UNIVERSITI TEKNOLOGI MARA

KINETIC MODELLING OF *LACTOBACILLUS PLANTARUM* IN FED-BATCH FERMENTATION

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TABLE OF CONTENTS

APPROVAL SHEET i

ACKNOWLEDGEMENTS ii

TABLE OF CONTENTS iii

LIST OF TABLES vi

LIST OF FIGURES vii

LIST OF ABBREVIATIONS viii

ABSTRACT x

CHAPTER 1 (INTRODUCTION) 1

1.1 Background of Study 1

1.2 Problem Statement 3

1.3 Objective 3

1.4 Significance of Study 3

1.5 Hypothesis 4

CHAPTER 2 (LITERATURE REVIEW) 5

2.1 Biotechnological Process of Fermentation 5

2.1.1 Bioreactor 6

2.1.2 Mode of Operation 7

2.2 Fed-batch Bioprocess 8

2.3 Microbial Growth Curve and Microbial Products 13

ABSTRACT

Fed-batch cultivation in bioreactors has been extensively used in fermentation industry to increase the cell density and productivity of the desired bioproduct. The development of kinetic modelling has further improved the fed-batch fermentation process by predicting the growth kinetic behaviour of organisms. The aims of this research were to develop a model for kinetic growth of *Lactobacillus plantarum (L. plantarum)* and determine the ideal feeding strategy of the substrate for maximum biomass production in fed-batch fermentation. Appropriate models have been selected from the literature which includes Monod equation to describe biomass production and substrate utilisation on the cell growth. Product formation of lactic acid follows Luedeking-Piret model. These models are associated with product inhibition term, both in constant and exponential fed-batch, to investigate its effect on the biomass production. These models are then simulated by MATLAB software. The results show that Monod and Luedeking-Piret model which takes into account the product inhibitory effect can maximise the biomass production of *L. plantarum* by exponential feeding of the substrate. However, longer fermentation time is required compared to constant fed-batch.

Keywords: Fed-batch fermentation, Kinetic modelling, Constant fed-batch, Exponential fed-batch, Product inhibition term

CHAPTER 1

INTRODUCTION

1.1 Background of Study

Numerous studies have been established by various fermentation approaches such as batch mode, microfiltration, cell cycle reactors, fermentation in bioreactor or pH uncontrolled fermentation (Goswami and Srivastava, 2000; Lee et al., 2007; Elmarzugi et al., 2010) to improve the productivity of the desired bioproduct. Among those techniques, fed-batch is one of the most commonly used approaches to achieve the high productivity goals in the fermentation process.

Fed-batch cultivation in bioreactors has been extensively used in fermentation industry to improve the volumetric productivity of the desired bioproduct by substantially achieved high biomass production and product formation. Since the fed-batch is a controllable system, it is an advantage to the industry in maximising the production. Several fed-batch culture techniques have developed in various strains. Examples are productivity comparison through exponential and constant feeding strategy for *Lactobacillus plantarum (L. plantarum)* (Hwang et al., 2011) and fed-batch mode followed by microfiltration (Alfano et al., 2015). Others are pseudo-exponential feeding method for *Escherichia coli* by Cheng et al., (2002) and biomass production of *Lactobacillus lactis* in batch and fed-batch culture (Elmarzugi et al., 2010). However,