

PROCESS DESIGN AND MICROBIAL GROWTH MODELLING OF SELF-INDUCED ANAEROBIC FERMENTATION FOR MIXED-MATURITY ARABICA COFFEE PROCESSING

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**AGROINDUSTRIAL ENGINEERING STUDY PROGRAM
FACULTY OF ENGINEERING AND TECHNOLOGY
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ABSTRACT

ADZKIA ZAVIER MUHAMMAD. Process Design and Microbial Growth Modelling of Self-Induced Anaerobic Fermentation for Mixed-Maturity Arabica Coffee Processing. Supervised by ENDANG WARSIKI and TITI CANDRA SUNDARTI.

Mixed-maturity Arabica coffee cherries constitute a heterogeneous raw material requiring postharvest processing capable of improving process consistency and product quality. This study aimed to develop a self-induced anaerobic fermentation (SIAF) process and model microbial population development during spontaneous and *L. plantarum*-inoculated solid-state fermentation. Process development followed an iterative approach comprising natural processing, submerged SIAF, and solid-state SIAF. Microbial growth modelling of solid-state SIAF used observations at 0, 12, 24, 36, and 48 h for total plate count (TPC), lactic acid bacteria (LAB), and mold and yeast, supported by pH, titratable acidity, and temperature measurements. Microbial populations were fitted using modified Gompertz and Logistic models. Inoculation was associated with earlier and greater LAB development, reaching 9.00 log CFU/g at 48 h compared with 7.65 log CFU/g under spontaneous fermentation. The modified Gompertz model provided an equal or lower prediction error across all microbial trajectories than the Logistic model. However, sparse sampling, unobserved stationary phases, and population fluctuations limited the reliability of several model parameters. The resulting models provide exploratory reference profiles for fermentation monitoring and future scale-up validation.

Keywords: coffee fermentation, *L. plantarum*, microbial growth modelling, mixed-maturity coffee, self-induced anaerobic fermentation



ABSTRAK

ADZKIA ZAVIER MUHAMMAD. *Process Design and Microbial Growth Modelling of Self-Induced Anaerobic Fermentation for Mixed-Maturity Arabica Coffee Processing*. Dibimbing oleh ENDANG WARSIKI dan TITI CANDRA SUNARTI.

Kopi Arabika dengan tingkat kematangan buah yang beragam merupakan bahan baku heterogen yang memerlukan proses pascapanen untuk meningkatkan konsistensi proses dan mutu produk. Penelitian ini bertujuan mengembangkan proses *self-induced anaerobic fermentation* (SIAF) dan memodelkan perkembangan populasi mikroba pada fermentasi *solid-state* spontan dan yang diinokulasi *Lactiplantibacillus plantarum*. Pengembangan proses dilakukan secara iteratif melalui proses *natural*, SIAF *submerged*, dan SIAF *solid-state*. Pemodelan pertumbuhan mikroba pada SIAF *solid-state* menggunakan pengamatan pada jam ke-0, 12, 24, 36, dan 48 terhadap total plate count (TPC), bakteri asam laktat (BAL), serta kapang dan khamir, didukung pengukuran pH, total asam tertitrasi, dan suhu. Populasi mikroba dimodelkan menggunakan model Gompertz dan Logistic termodifikasi. Inokulasi berkaitan dengan perkembangan BAL yang lebih awal dan lebih besar, mencapai 9,00 log CFU/g pada 48 jam dibandingkan 7,65 log CFU/g pada fermentasi spontan. Model Gompertz termodifikasi memberikan galat prediksi yang sama atau lebih rendah pada seluruh trajektori mikroba dibandingkan model Logistic. Namun, keterbatasan titik pengamatan, belum teramatinya fase stasioner, dan fluktuasi populasi membatasi keandalan beberapa parameter model. Model yang dihasilkan dapat digunakan sebagai profil acuan eksploratif untuk pemantauan fermentasi dan validasi skala lebih besar.

Kata kunci: fermentasi kopi, kopi kematangan campuran, *L. plantarum*, pemodelan pertumbuhan mikroba, *self-induced anaerobic fermentation*

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ADZKIA ZAVIER MUHAMMAD

Undergraduate Final Project
as one of the requirements to obtain
a Bachelor's degree in 2026
Agroindustrial Engineering Study Program

**AGROINDUSTRIAL ENGINEERING STUDY PROGRAM
FACULTY OF ENGINEERING AND TECHNOLOGY
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PREFACE

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The author realizes that this final project still has limitations and therefore welcomes constructive suggestions for its improvement. It is sincerely hoped that this work may provide useful information for the development of controlled coffee fermentation, particularly self-induced anaerobic fermentation, and contribute to future research and practical applications in coffee postharvest processing.

Bogor, August 2026

Adzkia Xavier Muhammad



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