

CHAPTER 1

INTRODUCTION

1.1 Background of the Study

As a second most widely cultivated fruit in Malaysia, banana plantation covers about 26,000 hectare with a total production of 530,000 metric tonne per year (Abdullah et al., 2014). Banana needs 10-12 months from planting to harvest. It can grow to 5-9 m height and after harvesting of the single bunch of bananas and a considerable amount of agricultural residue is produced, such as the foliage, stem and rachis. However, banana plant only bears fruit once in a lifetime.

Normally the banana tree will be cut leaving the base part of the stem and rhizome untouched after the fruit is harvested. Banana is the common name for herbaceous plants of the genus *Musa* and for the fruit they produce. Banana is the of the tropical fruits that are well known to be associated with many medicinal properties (Debjit Bhowmik et al ., 2012).

This fruit has been reported to be a potent source of phenolic compounds. There have been several studies indicated that these fruits contain the important phenolic acid. Phenolic acids are simple compound of non-flavonoid family constituting as a large group of phenolic compounds. They are in the forms of hydroxybenzoic acids (caffeic acid, chlorogenic acid, ferulic acid, *p*-coumaric acid, sinapic acid) and hydroxycinnamic acid derivatives (gallic acid, vanillic acid, hydroxybenzoic acid, Syringic acid) (Ongphimai et al., 2013). The banana stem can be used as an alternative source to produce ferulic acid since the availability of banana stem is high in Malaysia.

Ferulic acid has excellent antioxidant properties which are higher than those of vitamin C and E that makes it as an important ingredient in the industry. Thus, it have a wide range of biological activities, such as antioxidant activities, protection against coronary heart diseases, anti-inflammatory , anti-tumour , anti-mutagenic, anti-carcinogenic and anti-microbial activities that will be helpful in pharmaceutical industry (Ongphimai et al., 2013). In food industries, ferulic acid can prevent the food from discoloration in order to maintain the colour tone of green peace, avoid discoloration of green tea , and prevent the banana from turning to black colour due to oxidation

(Ismail & Zainol, 2014b). Since the ferulic acid have the ability to moisturize skin, inhibit melanin formation, and protect the skin from UV light, it is the most important ingredient in the cosmetic field.

Ferulic acid is an enormously copious and almost ubiquitous phytochemical phenolic derivative of a cinnamic acid that present in the cell wall components as covalent side chains. It has been found that ferulic acid is linked with a variety of carbohydrates such as glycosidic conjugates, different esters and amides with a broad range of natural products (Kumar & Pruthi, 2014). Ferulic acid can be extracted by using several methods from different sources such as numerous alkaline , acidic and enzymatic methods (Kumar & Pruthi, 2014). Alternatively, a mechanical extraction has been introduced to extract the ferulic acid by using sugar cane press machine rather than using enzymatic and chemical reaction. The sugar cane press machine is a well establish equipment in the plant material processing and also to extract the sugar from the sugar cane and fresh oil palm frond (OPF) particularly (Ismail & Zainol, 2014b).

The purpose of kinetic study were to determine the factors that could controlling the fermentation process, increasing the productivity , determine the quality of the product , reducing the operating costs and eliminate disturbances (Su, 2014). In this study, ferulic acid was extracted from banana stem waste via sugar can press machine. To obtain the kinetic parameters which is the reaction constant 'K' of ferulic acid production from banana stem waste the method of integration is used. However, to determine the reaction rate constant we must determine the reaction order of the extraction process whether it is 0th, 1st or 2nd order reaction. There are several methods to determine the reaction constant which are graphical method and integral method. In this study, the integral method was implemented to determine the reaction order. The reaction order was first assumed and the differential equation used to model the batch system was then integrated. The integral method is mostly use when the reaction order is known and it is desired to evaluate the specific reaction rate constants at different temperatures to determine the activation energy (Fogler , 2014).

1.2 Motivation

Ferulic acid (FA) can be extracted from banana stem waste via various methods such as solvent and mechanical extraction. Solvent extraction are commonly used method due to its simplicity, efficiency and also it wide applicability. The yield of the chemical extraction depends on the type of solvents used such as methanol and ethanol (Dai & Mumper, 2010). However, this extraction method has it disadvantages because this extraction method may contain some non-phenolic substances such as sugar, organic acids and fats. For the mechanical extraction, the sugarcane press machine is used to extract the phenolic compounds which are ferulic acid from the banana stem waste. From the previous researcher, it is found that this method is easy to handle since it does not involve any chemicals. This mechanical extraction also takes a shorter time and high yield since the sugarcane press machine doing the mechanical press on the banana stem waste and produce high amount of juice in a shorter time. The mechanical extraction does not involve any uses of chemical and catalyst and this extraction is more way cheaper than solvent extraction (Ismail & Zainol, 2014).

1.3 Problem Statement

The kinetic study of the ferulic acid is performed to determine the value of kinetic parameters “K” in ferulic acid production. The important of kinetic study is to assess the role of acid concentration in the extraction yield that employing kinetics. The kinetic model established enabled the reliable comparison of the extraction efficiency of acetic acid and citric acid solution as a function of acid concentration. From previous study, it indicates that acetic acid solutions were more suitable in extraction process of phenolic compounds. The extraction kinetics of the extraction of phenolic compounds can be fitted to non-linear regression model between Y_{TF} values and t (Equation 1.1), was a hyperbola described by the equation:

$$y = \frac{ax}{1+bx}$$

Equation (1.1)

$$Y_{(TF)} (\mu g \text{ CTE } g^{-1} dpw) = \frac{(15.15 \times A (640) + 0.395) \times V}{m}$$

Equation (1.2)