ISSN 0125-9318 (Printed version)
ISSN 1858-3768 (Electronic version)

Accreditation No. 177/E/KPT/2024

MENARA PERKEBUNAN

INTERNATIONAL JOURNAL OF BIOTECHNOLOGY AND BIOINDUSTRY

Volume 93, No 2, 2025

INDONESIAN OIL PALM RESEARCH INSTITUTE
PT. RISET PERKEBUNAN NUSANTARA
Jl. Taman Kencana No. 1 Bogor 16128

ISSN 0125-9318 (Print version)
ISSN 1858-3768 (Electronic version)

Accreditation No. 177/E/KPT/2024

MENARA PERKEBUNAN

INTERNATIONAL JOURNAL OF BIOTECHNOLOGY AND BIOINDUSTRY

Volume 93, Number 2, 2025

INDONESIAN OIL PALM RESEARCH INSTITUTE
PT. RISET PERKEBUNAN NUSANTARA

Menara Perkebunan	Vol. 93	No.2	Page 83-157	Bogor, 2025	ISSN 0125-9318 (Print version) 1858-3768 (Electronic version)

ISSN 0125-9318 (Print version)
ISSN 1858-3768 (Electronic version)

Accreditation No. 177/E/KPT/2024

MENARA PERKEBUNAN

INTERNATIONAL JOURNAL OF BIOTECHNOLOGY AND BIOINDUSTRY

Volume 93, Number 2, 2025

INDONESIAN OIL PALM RESEARCH INSTITUTE
PT. RISET PERKEBUNAN NUSANTARA

ISSN 0125-9318 (Print version)
ISSN 1858-3768 (Electronic version)

Menara Perkebunan

International Journal of Biotechnology and Bioiondustry

Volume 93, Nomor 2, 2025

First published in 1926 under the name *De Bergculture*, in 1956 it change its name to *Menara Perkebunan*
First edition has ISSN number of 0125-9318 (print version) in 1977, and ISSN number 1858-3768 (electronic version) in 2004 edition

PUBLISHER
Indonesian Oil Palm Research Institute

ADDRESS
Indonesian Oil Palm Research Institute- Bogor unit
Jl. Taman Kencana No.1, Bogor 16128 – Indonesia
Telp. (0251) 8324048/8327449 Fax. (0251) 8328516
E-mail: menaraperkebunan@iribb.org/ menaraperkebunanppbbi@gmail.com http://mp.iribb.org

PUBLISHING PERMIT
Dep. Penerangan RI No. 1196/SK/Ditjen PPG/STT/1987
21 December 1987

Published on April and October, free download available at *www.mp.iribb.org*

Accreditation number 177/E/KPT/2024

REVIEWER OF MENARA PERKEBUNAN

Prof. Dr. Triwibowo Yuwono (Biotechnlogy/ Gadjahmada University- Indonesia)

Dr. Hasul A Hasibuan (Food Technology/ IOPRI- Indonesia)

Dr. Adam F Nugraha (Polymer, Energy, Material/ University-Indonesia)

Dr. Syamsul Falah (Biochemistry/ IPB University- Indonesia)

Ir. Sumaryono, MSc (Plant physiology/ IOPRI- Indonesia)

Dr. Ing. Dase Hunaefi, STP, M. FoodST (Food Science and Technology/ IPB University- Indonesia)

Prof. Dr. Ir. Decyanto Soetopo, MS (Plant Pest and Disease/ BRIN- Indonesia)

Dr. Mega Safithri (Bichemistry/ IPB University- Indonesia)

Dr. rer. Nat. Arli Aditya Parikesit (Bioinformathics/ Indonesia International Institute for Life Science- Indonesia)

Dr. rer.Nat. Rahadian Pratama (Biochemistry/ IPB University- Indonesia)

Dr. Nisa Rachmania Mubarik M.Si (Microbiology/ IPB University- Indonesia)

Annisa Krama, PhD (Food Innovation and microbiology /Unniversity of Tsukuba- Japan)

Dr. Jae Kweon Park (Chemistry/ Gachon University- South Korea)

Dr. Havid Aqoma Khoirudin (Energy and Chemical Engineering/ Xiamen University- Malaysia)

Dr. Hardian Susilo Addy (Molecular Biotechnology/ University of Jembar- Indonesia)

Prof. Dr. Sisunandar (Plant Biotechnology/ Universitas Muhammadiyah Purwakarta- Indonesia)

Dr. Endang Ciptawati (Chemistry/ State University of Malang- Indonesia)

Prof. Dr. Antonius Suwanto (Microbiology/ IPB University- Indonesia)

Prof. Dr. rer. Nat. Arli Aditya Parikesit (Bioinformatics/ Indonesia International Institute for Life Science- Indonesia)

Dr. Rifki Febriansyah, S,Farm, MSc.apt (Molecular Biology/ Universitas Muhammadiyah Yogyakarta- Indonesia)

Dr. Yogiara, PhD (Microbiology/ Atmajaya University-Indonesia)

Arinta Rury Puspitasari, S.P., M.P. (Agronomy/ Indonesian Sugar Research Institute- Indonesia)

Dr. Erwin Prastowo (Soil and Agroclimate/ PT RPN- Indonesia)

Prof. Dr. Herdhata Agusta (Ecology, Bioenergy, Sustainable Agriculture/ IPB University- Indonesia)

Dr Tjahyono Herawan (Chemical and Bioprocessing/ IOPRI- Indonesia)

Dr. Hernawan Yuli Rahmadi (Plant Breeding/ IOPRI- Indonesia)

Prof. Dr Laksmi Ambarsari (Biochemistry/ IPB University-Indonesia)

Dr Irma Kresnawaty (Biochemistry/ IOPRI- Indonesia)

Dr Dina Kartika Maharani, MSc (Chemistry/ Universitas Negrei Surabaya-Indonesia)

Prof Dr. Made Tri Ari Penia Kresnowati (Food Technology/ ITB-Indonesia)

Dr Hari Prawiratama (Plant Protection/ IOPRI-Indonesia)

Dr Rahardian Pratama (Bioinformatic/ IPB University-Indonesia)

Dr Naswandi Nur (Microbiology/ National Research and Innovation Agency- Indonesia)\

Dr Efi Toding Tondok, SP, MSi (Plant Protection/ IPB University-Indonesia)

MENARA PERKEBUNAN
International Journal of Biotechnology and Bioiondustry

Menara Perkebunan as the continuation of De Bergculture published by Algemeen Landbouw Syndicaat/Centrale Proefstation Vereniging since 1926, was published by the Bogor Research Institute for Estate Crops until 1992, based on a letter of the President Director of the Foundation of Research and Education Fund for Estate Crops No.103/JDPP/1967 and a letter of the Head of General Bureau for Research and Planning of the Ministry of Agriculture No.336/Kpts/OP/12/1968. Since 1993 Menara Perkebunan was published by the Indonesian Biotechnology Research Institute for Estate Crops, based on the Decree of the Chairman of the Managing Board of the Indonesian Planters Association for Research and Development No.084/Kpts/ DPH/XII/1992. During the period of 1997-2002 Menara Perkebunan was published by Biotechnology Research Unit for Estate Crops. Referring to a letter of Executive Director of the Indonesian Research Institute for Estate Crops No.05/Kpts/LRPI/2003, since January 2003 Menara Perkebunan has been published by the Indonesian Biotechnology Research Institute for Estate Crops which changed to the Indonesian Research Institute for Biotechnology and Bioindustry in 2015. On August 2022, Indonesian Research Institute for Biotechnology and Bioindustry join with Indonesian Oil Palm Research Institute (IOPRI) become Indonesian Oil Palm Research Institute, Unit Bogor (IOPRI -Unit Bogor)

Menara Perkebunan as a communication medium for research in estate crops publishes articles on original research results, improved technologies, and reviews of biotechnology and bioindustry and its applications in the areas of agriculture, health, environment, and other aspects of biotechnology.

Reviewer Acknowledment of Menara Perkebunan 2025 Volume 93, Nomor 2 edition

Dr. Hasrul A Hasibuan (Food chemistry/ IOPRI- Indonesia)
Prof. Dr. rer. Nat. Arli Aditya Parikesit (Bioinformatics/ Indonesia International Institute for Life Science- Indonesia)
Prof. Dr. Triwibowo Yuwono (Biotechnlogy/ Gadjahmada University- Indonesia)
Dr Irma Kresnawaty (Biochemistry/ IOPRI- Indonesia)
Prof. Dr Anja Meryandini (Microbiology/ IPB University-Indonesia)
Dr Dina Kartika Maharani, MSc (Chemistry/ Universitas Negrei Surabaya-Indonesia)
Prof Dr. Made Tri Ari Penia Kresnowati (Food Technology/ ITB-Indonesia)
Dr Hari Prawiratama (Plant Protection/ IOPRI-Indonesia)
Dr Rahardian Pratama (Bioinformatic/ IPB University-Indonesia)
Dr Naswandi Nur (Microbiology/ National Research and Innovation Agency- Indonesia)
Dr Efi Toding Tondok, SP, MSi (Plant Protection/ IPB University-Indonesia)
Dr. Ir Jenny Elisabeth, MS (Food Technology/ Wilmar Business Polytechnic- Indonesia)
Dr. Happy Widiastuti, MSi (Soil Microbiology / IOPRI - Indonesia)
Prof. Dr. Ing.Ir. Misri Gozan, MTech, IPU (Bioproses/ Universitas Indonesia- Indonesia)

FOREWORD FROM EDITOR IN CHIEF

Menara Perkebunan Journal as a research communication medium in the plantation sector has entered its 93rd publication edition and continues to present research results that are mandated by the institution, namely biotechnology, both in pre-harvest and post-harvest activities in the plantation industry. In the 2025 edition No.2, the Menara Perkebunan Journal presents seven research paper titles, 1) Characterization of novel acidic lipase of *Corynebacterium nuruki* PM2 from palm oil mill effluent for palm oil derivatisation Characterization of novel acidic lipase of *Corynebacterium nuruki* PM2 from palm oil mill effluent for palm oil derivatisation, 2) Factors affecting crude palm oil quality across the supply chain and implications for downstream industries in North Sumatra and Riau, 3) Extraction and characterization of fulvic acid from oil palm empty fruit bunches, 4) Techno-economic analysis and scale-up process simulation of compost production from OPEFB using rapid decomposition system (RDS) technology with SuperPro Designer®, 5) Effectiveness of a combination of organosulfur and polyphenols in controlling basal stem rot disease at selected levels of disease severity, 6) In silico study: identification and characterization of heat shock protein 90 (HSP90) in Arabica coffee (*Coffea arabica* L.), and 7) Characterization of *sn*-1,3 extracellular lipases of *Aspergillus niger* and *Rhizopus oryzae* for the crude palm oil hydrolysis.

We hope that with the eight articles presented in this journal, Menara Perkebunan can make a real contribution to the development of biotechnology in the plantation sector in particular and science and technology in Indonesia and International in general.

Editor In Chief

p-ISSN: 0125-9318
e-ISSN: 1858-3768

Menara Perkebunan
Volume 93, No 2, 2025
Abstract Sheet

Ludwinardo Putra, Irma Kresnawaty & Imron Riyadi

Characterisation of novel acidic lipase of *Corynebacterium nuruki* PM2 from palm oil mill effluent for palm oil derivatisation (page 83-92)

The palm oil industry generates significant amounts of palm oil mill effluent (POME), which harbors diverse microbial communities with potential biotechnological applications. Yet, only a limited number of lipolytic bacteria have been isolated and studied. A limited nutrient medium selection has been previously demonstrated for isolating unique indigenous bacteria. This study aimed to isolate novel lipolytic bacteria from POME and characterize the lipase for potential palm oil derivatization. *Corynebacterium nuruki* PM2 was successfully isolated and identified. Distinct colony morphologies were observed on different agar media. Lipase from *C. nuruki* PM2 (LipCN) exhibited optimum activity at 40-60°C, pH 5.0-8.0, and with vegetable oil as substrate. The enzyme also showed the highest stability at a temperature between 30°C and 40°C and at a pH of 7.0-8.0 after 30 minutes of incubation. The enzyme remained stable in methanol, isopropanol, and n-hexane. Metal ions such as Mn2+ and surfactants (e.g., Triton X-100, Tween-80, and Tween-20 significantly inhibit LipCN activity. Thin-layer chromatography identified 2-palmitoylglycerol in the hydrolyzed product of LipCN, suggesting *sn*-1,3 specific activity of the enzyme.

[Keywords: biocatalysis, enzymatic, microbial lipase, transesterification, palm oil residue]

Donald Siahaan, Ilmi Fadhilah Rizki, Frisda Rimbun Panjaitan, Manda Edy Mulyono, Brahmani Dewa Bajra & Mulki Salendra Kusumah

Factors affecting crude palm oil quality across the supply chain and implications for downstream industries in North Sumatra and Riau (page 93-105)

Crude palm oil (CPO) quality, which is vital for downstream industries, is affected by multiple supply chain factors. This study investigated these factors and industrial needs in North Sumatra and Riau, Indonesia's key provinces for CPO production. Methods included supply chain investigations fresh fruit bunch (FFB) production, palm oil mill (PMO) processing, and CPO transport/storage, a refinery case study, and a focused group discussion (FGD) with downstream industries. FFB handling practices, including loose fruit diversions, impacted mill intake quality. PMO processing significantly altered free fatty acid (FFA), moisture and impurities (M&I), and deterioration of bleachability index (DOBI). Substantial DOBI degradation and FFA increases occurred during CPO transportation and storage at the refinery due to oxidation and hydrolysis. Downstream, the refining and oleochemical sectors require high CPO quality (e.g., high DOBI and low FFA), whereas the biodiesel sector is more flexible. PMO operational alignment with advanced quality metrics like DOBI was limited. This study concludes that CPO quality is vulnerable throughout its supply chain, particularly post-milling. The findings necessitate an integrated approach that includes improved FFB handling, optimized PMO processing, and enhanced logistics to minimize degradation and align production quality with the specific demands of each downstream sector. Such an approach is crucial for improving the overall efficiency and competitiveness of the Indonesian palm oil industry.

[Keywords: FFB quality, industrial requirements, palm oil processing, storage effects, transportation]

Firda Dimawarnita, Khairy Yunda Maharani, Sutanto Sutanto, Yora Faramitha, Donny Nugraha Kalbuadi & Didiek Hadjar Goenadi

Extraction and characterization of fulvic acid from oil palm empty fruit bunches (page 106-115)

Oil palm empty fruit bunches (OPEFB) contain 27.78% lignin, which can serve as an alternative source of renewable fulvic acid, alongside soil and coal. This study aims to conduct the fulvic acid extraction process using a microwave extractor. The extraction process was carried out using H_2O_2 solvents with concentrations of 18%, 21%, and 24%, and various sample types (OPEFB, shilajit, and commercial fulvic acid fertilizer), with three repetitions. The resulting liquid fulvic acid extract was then made into powder using freeze-drying. Quantitative testing was conducted using the spectrophotometric method, while qualitative testing employed Fourier-Transform Infrared Spectroscopy (FTIR), Proton Nuclear Magnetic Resonance (^{1}H NMR), spectrofluorometry, a CHN analyzer, and Thermogravimetric Analysis - Differential Scanning Calorimetry (TGA-DSC). The results showed that the best solvent concentration for the fulvic acid extraction process was H_2O_2, 21% of the total in the OPEFB sample. The highest fulvic acid content was found in the OPEFB sample at 23.59%; in the shilajit sample, it was 9.62%, and in the commercial fulvic acid fertilizer sample, it was 6.97%. The characterization results from spectrophotometric analysis, elemental analysis, and TGA-DSC analysis showed the potential of fulvic acid in the OPEFB sample, as it exhibited similarities with the analysis results of commercial fulvic acid (shilajit and commercial fulvic acid fertilizer).

[Keywords: CHN analyzer, FTIR, HNMR, microwave extractor, TGA-DSC]

Silva Latisya, Firda Dimawarnita, Yora Faramitha, Mujahidah Kamilah, Serarifi Elagin Harahap & Didiek Hadjar Goenadi

Techno-economic analysis and scale-up process simulation of compost production from OPEFB using rapid decomposition system (RDS) technology with SuperPro Designer® (page 116-123)

Oil palm empty fruit bunches (OPEFB) are biomass waste from oil palm mills (POM) that are abundant and potential as feedstock for compost. However, the conventional composting process for OPEFB is time-consuming and inefficient. A Rapid Decomposition System (RDS) technology has been developed to accelerate the decomposition of OPEFB into compost, utilising microorganisms that produce ligninolytic and cellulase enzymes. RDS combines chemical delignification (using H_2O_2) and biological processes simultaneously, which significantly reduces the composting period (generally 2–3 months to only about 45 h per batch), while also producing valuable by-products such as fulvic acid and growth stimulating hormone (GSH). The system can reduce OPEFB volume, thereby improving efficiency and sustainability. This study aims to simulate the scale-up of the RDS compost production process from OPEFB and financial feasibility. A simulation production of 5 kg of RDS compost at a larger scale (scale-up) using SuperPro Designer® software has been conducted. The results showed that 100 kg of OPEFB could produce 32.67 kg of RDS compost with a process time of 45.01 hours per batch. The financial scenario, which covers the main product (compost) and by-products (GSH and fulvic acid), yields a gross margin of 55%, a return on investment (ROI) of 68.67%, and a payback period of 1.46 years. The techno-economic feasibility analysis yielded an internal rate of return (IRR) of 41.08% and a nett present value (NPV) of $24,743,000, indicating that this technology is feasible and profitable for scaling up to industrial scale.

[Keywords: feasibility, organic fertilizer, palm oil biomass, rapid composting, software simulation]

Deden Dewantara Eris, Ciptadi Achmad Yusup, Abdul Aris, Fransiska Natalia Purba & Faizal Shofwan Kusnendi

Effectiveness of a combination of organosulfur and polyphenols in controlling basal stem rot disease at selected levels of disease severity (page 124-134)

Basal stem rot (BSR) is a major disease of oil palm. One approach to control the pathogen is by using organic fungicides. This study aims to assess the efficacy of two kinds of fungicides, organosulfur and polyphenol, in suppressing *Ganoderma boninense* and their impact on seedlings. Poisoned agar media were used in the in vitro assay with organosulfur at concentrations of 0.8% and 0.125%, polyphenol at 1.6% and 0.125%, and two combinations: 0.8% organosulfur + 0.125% polyphenol and 1.6% organosulfur + 0.125% polyphenol (v/v), with a 3-replication test. In vivo trials were conducted on 4-month-old oil palm seedlings inoculated with *G. boninense*. Two treatments were tested: Combination 1 (0.8% organosulfur + 0.125% polyphenol, v/v) and Combination 2 (1.6% organosulfur + 0.125% polyphenol, v/v). The solution was applied by soil drenching, 200 mL per plant, at the stem base every 14 days, totalling four applications within a 3-month period. The treatments were evaluated under three levels of disease severity: Group 1 (asymptomatic plants with fungal fruiting bodies), Group 2 (leaf necrosis ≤ 50%), and Group 3 (leaf necrosis ≥ 50%). The first result demonstrated a full inhibition of fungal growth in treatments with 1.6% polyphenol and the combination of 1.6% organosulfur + 0.125% polyphenol (v/v). In vivo assay results showed that an increase in resistance (measured by prolonged survival) was observed in Groups 1 and 2. These findings indicate that combining organosulfur and polyphenol fungicides can improve seedling resistance to BSR, particularly at early and moderate disease stages.

[Keywords: in vitro, in vivo, *Ganoderma boninense*]

Mukhamad Su'udi, Qori'atul Mustafidah

In silico study: identification and characterization of heat shock protein 90 (HSP90) in Arabica coffee (*Coffea arabica* L.) (page 135-147)

The use of low-quality planting material and extreme weather conditions caused by global warming are major factors contributing to low Arabica coffee productivity in Indonesia. The development of new cultivars and the improvement of Arabica coffee adaptability play crucial roles in preventing productivity decline. This study aims to identify and characterize HSP90 proteins in Arabica coffee through in silico analysis, focusing on their adaptability to biotic and abiotic stress conditions. This study was conducted using DNA and HSP90 protein sequences from Arabica coffee retrieved from various databases. The analysis included assessments of physicochemical properties, gene structure analysis, protein subcellular localization prediction, cis-acting element analysis, protein interaction analysis, and phylogenetic analysis. The results identified a total of twenty *CaHSP90* genes distributed across 11 Arabica coffee chromosomes. Characterization revealed that the HSP90 protein family has diverse physicochemical properties, with varying sequence lengths and molecular weights. Most members are acidic, hydrophilic proteins localized in the cytoplasm. Analysis of the *CaHSP90* gene expression based on cis-acting elements and phylogenetics showed that HSP90 in Arabica coffee is expressed in response to biotic and abiotic stresses as well as defense against pathogens. The results of this study provide a foundation for the development of new Arabica coffee cultivars with improved resistance to biotic and abiotic stresses, and support the selection of candidate CaHSP90 genes for breeding programs.

[Keywords: bioinformatics, biotic and abiotic stress, C3 plant, heat stress]

Ludwinardo Putra, Eneng Nurhasanah, Eti Rohaeti, Irma Kresnawaty

Characterization of *sn*-1,3 extracellular lipases of *Aspergillus niger* and *Rhizopus oryzae* for the crude palm oil hydrolysis (page 148-157)

Crude palm oil (CPO) processing for *sn*-2 palmitate synthesis requires a specific *sn*-1,3 lipase to catalyze the hydrolysis step. These lipases are known to be derived from filamentous fungal isolates

including *Aspergillus niger* and *Rhizopus oryzae*. The purpose of this study was to describe extracellular lipases from *A. niger* and *R. oryzae* that hydrolyze CPO. Extracellular lipases were successfully recovered from both fungal isolates using CPO-enriched fermentation media. The crude fraction was partially refined using $(NH_4)_2SO_4$ and dialyzed, yielding two fractions. Lipase fraction I from both fungal species had the highest specific activity, had a molecular mass of ~30 kDa, and was *sn*-1,3 specific. The best conditions for enzyme activity of both fungal species in CPO hydrolysis were pH 6-7 and 35°C. The pH and heat stability of lipase fraction I in both fungi were relatively low. However, this enzyme worked effectively in benzene, ethanol, and methanol solvents.

[Keywords: enzymatic hydrolysis, filamentous fungi, *sn*-2 palmitate, vegetable oil]

ISSN 0125-9318 (Print version)
ISSN 1858-3768 (Electronic version)

Menara Perkebunan **Volume 93, No.2 2025**

CONTENTS