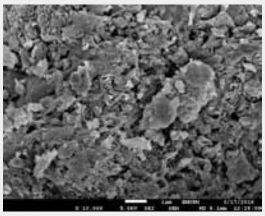

Figure 2. SEM micrograph of activated OPDC

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Co-composting of Kitchen Waste and Sawdust with Addition of Biochar

Malaysia is facing crucial solid waste management issue due to population, economic growth, lack of waste management legislation, infrastructure and attitude of public especially in urban areas. Ministry of Housing and Local Government reported that in 2010, peninsular Malaysia alone has generated an estimated 25,000 metric tonnes of municipal solid waste (MSW) daily of which 50% were kitchen wastes (at source) whereas 930 tonnes food unconsumed and being disposed.

Composting seems to be feasible approach since kitchen wastes has high moisture content, high organics-to-ash ratio, and loose physical structure. However, composting of kitchen wastes need to be sustained to reduce problem that commonly arise while the process is undergone. Recent studies showed the interest of researchers on applying biochar to compost to improve degradation process. Unique characteristics of biochar which has high porosity, sorption capacity and cation exchange capacity can allow microorganisms to live at the surface and promotes different activity in soil. Recent studies has shown that application of biochar into the composting process improve physico-chemical characteristics of composts. In summary, this research can contribute to improve waste recycling system in this country by utilizing biomass produced from local and industry.

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

Figure 2. Kitchen waste collected from Serdang food court

Figure 3. Compost product

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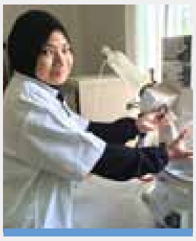
Master Student

Optimization of Biobutanol Production through Simultaneous Saccharification and Fermentation from Oil Palm Empty Fruit Bunch

Biobutanol has become one of the potential biofuels that serve as an alternative to fossil fuels. Biobutanol production has been successfully conducted through simultaneous saccharification and fermentation (SSF) using oil palm empty fruit bunch (OPEFB). OPEFB is one of the low-cost lignocellulosic biomass, with high cellulose and hemicellulose content which can be saccharified into sugars by cellulase enzymes. The sugars are subsequently fermented by Clostridium acetobutylicum into biobutanol. The SSF process involves the one-step addition of Clostridia species, cellulase enzymes and OPEFB in a vessel. The SSF process generates biobutanol yield that is comparable with the separate hydrolysis and fermentation (SHF) with improvements in the terms of reducing steps in the OPEFB conversion to biobutanol. However, the SSF process needs to undergo optimisation to increase the biobutanol production. The capabilities of SSF process at higher working capacity using bioreactor have not been tested. Due to these several advantages, further study for improvements of the SSF process is to be discovered.

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

Figure 2. Gas chromatography



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Biosurfactant Production from Used Cooking Oil by Local Isolates for Heavy Metals Removal

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

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

Figure 2. Raw biosurfactant was dried using a rotavap prior to purification

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

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

Figure 1. Fermentation in incubator shaker

Figure 2. Fermentation using engineered strain

Figure 3. Fermentation using parental strain

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Optimization of Simultaneous Saccharification and Fermentation for Biobutanol Production from Sago Hampas

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

Figure 1. Drying sago hampas under sunlight

Figure 2. Determination of ABE and organic acids using gas chromatography (Model GC-17A, Shimadzu, Japan) with column BP21 and equipped with flame ionisation detector

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In Situ Recovery of Biobutanol Produced from Simultaneous Saccharification and Fermentation using Gas Stripping-Distillation Techniques

Biobutanol is one of the next promising future sources of energy that can substitute the depleting underground fossil fuels. As compared to other energy sources, biobutanol is the most suitable bioenergy as it has less negative impacts on the environment and produces better energy density than ethanol. However, the process of biobutanol extraction is rather challenging due to the requirement of a large amount of biomass, low yield of butanol, low butanol titer, and slow fermentation rate. Therefore, this study is conducted to increase the recovery of biobutanol produced from simultaneous saccharification and fermentation by using pretreated oil palm empty fruit bunch (OPEFB) waste as a substrate. Powerful microbe like Clostridium acetobutylicum is used to utilize the released sugar after an enzymatic attack of OPEFB and produce biobutanol. By applying in-situ recovery such as gas stripping technique, the butanol toxicity is reduced and subsequently the fermentation efficiency is improved. The gas stripping-distillation recovery system is believed to be the next future system for large scale biobutanol processing.

Figure 1. Sample injection into Gas Chromatography bioreactor

Figure 2. Bioreactor

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Effect of Physico-Chemical and Biological Pretreatment of Oil Palm Biomass for Fermentable Sugars Production

Oil palm empty fruit bunch (OPEFB) and oil palm mesocarp fiber (OPMF) are lignocellulosic biomass wastes that abundantly generated in palm oil mills which provide potential bioresources for the conversion into value-added products such as biosugars. The presence of hemicellulose and lignin hinders the access of cellulase to cellulose thus resulting in low efficiency of the hydrolysis. Effective pretreatments are needed to reduce the recalcitrance of lignocellulosic structures to improve fermentable sugars production. This study proposes an environmental approach by combining physico-chemical and biological pretreatment of OPEFB and OPMF to obtain high fermentable sugar production. The physico-chemical pretreatment used in this study was superheated steam (SHS) where the unsaturated steam generated by addition of heat to saturated steam during its process. However, from previous studies, SHS treatment alone does not produce high fermentable sugars thus combination with the biological pretreatment will enhance the production of fermentable sugars. In biological pretreatment, laccase is a ligninolytic enzyme use to degrade lignin. It loosened the compact wrap of lignin-carbohydrate complex and consequently enhances saccharification efficiency of cellulose. Further improvement on the combination process is expected to enhance fermentable sugars production.

Figure 1. Superheated steam pretreatment of OPMF and OPEFB

Figure 2. Fermentable sugar after 48 hours saccharification

Master Student

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

Palm oil industry is one of the major industry that contributes significantly to Malaysia's economic growth. Concurrent to the high production of palm oil, an enormous volume of palm oil mill effluent (POME) is being generated each year. The most common practice of palm oil mills is discharging the treated and partially treated POME into the nearby river water, and this situation has led to unfavourable impacts on the water system. However, up to this date, little is known about the relationship between the microbial community and hydrogeochemistry at effluent-receiving river water. The emergence of metagenomic studies which are based on the next-generation sequencing and molecular fingerprinting for particular has allowed the study of the responses of the indigenous microbial community towards environmental perturbations in situ and revealed an enormous reservoir of uncultured microbes that previously could not be explored due to the limitation of the conventional laboratory culturing method. The knowledge on the responses of the bacterial population towards perturbation of wastewater discharged from palm oil mill helps us to comprehend the influence of this industry on the water bodies in order to ensure a sustainable industrial practice.

Figure 1. The discharging of treated palm oil mill effluent from mill into the river water

Figure 2. Samples from unpolluted and polluted part of the river.

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Enzyme-Assisted Extraction of Essential Oil from Pineapple Peels using Cellulase

The pineapple canning industry produces a substantial amount of solid waste like peels, cores, stems, crowns and pulp. Pineapple waste disposal can cause microbial spoilage and environmental problems due to the waste material containing high moisture and sugar content. This study is proposed to utilize the pineapple peels, to produce a high value added product of essential oil. The volatile compounds of pineapple peels can be extracted through a green approach using hydro-distillation method. Pretreatment of the substrate using commercial cellulase is applied prior to the hydro-distillation extraction, in order to improve the yield. In addition, several factors are optimized to determine the optimum condition of enzymatic pretreatment and extraction process. The factors involved includes enzyme loading (FPU/g), hydrolysis time (minutes), the substrate to solvent ratio, extraction time (hour) and extraction temperature (ºC). The aromatic compounds of the obtained essential oil are analysed using GC and GC-MS, respectively. Moreover, the cell wall of the enzymatic pretreated substrate is observed under Scanning Electron Microscopy (SEM) as compared to the untreated substrate. Overall, this study is crucial to promote an efficient pineapple waste management by producing a high value added product of essential oil through an optimized green method of enzyme-assisted extraction.

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

Figure 2. The hydro-distillation set up

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Utilization of oil palm mesocarp fiber for the production of cellulose nanofiber and nanocomposite

Oil palm mesocarp fiber (OPMF) is one of the major biomass generated from palm oil industry and it is currently inefficiently burnt at palm oil mill as a mean of disposal. With the growing concern on environmental sustainability and finite supply of non-renewable resources, particular attention can be given to produce value-added materials from OPMF such as cellulose nanofibers (CNF). In this study, OPMF-cellulose was subjected to different fibrillation process; electrospinning, ultrasonication and high pressure homogenization. CNF produced was then used for CNF/polyethylene, PE nanocomposite production using an internal blending mixer. Scanning electron microscopy micrographs of CNF produced from all the three methods revealed that CNF produced were in the range of 40 to 110 nm. It was discovered that thermal, crystallinity and mechanical properties of CNF/PE nanocomposites produced from were markedly enhanced compared to neat PE, even at 1% wt CNF content. The properties of CNF/PE nanocomposite produced using one-pot extrusion method were at the same par with those obtained from two-step process. Overall, results obtained from this study provide new insight on the production of cellulose nanofiber and nanocomposites from oil palm biomass, without compromising the properties of the CNF and nanocomposites obtained.

Figure 1. Chemically treated OPMF

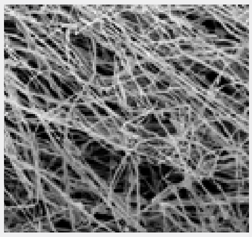

Figure 2. Cellulose nanofibers viewed from SEM

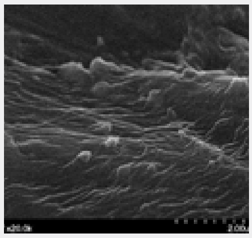

Figure 3. The distribution of cellulose nanofibers reinforced in PE matrix

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Production of xylooligosaccharides from oil palm mesocarp fiber using hydrothermal pretreatment

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

Figure 1. Sand bath reactor for hydrothermal process

Figure 2. HPLC for analysis

Figure 3. EDX analysis for morphological characteristic

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Development of Robust Hydrothermal Pretreatment to Produce Glucose from Oil Palm Biomass

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

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

Figure 3. Pretreated solid after saccharification process

Figure 2. Saccharification process of mixed oil palm biomass

Master Student

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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

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Biological Pretreatment of Oil Palm Empty Fruit Bunch (OPEFB) Using Indigenous Fungus for Fermentation Feedstock

Oil palm empty fruit bunch (OPEFB) is one of the biomass generated from palm oil mills. OPEFB contained lignocellulosic components that can be converted into value-added product through several alternative pretreatments such as physical, chemical, physicochemical and biological pretreatment. At present, mild pretreatment such as biological pretreatment is being considered to replace the conventional pretreatment (physicochemical pretreatment) as they require low energy and an environmental friendly pretreatment. Biological pretreatment can be divided into two categories which are microbial pretreatment and enzymatic pretreatment. Particularly, biological pretreatment using indigenous fungus is considered as a cheaper option compared to enzymatic pretreatment. At present, the wood-rot fungi such as white-rot fungi, soft-rot fungi, and brown-rot fungi are the fungi that able to produce the lignocellulosic enzymes and contributed to the modification of lignocellulosic structure and hemicellulosic removal. Thus, biological pretreatment using indigenous fungus will be carried out in this study to convert the OPEFB into fermentation feedstock as the value-added product.

Figure 1. Culture of indigenous fungus on agar plate

Figure 2. Fungal pretreatment of OPEFB

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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. The POME contains high COD, high BOD, soluble materials, some gases such as CH4, S02 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. The approach of this experiment is to treat POME that will be by using the wetland system. This wetland system is more compatible as compare to other system to treat the POME final discharge since it is more cost effective and fewer side effects as compared to the biological and chemical approach.

Figure 1. Sample empty fruit bunch fibre (EFB)

Figure 2. POME pond at Felda Pasoh, Negeri Sembilan

Figure 3. POME sampling at Felda Pasoh, Negeri Sembilan

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Non-chlorinated, Eco-friendly Cellulose Nanofiber Production Production from Oil Palm Biomass

Cellulose nanofiber (CNF) is an emerging bioproduct, produced mainly from plant resources. Among CNF applications are including in composite products, automotive, binding agent, ink, tissues scaffold and etc. The biggest challenge in producing CNF lies on pretreatment method for cellulose extraction. Current pretreatment methods require harsh treatment and chlorinated bleaching agent for delignification, which is environmentally unfavorable. Therefore this study aims to evaluate the potential use of non-chlorinated bleaching agent for cellulose extraction from oil palm biomass (OPB). OPB will be firstly treated using a superheated steam (SHS) oven for hemicellulose removal. Previous research exhibited that there was hemicellulose residue left after SHS treatment, which is expected due to recalcitrant hemicellulose. Thus, in this study the use of xylanase followed by NaOH treatment is expected to promote the removal of recalcitrant hemicellulose, and also lignin. CNF obtained will be characterized using field emission scanning electron microscopy (FE-SEM), thermogravimetric analyzer (TGA), Fourier transform infrared spectroscopy (FTIR) and wide angle x-ray diffraction (WAXD). By using multi-step treatment consists of thermal (SHS), enzymatic (xylanase) and mild chemical (NaOH), it is foreseen that fibrillation of cellulose in WDM will occur faster and that the cellulose nanofiber obtained will have smaller diameter.

Figure 1. Superheated steam treatment (SHS)

Figure 2. Delignification process

Figure 3. Fibrillation using wet disc milling (WDM)

Alumni EB 2016

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Title of Project : Production of Activated Carbon from Oil Palm Mesocarp Fiber for the Treatment of Palm Oil Mill Final Discharge
Former Supervisor : Prof. Dr. Mohd Ali Hassan

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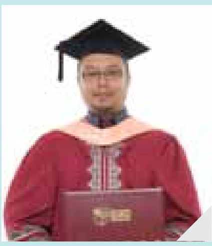
Nur Sharmila Sharip

Title of Project : Characterization and Antifungal Properties of Oil Palm Mesocarp Fiber Superheated steam Condensate
Former supervisor : Assoc. Prof. Dr. Hidayah Ariffin



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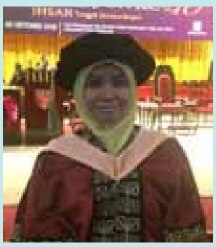
Former supervisor : Prof. Dr. Suraini Abd Aziz



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	3	Dr. Mohd Huzairi Mohd Zainudin	Institute of Tropical Agriculture & Food Security, UPM, Selangor.	Research Officer	PhD	Prof. Dr. Mohd Ali Hassan
	4	Dr. Sharifah Soplah Syed Abdullah	UniKL, Malacca.	Senior Lecturer	PhD	Prof. Dr. Yoshihito Shirai
	5	Che Mohd Hakiman Che Maail	Biosyntech Sdn Bhd, Selangor.	Sales Executive	MSc	Assoc. Prof. Dr. Hidayah Ariffin
	6	Mohd Rahimi Zakaria @ Mamat	Malaysia Rubber Board, Selangor.	Research Officer	MSc	Assoc. Prof. Dr. Hidayah Ariffin
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	9	Dr. Nor Asma' Abdul Razak	Biomolecule Medicine Laboratory, Institute of Bioscience, UPM, Selangor.	Research Officer	PhD	Prof. Dr. Mohd Ali Hassan
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	18	Farah Nadia Omar	Faculty of Engineering, UPM	PhD student	MSc	Assoc. Prof. Dr. Nor'Aini Abdul Rahman
	19	Halimatun Saadiah Hafid	Faculty of Biotechnology and Biomolecular Sciences, UPM	PhD student	MSc	Assoc. Prof. Dr. Nor'Aini Abdul Rahman
	20	Isnazunita Ismail	Environmental Technology Research Centre, SIRIM Berhad, Shah Alam, Selangor.	General Manager	MSc	Prof. Dr. Suraini Abd Aziz
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	22	Nurul Kartini Abu Bakar	Malaysian Technology Development Corporation, Kuala Lumpur.	Acting Head, Processing TAF/CRDF Unit	MSc	Prof. Dr. Suraini Abd Aziz
2010	23	Dr. Khanom Simarani	Faculty of Sciences, UM, Kuala Lumpur.	Senior Lecturer	PhD	Prof. Dr. Yoshihito Shirai
	24	Dr. Alawi Sulaiman	Faculty of Plantation and Agrotechnology, Universiti Teknologi MARA (UiTM), Shah Alam, Selangor.	Deputy Dean (Research, Industry Community, Alumni Network and Entrepreneurship)	PhD	Prof. Dr. Mohd Ali Hassan
2009	25	Dr. Mei-Ling Chong	Technology Park Malaysia	Research Officer	PhD	Prof. Dr. Mohd Ali Hassan
	26	Assoc. Prof. Dr. Norjan Yusof	Faculty of Science & Mathematics, Universiti Pendidikan Sultan Idris (UPSI), Tanjung Malim, Perak.	Associate Professor	PhD	Prof. Dr. Yoshihito Shirai
	27	Zatilfarihiah Rasdi	UiTM, Kuala Pilah Negeri Sembilan.	Senior Lecturer	MSc	Assoc. Prof. Dr. Nor'Aini Abdul Rahman
	28	Dr Meisam Tabatabei	Agricultural Biotechnology Research Institute of Iran (ABRII), Iran.	Assistance Professor	PhD	Prof. Dr. Mohd Ali Hassan
2008	29	Zulkarami Berahim	Institute of Tropical Agriculture & Food Security, UPM, Selangor.	Research Officer	PhD	Prof. Dr. Suraini Abd Aziz
	30	Assoc. Prof. Dr. Tengku Elida Tengku Zainal Mulok	Faculty of Applied Sciences, UiTM Shah Alam, Selangor.	Senior Lecturer	PhD	Prof. Dr. Mohd Ali Hassan
2007	31	Majd Khalid Eshtaya	Chemical Engineering Department, An-Najah National University, Palestine.		MSc	Prof. Dr. Mohd Ali Hassan
	32	Dr. Shahrakbah Yacob	Sime Darby Plantation Berhad, Selangor.	Principal Agronomist	PhD	Prof. Dr. Mohd Ali Hassan

Wall of Fame

Norjan Yusoff (PhD) is an Associate Professor of Department of Biology, Faculty of Science and Mathematics, Universiti Pendidikan Sultan Idris (UPSI). Before becoming senior lecturer at UPSI, she had served in Universiti Kebangsaan Malaysia (UKM) as lecturer since 1998. Dr. Norjan graduated from Kyushu Institute Technology, Japan (Kyutech) in 2010 under supervision of Prof Yoshihito Shirai. Currently, her research interest is focused on biological nitrogen removal from wastewater via nitrification, denitrification and anammox, solid waste management and biofuel production from microalgae. She had successfully completed three university research grants and one international grant funded by Sumitomo Foundation, Japan. She has co-authored 1 book, 2 book chapters and more than 10 research papers in peer reviewed international journals. She also has reviewed manuscript papers in leading Elsevier scientific journals Desalination (IF: 3.960) and Waste Management (IF: 3.157). She had received medals and awards in National Research & Innovation Competition (NRIC) 2011, Malaysia Technology Expo (MTE) 2011, UPSI Research and Innovation Expo 2007. In 2011, she had been awarded with Travel Grant Award from Nitrification Network, USA for attending the International Conference on Nitrification, Nijmegen, The Netherlands. She has delivered numerous invited lectures on topics in the field of solid waste management and landfill leachate treatment. In addition, she pioneered community project of solid waste management at Tanjung Malim, Perak for Knowledge Transfer Programme Grant Scheme (KTP) funded by MOHE. Her current professional memberships include the Environmental Management Society of Malaysia (EMS) since 2005 and Nitrification Network (International) since 2009.

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