CHAPTER 1

INTRODUCTION

1.1 Background of Study

Bioconversion technologies play an important role in transforming organic material such as agricultural waste into usable products through biological process (Maurya *et al*., 2015). Enzymatic hydrolysis is one of the biological processes which mostly apply in glucose production from agricultural biomass waste (Alvarez *et al*., 2016). Agricultural biomass waste is largely categorized as lignocellulose materials (Maurya *et al*., 2015). There are abundance of agricultural biomass waste such as coconut residue, sugarcane residue, and empty fruit bunch residue whole over the world which imposes to environmental problems (Chang, 2011).

According to Li *et al*. (2010), agriculture contributes 60% of lignocellulose materials from approximately 4 billion tonnes of crops annually in global production. Malaysia is one of the listed countries that generate large quantities of agricultural waste materials (Economic Planning Unit, Malaysia, 2010). Besides the cultivated plants including paddy, rubber, palm oil, and cocoa, there is a variety of domesticated plants especially fruits production existed in Malaysia such as rambutan, pineapples, and bananas. According to Agriculture and Agri-Food Canada (2014) and Food and Agriculture Organization of the United Nations (2014, 2017), banana is one of the top ten crops in Malaysia with the best volume growth of 336,000 tonnes in year 2012 and this best growth achievement maintain until nowadays in year 2017.

In order to reduce the environmental pollution due to the agricultural waste residues, reutilization of waste materials with high cellulose content such as banana

plant residues – banana trunk after fruit harvesting is one of the solutions to produce secondary benefit products such as glucose instead of just manipulating them as natural manure and animal feed (Teoh and Ooi, 2016). The glucose obtained is able to be further transformed into valuable product such as bioethanol as renewable energy resources. Banana trunk is chosen as the research sample compared to other agro plantation wastes in Malaysia mentioned before is due to its higher cellulose content (60 % – 65%) and lower lignin content (5% – 10%) which contributes to the high suitability in high glucose production (Preethi and Balakrishna, 2013).

Most of the agricultural waste raw materials including banana trunk are majorly made up of lignocellulose which mainly 90% consist of cellulose, hemicellulose, and lignin in dried condition (Li *et al*., 2010). In order to extract cellulose for further saccharification into glucose production via hydrolysis process, lignin which mainly contributes to the formation of secondary cell walls of raw materials must be removed first via pretreatment process. This delignification process can either be carried out through alkali pretreatment or acid pretreatment on the raw materials. Both of these pretreatments are categorized as chemical pretreatment with the literature proven of the most cost effective method in biodegradation of complex raw materials among others pretreatment methods including biological and physical treatments (Song *et al*., 2012). Environmental pollution issue that might bring from the application of chemical pretreatment method can be solved through interventions studies later after determination of the suitable chemical solvent to banana trunk wastes since there is no chemical that work best to all the biomass (Bensah and Mensah, 2013).

Chemical pretreatment step is the essential process to increase the accessibility of cellulose to enzymes by removing lignin and hemicellulose in order to speed up the hydrolysis rate (Tutt *et al*., 2012). Therefore, the type of chemical used is the crucial factor to influence the glucose production from banana trunk. Both acidic and alkaline pretreatment processes will have significantly different effects on the amounts of sugar produced (Lehto and Alen, 2015). Different agricultural biomasses with different lignocellulosic content composition also have the influence on the contact effect to chemical used in order to produce sugar.

Hence, to obtain the most effective technique for lignocellulosic glucose production among acidic and alkaline pretreatment methods, optimization studies can be carried out by using One-Factor-at-A-Time (OFAT) and Response Surface Methodology (RSM) via Design-Expert software (Chi *et al*., 2012). The response in this research is the glucose concentration produced which influenced by the different significant factors studied including the substrate concentration, treatment duration, and treatment temperature.

1.2 Problem Statements

The banana plant can only be harvested once for fruits and the remaining useless pseudostem which normally known as banana trunks are abandoned as agricultural wastes at plantation area as landfill. This non-economical way of biomass waste disposal has lead to environmental pollution for long term. So, the success of finding the effective chemical pretreatment conditions for banana trunk wastes to achieve optimal glucose production might contribute to the reduction of environmental issue. Moreover, the finding of this research could serve as a scientific platform for the industrial scale-up purposes.

During the pretreatment of the biomass, there is no universal chemical solvent that is applicable or feasible for the various cellulosic biomasses from agricultural source. Hence, it is crucial to investigate the best chemical pretreatment of banana trunk wastes for glucose production in order to determine the most suitable chemical solvent for delignification of the banana trunk wastes according to its own specific lignocellulosic content composition. An effective pretreatment on the banana trunk wastes will subscribe to productive enzymatic hydrolysis. The influencing parameters in the pretreatment stage must be evaluated to ensure the achievement of optimal glucose production from banana trunk wastes via enzymatic hydrolysis.

In short, glucose can be chemically synthesized from agricultural biomass wastes which are rich in cellulose content. This method is practically a green bioconversion technology by converting wastes into valuable products. Smart

exploitation and reutilization of the agricultural biomass wastes in glucose production is always being the concern of the researchers to ensure the benefits to environment and society.

1.3 Research Objectives

1.3.1 General Objective

The purpose of this study is to determine the most effective chemical pretreatment between acidic and alkaline treatments on banana trunk raw materials as substrates for optimum glucose production based on the optimization studies of three parameters which include substrate concentration (% (w/v)), treatment duration (min), and treatment temperature (℃).

1.3.2 Specific Objectives

This research has three major objectives as listed below.

i. To investigate the most effective chemical pretreatment between acidic and alkaline treatments on banana trunk wastes for glucose production.

ii. To study the effect of selected range of substrate concentration, treatment duration, and treatment temperature for chemical pretreatment on banana trunk for glucose production using One-Factor-at-A-Time (OFAT) method using selected chemical pretreatment.

iii. To optimize the pretreatment conditions on banana trunk wastes for the highest glucose production via enzymatic hydrolysis using Design-Expert software.