CHAPTER 1

Introduction

1.1 Statement and Rationale of the Study

Mango (*Mangifera indica* L.) is considered a popular and economically important tropical fruit around the world because of its attractive color, favorable flavor, and high nutritional qualities (Baloch and Bibi, 2012; Khaliq *et al*., 2015; Xu *et al*., 2017). It was in the fifth rank of total production of fruit crops worldwide and its production was over 38.9 million tons per year (FAO, 2011; Santhirasegaram *et al*., 2015). Nowadays, consumers need safe, fresh and nutritious fruits that undergo minimal processing with low or free of microorganisms and chemical contamination. Conventional postharvest washing treatments are not highly effective for eliminating pesticide residues as well as against the growth of mold and pathogens (Iizuka and Shimizu, 2014; Lacombe *et al*., 2015). However, various microorganisms lead to quality deterioration and reduce market value occurring on mango. Anthracnose, caused by *Colletotrichum gloeosporioides*, is one of the most serious postharvest diseases of this fruit. Most immature mangoes infected by the mold appear healthy and remain latent until storage and ripening, when lesions rapidly develop (Nelson, 2008; Hu *et al.*, 2014). Moreover mango suffers from more than 492 species of insects, 17 species of mites and 26 species of nematodes. To minimize the economic losses caused by these noxious small creatures, farmers rely on pesticides such as carbaryl, cypermethrin, malathion, methyl parathion, carbendazim and chlorpyrifos (Singh *et al*., 2008). When applied improperly, residues of some of these pesticides can remain and make a significant hazard to human health (Sharma *et al*., 2010).

Regarding to this problem, several methods have been applied for eliminating the chemical residues and microorganisms. Chemical sanitizing methods, usually chlorine based, which are commonly used in the food industry, have increased public health concerns about the risk of carcinogenic by-products formation and have also been

prohibited in a number of European countries (Ramos *et al*., 2013; Baier *et al*., 2013; Schnabel *et al*., 2015). Other thermal treatments ensure a safe level for food, but they also affect flavor, color and texture of products (Heo *et al*., 2014; Surowsky *et al*., 2014). Thus, new processes for decontamination chemical residues and microbes together with maintaining nutritional and sensory qualities of fruits are required.

Non-thermal plasma (NTP) is one of the emerging novel technologies that could potentially decontaminate fresh food and food processing surfaces. It involves exposing food to ionizing radiation including charged particles, electric fields, photons or reactive species to disinfect microbes and hazards while ensuring the safety of products (Niemira, 2012; Heo *et al*., 2014; Misra *et al*., 2014b). NTP using a dielectric barrier discharge to degrade pesticide residues on strawberries had been successfully investigated (Misra *et al*., 2014b). The reduction of organophosphorus pesticides sprayed onto maize samples when treated with oxygen NTP was also studied by Bai *et al*. (2009). By applying NTP, harmful bacteria and toxins in fruits, vegetables, and meat products can be eliminated effectively while the fresh taste, aroma, texture, wholesomeness, and nutritional content of them are still preserved (Baier *et al*., 2013; Pankaj *et al*., 2014). Recent researches have reported that cold plasma activated water can highly inactivate foodborne pathogens in fresh strawberry and mushroom (Ma *et al*., 2015b; Xu *et al*., 2016). Besides, disinfecting ability of NTP offers the advantage of being free of chemicals, low temperature, in addition to being able to operate openly and continuously (Lacombe *et al*., 2015).

However, there are still limited studies concerning about NTP supporting pesticide degradation on fresh fruits and vegetables, in general, and mangoes in particular. Researches into influence of NTP technology on reducing postharvest disease of mango fruits are very few also. Therefore, this research aims to investigate the potential of NTP produced by applying gliding arc (GA) discharge and transferred to a large volume of water for decontaminating pesticide residues on fresh mangoes as well as the effectiveness of this NTP technique on the inactivation of *C. gloeosporioides* inoculated on the fruits.

1.2 Objectives

The aims of this research can be summarized as follows:

1.2.1 To study and find the optimal condition of NTP generated by GA discharge under different Argon (Ar) gas flow rates and treatment time for decontamination of pesticide residues as well as inhibition of *C. gloeosporioides* inoculated on fresh mangoes.

1.2.2 To quantify the degradation of pesticides including chlorpyriphos, cypermethrin, and carbendazim on mango surface with different NTP treatments.

1.2.3 To evaluate the *in vitro* and *in vivo* inactivation of *C. gloeosporioides* affected by different NTP conditions.

1.2.4 To determine reactive agents and hydrogen peroxide (H_2O_2) concentration produced by NTP treatments.

1.2.5 To analyze the physicochemical characteristics and sensory properties of mango before and after treating with NTP.

1.3 Research scope

In this research, Nam Dok Mai mango fruits from a Thai company exporting mango were used. Several flow rates of Ar gas applied to generate NTP by gliding arc discharge as well as duration of plasma treatment for decontamination of pesticides residues and inactivation of *C. gloeosporioides* on mango surface were investigated. The reactive components together with H_2O_2 concentration produced by this NTP source were also determined. In addition, the physicochemical characteristics and quality indexes of mango samples before and after NTP treatments including skin color, texture, moisture content, total soluble solid, total titratable acidity, ascorbic acid content, total carotenoid and total phenolic compounds were measured. The sensory properties of mango treated with optimal condition of NTP parameters were also evaluated, then compared with the fresh mango without any treatments and with the fruits treated with thermal conventional method as well.