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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.

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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.1, the Menara Perkebunan Journal again presents eight research paper titles, 1) Storage stability of hydrolyzed palm kernel oil and red palm super olein blend and its softgel capsule, 2) In silico test of brotowali (*Tinospora crispa*) as potential anticancer agent targeting mTOR on colorectal cancer, 3) Antioxidant activity, total phenolic, flavonoid, and caffeine contents of robusta coffee (*Coffea canephora*) fermented with lactic acid bacteria, 4) The impact of bio-silicic acid (BioSilAc) to increase productivity and water use efficiency in sugarcane, 5) Relationship between altitudes, morphological traits, and biochemical compositions of *Coffea canephora* Pierre ex A. Froehner in Temanggung, Indonesia, 6) The influence of pyrolysis temperature and dosage of shorea wood biochar produced on soil properties and sengon (*Falcataria moluccana*) seedling biomass, 7) Fabrication of nanocellulose-EDTA composite from oil palm trunks for cadmium removal from aqueous solutions, and 8) Identification of metabolites for biomarker of nitrogen and potassium use efficiency in oil palm.

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

Menara Perkebunan
Volume 93, No 1, 2025

Abstract Sheet

Manda Edy Mulyono, Ilmi Fadhilah Rizki, Frisda Rimbun Panjaitan, & Brahmani Dewa Bajra

Storage stability of hydrolyzed palm kernel oil and red palm super olein blend and its soft-gelcapsule (page 1-11)

Hydrolyzed palm kernel oil and red palm super olein blend (HPRB) is a novel product with potential benefits for digestive health. This blend combines the antimicrobial properties of hydrolyzed palm kernel oil (PKO) with the antioxidant effects of red palm super olein (RPSO). However, the long-term stability of HPRB under different storage conditions is crucial to ensure its efficacy and safety. This study aims to evaluate the storage stability of HPRB in its oil form and as a soft-gel capsule. The research investigated the impact of various storage conditions on the phytonutrient content, fatty acid composition, and acylglycerol profile of HPRB. The results showed that cool and dark storage conditions is the best preserve for the phytonutrient content of HPRB. The fatty acid and acylglycerol compositions of HPRB remained stable regardless of the storage conditions. Accelerated stability testing of HPRB soft-gel capsules demonstrated excellent stability across various parameters, including physical characteristics, microbiological quality, and chemical stability. Shelf-life estimation indicated a relatively long shelf life for the soft-gel capsules under accelerated conditions. These results suggest that HPRB, particularly when stored appropriately or encapsulated in soft-gel form, has the potential for long-term stability and safe use.

[Keywords: digestive health, monolaurin, phytonutrient, shelf life]

Hanik Isnaini, Adinda Amalia Agustin RJ, Washeilatus Sholehah, Nida Sudarlina, Safina Oktafia, Luluk Ayu Khodariyah, & Siwi Putri Mumpuni

In silico test of brotowali (*Tinospora crispa*) as potential anticancer agent targeting mTOR on colorectal cancer (page 12-20)

Colorectal cancer is one of the deadliest diseases in the world. Treatment to overcome colorectal cancer has been pursued in such a way. Still, the results are unsatisfactory, so treatment turns to herbal plants such as brotowali (*Tinospora crispa*) as an alternative colorectal anticancer. *T. crispa* is one of the herbal plants that contains a typical compound in the form of N-acetylnornuciferine and alkaloid-derived active compounds in the form of N-formylanonaine, N-trans-coumaroyltyramine, and Tyramine which are potential as colorectal anticancer agents. The study used the mTOR (Mammalian Target of Rapamycin) receptor with PDB code (4DRJ) with its native ligand,

RAP (receptor-associated protein). This study aims to analyze the potential of colorectal anticancer targeted by active compounds of alkaloid derivatives in *T. crispa* against mTOR. The method used is to explore active compounds through the KnapSack web and 3D protein structures on NCBI, docking validation using PyMol, tethering compounds N-acetylnornuciferine, N-formylanonaine, N-trans-coumaroyltyramine, and Tyramine to the target ligand using Pyrx and then visualized using BIOVIA Discovery Studio Visualizer. Analysis of the in silico test results showed that the compounds of N-acetylnornuciferine, N-trans-coumaroyltyramine, and Tyramine in *T. crispa* have good potential as colorectal anticancer agents in low doses but are not recommended for people with heart disease.

[Keywords: colorectal cancer, molecular docking, *Tinospora crispa*]

Nadira Aisyah, Titi Candra Sunarti, & Anja Meryandini

Antioxidant activity, total phenolic, flavonoid, and caffeine contents of robusta coffee (*Coffea canephora*) fermented with lactic acid bacteria (page 21-30)

Robusta coffee is widely cultivated in Indonesia, but it struggles to dominate the global market due to its bitterness, slightly sour taste, and higher caffeine content. Coffee bean fermentation can be done to reduce undesirable characteristics in robusta coffee. This study aimed to evaluate the effects of lactic acid bacteria fermentation on the quality of coffee and its brewing characteristics, comparing it to spontaneous fermentation. The goal was to explore the potential of fermented coffee beans as functional beverages with health benefits. Three lactic acid bacteria (LAB) isolates were tested, and *Lactiplantibacillus plantarum* H 2.34 was identified as the most effective starter culture for coffee fermentation. After 12 hours of fermentation using coffee mucilage, LAB growth was significantly enhanced. A significant increase in flavonoid content was observed in coffee fermented with the starter culture. All brewed coffee samples demonstrated strong antioxidant activity, and LAB fermentation successfully reduced caffeine content by 4.85%. These results suggest that fermented robusta coffee could offer functional health benefits while improving its sensory profile.

[Keywords: antioxidant, flavonoid, *Lactiplantibacillus plantarum*, phenolic compound]

Indah Puspita Sari, Donny Nugroho Kalbuadi, Poppy Arisandy, Yusuf Mahali, Habiburrahman Malik Al Hamda, & Didiek Hadjar Goenadi

The impact of bio-silicic acid (BioSilAc) to increase productivity and water use efficiency in sugarcane (page 31-38)

Sugarcane (*Saccharum officinarum* L.) is a vital plantation crop, serving as a raw material for various industries, including sugar, bioethanol, amino acids, and food ingredients. Therefore, the advancement of technologies aimed at increasing productivity and fertilization efficiency in sugarcane cultivation has become a priority. Bio-silicic acid (BioSilAc) is a technology that can optimize the cultivation process. This study evaluated the effectiveness of water and fertilizer usage in plant cane (PC) and ratoon cane (RC) during low rainfall by applying BioSilAc and its impact on sugarcane productivity. This research utilized a randomized block design with three treatments (P1: 100% NPK; P2: 100% NPK + BioSilAc; and P3: 75% NPK + BioSilAc) replicated three times. Observed variables included soil and leaf nutrient levels, sugarcane growth, and productivity. Daily and potential water consumption was measured in real-time using a sap flow meter to calculate water use efficiency for P1 (control) and P2, representing the BioSilAc application. The P3 treatment (75% NPK + BioSilAc) demonstrated the highest effectiveness in terms of fertilization efficiency and productivity, resulting in notable increases in crop yield and crystal sugar. The PC category saw increases of 13.5% and 12.4%, while the RC category experienced gains of 22.82% and 25.81%, respectively. Furthermore, water use efficiency was recorded at 22.55% for the PC category and 13.72% for the RC category. Our findings suggest that the application of BioSilAc not only increase the productivity of sugarcane but also improves both fertilizer and water use efficiency.

[Keywords: biosilic, plant cane, ratoon cane, sap flow, water consumption]

Intan Widya Pangestika, Ari Susilowati, Edi Purwanto, & Gunawan

Relationship between altitudes, morphological traits, and biochemical compositions of *Coffea canephora* Pierre ex A. Froehner in Temanggung, Indonesia (page 39-56)

Among various edaphoclimatic factors influencing coffee bean quality, altitude is one of the primary factors that should be taken into account. This study aims to explore the relationship between altitude, morphological traits, and biochemical composition of robusta coffee in Temanggung Regency, the largest coffee-producing area in Central Java Province, Indonesia. Research sites were purposively selected and categorized into two altitude groups: GS, PS, and GN, located at circa 600 m a.s.l., and GT, WO, and TG, located at circa 900 m a.s.l. A total of 15 morphological traits were observed, consisting of eight vegetative and seven generative traits. Caffeine content was measured following the AOAC procedure using UV-Vis spectrophotometry, while brew acidity was evaluated using a pH meter. Several morphological traits of Temanggung robusta coffee demonstrated significant relationships with altitude. Canopy and stem diameter showed negative correlations with altitude, with correlation coefficients of -0.366 and -0.408, respectively. Conversely, fruit width ($r = 0.041$), bean length ($r = 0.049$), and bean thickness ($r = 0.047$) exhibited positive correlations. Regarding biochemical composition, caffeine content

stood out by displaying a strong positive correlation with altitude ($r = 0.816$). Additionally, several morphological traits, including the number of primary branches, the number of productive branches, the number of fruits per bunch, and traits related to fruits and beans, appear to be advantageous for selection and breeding programs. Understanding these relationships provides valuable insights for developing superior Temanggung robusta coffee plants adapted to specific altitudinal conditions.

[Keywords: altitude, correlation, phenotype, robusta coffee, topographical condition]

Melya Riniarti, Wahyu Hidayat, Hendra Prasetya, & Bangun Adi Wijaya

The influence of pyrolysis temperature and dosage of shorea wood biochar produced on soil properties and sengan (*Falcataria moluccana*) seedling biomass (page 57-67)

This study explores the effects of pyrolysis temperature of shorea wood biochar and its doses on the soil properties and biomass of *Falcataria moluccana* seedlings. The focus is optimizing pyrolysis temperatures (400°C and 600°C) and biochar doses (0%, 25%, and 50%) to enhance soil fertility and seedling biomass. Both pyrolysis temperature and biochar dose are critical factors that influence the soil properties, directly affecting its effectiveness as a soil amendment. The research was conducted as a controlled greenhouse experiment over 120 days; each treatment was replicated 15 times. We observed several soil chemical properties, including pH, cation exchange capacity (CEC), organic carbon (C-organic), total nitrogen (N-total), and total phosphorus (P-total). The growth parameters assessed included above ground biomass (AGB), below ground biomass (BGB), total biomass (TB), and root to shoot ratio (R:S). Data analysis involved one-way and two-way ANOVA. Results indicated that soil properties, particularly cation exchange capacity (CEC) and organic carbon content, were improved, thereby enhancing soil fertility. However, ANOVA indicated no statistically significant differences across treatments. Biochar significantly enhanced above-ground and below-ground biomass (AGB and BGB). Nevertheless, both pyrolysis temperature and biochar dose independently influenced biomass accumulation in *F. moluccana* seedlings. The highest increases were observed in the treatment with the highest pyrolysis temperature (600°C) and the highest dose (50%), which led to an 85% increase in AGB and a 60% increase in BGB compared to the control. Based on the study, Shorea wood biochar, particularly when used at 600°C and 50% dose, significantly improves soil fertility and seedling growth, providing a promising approach for developing *F. moluccana* plantations.

[Keywords: ameliorant, charcoal, meranti, sengan, waste]

Pemta Tiadeka, Diah Ratnasari, Mega Mustikaningrum, Sasti Amilia Putri, & Lutiana

Fabrication of nanocellulose-EDTA composite from oil palm trunks for cadmium removal from aqueous solutions (page 68-73)

The development of nanocellulose-based materials with enhanced properties has garnered significant interest among scientists. Oil palm trunks are a promising source of nanocellulose due to their high cellulose content, excellent adsorption capacity, and abundant availability. Cadmium, a toxic heavy metal, poses serious risks to environmental and human health. It accumulates in fish and plants, entering the human body through the food chain. Since cadmium resists natural degradation, effective removal methods are crucial to mitigate its hazardous effects. In this study, a functionalized nanocellulose composite (NCE) was successfully synthesized using ethylenediaminetetraacetic acid (EDTA) as a chelating agent to enhance cadmium adsorption in aqueous solutions. Analysis with FTIR confirmed the reaction between nanocellulose and EDTA, with characteristic bonds appearing at wavenumber 1100, 1172, and 48 cm^{-1} . Particle size analysis revealed polydisperse nanoparticles, with average sizes of 411.5 nm for nanocellulose and 665.3 nm for NCE. Microscopic imaging showed distinct morphological changes, indicating successful EDTA incorporation into the nanocellulose structure. NCE exhibited a high surface area (2.792 $\text{m}^2 \text{g}^{-1}$). Atomic absorption spectroscopy showed a decrease in cadmium concentration, from 1 ppm to 0.2–0.3 ppm, indicating the adsorption ability of NCE. These findings highlight the potential of NCE for heavy metal remediation in water.

[Keywords: adsorption, cadmium, EDTA, membrane nanocellulose]

Retno Diah Setiowati, Sri Wening, Tri Rini Nuringtyas, Megayani Sri Rahayu, & Sudarsono Sudarsono

Identification of metabolites for biomarker of nitrogen and potassium use efficiency in oil palm (74-82)

Nutrient-use efficiency in oil palm is important for economic and environmental reasons. This research aimed to identify biomarkers to discriminate between tolerant and susceptible oil palms to potassium (K) and nitrogen (N) deficiency. A screening of oil palm materials for N or K use efficiency was conducted using an omission trial experiment, where only targeted nutrient was applied as treatment, while all other nutrients were applied as recommended. The treatment was performed in the main nursery for ten months to identify progenies with contrasting traits. Metabolite analysis was performed to identify specific metabolites as biomarkers for N-efficient and K-efficient palms. Samples taken from the roots of the contrasting progenies were treated with liquid nitrogen prior to grinding into a powder for liquid chromatography-high resolution mass spectrometry (LC-HRMS) analysis. The LC-HRMS analysis showed 277 metabolites from K and N treatments after data trimming, which were then analysed in MetaboAnalyst 6.0 for biomarker identification. The results showed that some metabolites were statistically significant. Metabolites identified in more than one analysis have a higher likelihood of being considered as biomarkers. In this experiment, we compared PLS-DA, sPLS-DA, and *Random Forest*. However, some identified metabolites were not to occur naturally in the treatment palms. Some amino acids and antioxidants were promising biomarkers to differentiate the N-deficiency-tolerant and K-deficiency-tolerant palms. Thus, the biomarkers facilitate the breeding scheme to create a nutrient-efficient palm planting material.

[Keywords: antioxidant, biomarkers, LC-HRMS, liquid nitrogen, nutrient-use efficiency]

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