CHAPTER I

INTRODUCTION

1.1 Background

Nanotechnology is a technology that takes place on nanometer scales, which is around 1 to 100 nanometer(s) (nm). Nanoparticles can help food industries for adding essential substances, for example antioxidant agents to foods without changing any shapes or texture of the food. Therefore, nanotechnology is a promising field of study for the industries to make innovative products. Nanoparticles is usually being synthesized using metals such as silver, zinc, gold, copper, or platinum (Sabliov, *et al*., 2015).

Silver is one of the most commonly used metals as a noble nanoparticles that has properties of high surface area and high dispersion. Silver is also a safe metal because it is non-toxic to animal cells and also it has antioxidant and antimicrobial properties. Silver is conventionally synthesized using chemical and physical methods, which uses a huge amount of toxic chemicals and high temperature conditions, and also expensive. Therefore, some studies found another method, which is called the green synthesis (Abdel-Aziz, *et al*., 2014).

Green synthesis is an eco-friendly method that is used to synthesize non-toxic Silver Nanoparticles. The green synthesis method produces less toxic to the environment, thus it is a more preferable method in producing silver nanoparticles. The green synthesis of nanoparticles involves the process of the reduction of salts of silver into silver nanoparticles. Plant phytochemicals such as phenols, alkaloids,

and flavonoids could act as a reducing agent, which reduces salts of Silver into Silver nanoparticles (Abdel-Aziz, *et al*., 2014).

Therefore, the synthesis can be done using a plant extract, microorganisms, or enzymes. Moreover, the advantages of the green synthesis are more stable, faster, low in cost, and safer for environment. In this experiment, the plant that is used for green synthesis are green spinach *(Amaranthus blitum* L.) leaf and stem. The plants are going to be extracted using different solvents, such as distilled water, ethanol, and the combination of both solvents. The sample will be extracted using Microwave-Assisted Extraction (MAE) (Gupta, 2011 & Charles, 2013).

Green spinach is a type of green vegetables (*Amaranthus blitum* L.) that is commonly consumed as a healthy food to increase the nutrition that is needed for human body. Green spinach is one of plants that contains high amount of phytochemical compounds, therefore, green spinach can be used as a reducing agent of salts of Silver into Silver nanoparticles. According to Rao, *et al*. (2016), the only compounds that could reduce the ion metallic compounds become nanoparticles were phytochemicals. In addition, according to Chaturvedi, *et al*. (2013), green spinach has high phytochemicals compounds, especially phenolic and flavonoids.

Thus, the aim of this research is to study about the synthesis of silver nanoparticles using different phytochemicals extracted using different type of solvents and different parts of plant to evaluate the antioxidant properties, and also to evaluate the characteristics of nanoparticles (Gupta, 2011 & Charles, 2013).

1.2 Research Problem

The green synthesis of silver salts needs a reducing agent to make the silver nanoparticles. Green spinach (*Amaranthus blitum* L.) leaf and stem extracts were expected to be able to act as a reducing agent of the green synthesis of silver nanoparticles due to the presence of plant phytochemicals (phenolic compounds). However, there is no research yet about the use solvents of different polarities used to extract green spinach leaf and stem, which results in different phytochemicals extracted affecting the reduction of salts of silver into silver nanoparticles.

Therefore, this research was designed to evaluate the potency of green spinach leaf and stem extracts in the formation of Silver Nanoparticles (Ag-NPs) as an antioxidant. Moreover, research about the effect of calcination temperature to the antioxidant capacity and physical properties of Silver nanoparticles will be further studied.

1.3 Research Objectives

1.3.1 General Objectives

The general objective of this research was to form Silver Nanoparticles (Ag-NPs) synthesized from the extracts of green spinach leaf and stem (*Amaranthus blitum* L.).

1.3.2 Specific Objectives

The specific objectives of this research were:

1. To determine the effect of solvents with different polarities towards the formation and antioxidant capacity of Silver Nanoparticles; and based on

this, to select the best solvent combined either with leaf or stem extract of green spinach.

2. To determine the effect of calcination temperature towards the antioxidant activity, particle size and morphology of Silver Nanoparticles.