SYNERGISTIC FERULIC ACID PRODUCTION FROM BANANA STEM WASTE BY CO-CULTURE

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DOCTOR OF PHILOSOPHY (CHEMICAL ENGINEERING)

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SUPERVISOR'S DECLARATION

We hereby declare that we have checked this thesis and in our opinion, this thesis is adequate in terms of scope and quality for the award of the degree of Doctor of Philosophy in Chemical Engineering.

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STUDENT'S DECLARATION

I hereby declare that the work in this thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at Universiti Malaysia Pahang or any other institutions.

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TABLE OF CONTENT

LIST OF TABLES

LIST OF FIGURES

LIST OF SYMBOLS

3-D	Three dimensional
β_0	Constant coefficient
β_i	Coefficient of the linear parameters
dS/dt	Rate of substrate utilization
dP/dt	Rate of product formation
$[S]$	Substrate concentration
V_{max}	Maximum rate of reaction
μ_{max}	Maximum cell growth rate
$[P]$	Product concentration
K_m	Michaelis constant
K_s	Substrate constant
R^2	Coefficient of determination
R_t	Retention time
g	Gram
h	Hour
L	Liter
min	Minute
mL	Milliliter
µm	Micrometer
M	Molar
mM	Milimolar
mol	Mole
µmol	Micromoles
pH	Potential Hydrogen
R^2	Coefficient of determination
%	Percentage
µL	Microliter
°C	Degree Celsius

LIST OF ABBREVIATIONS

ADF	Acid detergent fiber
ADL	Acid detergent lignin
ANOVA	Analysis of variance
BBD	Box-Behnken Design
BLAST	Basic Local Alignment Search Tool
BSG	Brewer’s spent grain
BSW	Banana stem waste
CCD	Central composite design
CV	Coefficient of variation
DAD	Diode array detector
DCW	Dry cell weight
DNA	Deoxyribonucleic acid
DO	Dissolved oxygen
DX	Design Expert
FA	Ferulic acid
FAE	Ferulic acid esterase
FFD	Fractional factorial design
GDP	Gross domestic product
GN	Gram negative
GP	Gram positive
HPLC	High performance liquid chromatography
IF-A	Inoculating fluid A
LB	Lineweaver Burk
LCC	Lignin-carbohydrate complex
NA	Nutrient agar
NB	Nutrient broth
NCBI	National Center for Biotechnology Information
NDF	Neutral detergent fiber
NP	Natural product
OD	Optical density
ODE	Ordinary differential equation

OFAT	One factor at a time
PAL	Phenylalanine ammonia lyase
PBD	Plackett-Burman Design
PCR	Polymerase chain reaction
PDE	Partial differential equation
PRESS	Prediction residual error sum of squares
RK	Runge-Kutta
rpm	Revolutions per minute
rRNA	Ribosomal ribonucleic acid
RSM	Response surface methodology
RV	Revolution
SBP	Sugar beet pulp
TAL	Tyrosine ammonia lyase
TLC	Thin layer chromatography
WB	Wheat bran