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**Analisis Metabolomik Untargeted dan Kuantifikasi Targeted Asam ?-Aminobutirat pada Fermentasi Galur
Tunggal dan Galur Jamak Bakteri Asam Laktat**
Almayra Khanza Fahrani, M. Saifur Rohman, S.P., M.Si., M. Eng., Ph.D. ; Prof. Dr. Ir. Endang Sutriswati Rahayu, M.S
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INTISARI

Probiotik merupakan mikroorganisme hidup yang berperan penting dalam fermentasi pangan karena kemampuannya menghasilkan berbagai metabolit fungsional. Profil dan dinamika metabolit probiotik dipengaruhi oleh karakteristik strain serta sistem fermentasi galur tunggal dan galur jamak yang dapat dianalisis secara komprehensif menggunakan pendekatan metabolomik *untargeted* untuk pemetaan metabolit global dan metabolomik *targeted* untuk kuantifikasi metabolit fungsional seperti GABA. Penelitian ini bertujuan untuk menganalisis pola pertumbuhan, perubahan pH, profil metabolit, serta produksi GABA pada fermentasi galur tunggal dan galur jamak *Lactiplantibacillus plantarum* subsp. *plantarum* Dad-13, *Lactiplantibacillus plantarum* FNCC-0250, dan *Lacticaseibacillus paracasei* GMRMP-001. Fermentasi menggunakan medium MRS *broth* selama 24 jam pada suhu 37°C. Pola pertumbuhan bakteri diamati menggunakan jumlah sel dan perubahan pH, sedangkan analisis metabolomik *untargeted* dilakukan menggunakan *Liquid Chromatography–High Resolution Mass Spectrometry* (LC-HRMS) dan kuantifikasi GABA dilakukan secara *targeted* menggunakan *High Performance Liquid Chromatography* (HPLC). Hasil penelitian menunjukkan bahwa fermentasi galur tunggal dan galur jamak memiliki pola pertumbuhan dan penurunan pH yang relatif serupa, dengan laju pertumbuhan spesifik (μ) yang tidak berbeda signifikan antar strain ($p > 0,05$). Fermentasi galur jamak menunjukkan konsistensi pertumbuhan yang lebih baik, ditunjukkan oleh nilai standar deviasi yang lebih kecil. Analisis metabolomik *untargeted* menunjukkan adanya perbedaan profil metabolit antara galur tunggal dan galur jamak, dengan profil metabolit galur jamak yang lebih kompleks, serta *succinic acid, indole-3-lactic acid,* dan turunan asam amino sebagai pembeda utama antar strain. Hasil kuantifikasi menunjukkan bahwa fermentasi galur tunggal *Lactiplantibacillus plantarum* Dad-13 dan fermentasi galur jamak menghasilkan kadar GABA tertinggi, masing-masing sebesar 119,74 mg/100 g dan 119,33 mg/100 g. Temuan ini menunjukkan bahwa jenis strain dan sistem fermentasi berperan penting dalam menentukan dinamika metabolit dan tingkat produksi GABA pada fermentasi probiotik.

Kata kunci: probiotik, galur tunggal, galur jamak, metabolomik, GABA

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ABSTRACT

Probiotics are live microorganisms that play an important role in food fermentation due to their ability to produce various functional metabolites. The profile and dynamics of probiotic metabolites are influenced by strain characteristics as well as fermentation systems, including single-strain and multi-strain cultures. These can be comprehensively analyzed using untargeted metabolomics for global metabolite profiling and targeted metabolomics for the quantification of functional metabolites such as gamma-aminobutyric acid (GABA). This study aimed to analyze growth patterns, pH changes, metabolite profiles, and GABA production during single-strain and multi-strain fermentation of *Lactiplantibacillus plantarum* subsp. *plantarum* Dad-13, *Lactiplantibacillus plantarum* FNCC-0250, and *Lacticaseibacillus paracasei* GMRMP-001. Fermentation was carried out in MRS broth for 24 hours at 37°C. Bacterial growth was evaluated based on cell counts and pH changes. Untargeted metabolomic analysis was performed using Liquid Chromatography–High Resolution Mass Spectrometry (LC-HRMS), while GABA quantification was conducted using targeted High Performance Liquid Chromatography (HPLC). The results showed that both single-strain and multi-strain fermentations exhibited relatively similar growth patterns and pH reduction, with no significant differences in specific growth rate (μ) among strains ($p > 0.05$). Multi-strain fermentation demonstrated better growth consistency, as indicated by lower standard deviation values. Untargeted metabolomic analysis revealed differences in metabolite profiles between single-strain and multi-strain systems, with the multi-strain fermentation producing a more complex metabolite profile. Succinic acid, indole-3-lactic acid, and amino acid derivatives were identified as key discriminating metabolites among strains. Quantitative analysis showed that single-strain fermentation of *Lactiplantibacillus plantarum* Dad-13 and multi-strain fermentation produced the highest GABA levels, reaching 119.74 mg/100 g and 119.33 mg/100 g, respectively. These findings indicate that strain type and fermentation system play important roles in determining metabolite dynamics and GABA production in probiotic fermentation.

Keywords: probiotics, single-strain, multi-strain, metabolomics, GABA