CHAPTER I

INTRODUCTION

1.1 Background of Study

Sun continuously emits ultraviolet (UV) radiation, which can be divided into three categories dependent on wavelength: UVC (200–280 nm), UVB (280–320 nm) and UVA (320–400 nm). UVC is prevented from reaching the earth as it is largely absorbed by atmospheric ozone layer. However, UVA and UVB can reach the earth and penetrates the skin. Epidemiological, clinical and in vitro studies show that overexposure to UV radiation results in the generation of reactive oxygen species (ROS), which leads to lipids, protein and nucleic acids damage in cell membranes and contribute to the sunburn, wrinkle, lower immunity against infection, premature aging as well as cancer (Oresajo et al., 2008).

Accordingly, wide variety of sunscreen products with sun protection value (SPF) values flooding our market now (Manová et al., 2013). These sunscreen products incorporate with different chemicals that have high UV-light-absorbing properties, which are commonly known as UV filters. Chief innovations nowadays not only focus on UV filters which can filter or block the UV radiation, but also have antioxidants properties to prevent or counteract undesirable effects of the radiation on skin cells (Gonzalez et al., 2011). Among many available photo-protective agents, ferulic acid has aroused great interest due to its strong antioxidant activity.

Ferulic acid or 4-hydroxy-3-methoxycinnamic acid is a ubiquitous phenolic acid naturally found in plant kingdom with maximum UV absorption at 322 nm which falls between the UVA and UVB region (Compton et al., 2000). Due to the special chemical structure of having phenolic nucleus and unsaturated chain, ferulic acid is readily forms resonance stabilized phenoxy radical to protect DNA and lipids against oxidation through ROS. In addition, literature survey also reveals that ferulic acid has proven to treat several age-related diseases such as neurodegenerative disorders, cardiovascular disease, Alzheimer, diabetes and cancers (Barone et al., 2009).

Due to small polar compound, however, ferulic acid is not easily incorporated into an oil phase of emulsions or anhydrous compositions which reduces its antioxidant effectiveness. Thus, modifications of ferulic acid have been made by conjugating with fatty alcohols to improve its oil-solubility which keeps its original function properties. Kikuzaki et al. (2002) proved that alkyl esters of ferulic acid, such as hexyl, octyl and 2-ethyl-1hexylferulates, have higher antioxidant activity than unmodified ferulic acid. Thus, incorporation of these alkyl ferulate with triglycerides to produce ferulate esters have become remarkable in the development of natural antioxidants with respect to photo-protective agent (Laszlo & Compton, 2006; Xin et al., 2009; Sun et al., 2012).

Owing to a number of drawbacks in the chemical synthesis of ferulate esters, the recent trends are more towards green synthesis by using biocatalysts in order to conserve energy and raw materials, eliminate waste as well as avoid use of hazardous solvents (Sheldon, 2000). Different synthetic routes of ferulate esters have been approached by using different substrates (Compton et al., 2000; Karboune et al., 2008; Sun et al., 2013). Up to date, Sun & Bi (2014) reported almost 100 % of ferulate esters conversion in solvent-free enzymatic transesterification between ethyl ferulate and castor oil. Nevertheless, there are some problems related to the synthesis processes such as high cost of biocatalysts and low production yield within time, which make it uneconomical for industrial application.

Besides, introduction to multiple enzyme systems or known as combinatorial biocatalysts in the synthesis of several esters have been successfully carried out by researchers and revealed to have high potential to be employed (Ibrahim et al., 2008; Guan et al., 2010). Since the study on the combination of biocatalysts in the production of ferulate esters has not yet been found, alternatively, this technique is expected to improve the production of the esters. Regarding the enzymatic synthesis, optimization of reaction process is very important. One of the best techniques for obtaining the optimum design parameters is by using response surface methodology (RSM). Not only requires a limited number of experiments, RSM also offers a mathematical model of overall process which is advantageous over conventional study.

Other aspects to be highlighted in the production of a new compound are antimicrobial activity and physicochemical characterization. Both studies are important and prerequisite for the development of efficacy and safety of a product. Recently, there has been a paucity of information on the biological study and physicochemical properties of the synthesized ferulate esters.

Starting from this background, a project was embarked upon in which the main aim was to develop a dual lipases system, combination between two immobilized lipases of non-specific of Novozym 435 and 1, 3-specific of Lipozyme RM IM, for synthesis of ferulate esters using olive oil as substrate. Synthesized ferulate esters were believed to develop a multifunctional range of ingredients, while providing a value-added use for vegetable oils. The experimental design was figured as shown in Appendix A.

1.2 Objectives

Therefore, such product and process development involved the following approaches:

1. To examine the feasibility and effectiveness of a dual lipases system in the performance of ferulate esters production.
2. To optimize the reaction conditions using conventional and statistical approaches.
3. To investigate the biological properties of synthesized ferulate esters.
4. To determine the physicochemical characteristics of synthesized ferulate esters.