CHAPTER 1

Introduction

Principle and rationale

Mango (*Mangifera indica* Linn.) is an important exported fruit for Thailand. It has a short postharvest life at ambient conditions which leads to ripening and decay during long distance transport to markets. Low temperature storage at 13 °C with 85-95% relative humidity (RH) is recommended for long-distance transport of mango fruits shipped successfully for 15 days to Asian countries (Department of Agriculture, 2011). Shipping over long distances across Europe and America needs a longer time. Low temperature storage below 13 °C is considered, but may result in chilling injury (CI) if the temperature is too low (2-12 °C) (Phakawatmongkol *et al*., 2004).

CI is a physiological disorder appearing during storage at low temperature. The symptoms are exocarp browning, mesocarp discoloration and surface pitting (González-Aguilar *et al*., 2000, 2001; Phakawatmongkol *et al*., 2004; Ding *et al*., 2007). CI affects the quality of mango fruit. Abnormal ripening including poor exocarp color development, poor aroma and flavor and susceptibility to decay are found in CI fruit (González-Aguilar *et al*., 2000, 2001). Many studies showed that CI development is associated with the increase in free radicals production and accumulation and decrease in the antioxidant defense system during storage at low temperature in peach, loquat and lemon fruits (Jin *et al*., 2009a; Cao *et al*., 2011; Siboza and Bertling, 2013). Oxidative stress from excess of free radicals induces oxidation of biomolecules in fruit cells including lipid peroxidation, protein oxidation and nucleic acid oxidation (Gill and Tuteja, 2010). Especially, lipid bilayer of membrane induced membrane breakdown leading to oxidative membrane damage and electrolyte leakage from the organelles or cells resulting in abnormal metabolism and finally appearance of CI symptoms (Lyons, 1973). It is important to find methods for avoiding or reducing CI of mango fruit during storage at low temperature for transport to distant markets in Europe and America.

Many methods to reduce CI have been used for mango fruit, but most of them were not effective enough. Salicylic acid (SA) and methyl jasmonate (MJ) are plant growth regulators and signal molecules that have an important role in response to environment stress (Raskin, 1992; Creelman and Mullet, 1997; Ananieva *et al*., 2004; Wang *et al*., 2006). It was found that SA and MJ are highly effective in reducing CI symptoms of some mango cultivars such as Tommy Atkins (González-Aguilar *et al*., 2000), Kent (González-Aguilar *et al*., 2001) and Zill (Ding *et al*., 2007) and other fruits such as loquat (Cao *et al*., 2009), peach (Meng *et al*., 2009) and pomegranate (Sayyari *et al*., 2009). They could improve or maintain the quality of fruit such as enhanced exocarp color development (González-Aguilar *et al*., 2001), increased total soluble solids (Tareen *et al*., 2012), reduced weight loss (Nilpraprucк *et al*., 2008) and disease incidence (Luo *et al*., 2011) and increased overall quality (González-Aguilar *et al*., 2001). The mechanism of SA and MJ on reduced CI are linked to enhance the antioxidant defense system including induced expression of antioxidant enzyme genes (Fung *et al*., 2004; Chen *et al*., 2011), and increased activities of antioxidant enzymes such as superoxide dismutase, catalase and ascorbate peroxidase (Cao *et al*., 2009; Promyou *et al*., 2012), and increased non-enzymatic antioxidant contents such as ascorbic acid (Chen *et al*., 2011), glutathione (Chen *et al*., 2011) and phenolic compounds (Sayyari *et al*., 2011b) and increased total antioxidant capacity (Tareen *et al*., 2012). The enhancement of the antioxidant defense system by SA and MJ treatments increased the effectiveness to eliminate free radicals and repair oxidative damage during storage at low temperature, resulting in CI tolerance in SA and MJ treated fruits. The optimum concentrations of SA and MJ for reducing CI are dependent on the fruit species and cultivars.

Although SA and MJ have been shown to reduce CI in mango and other fruits, there have been very few studies on Thai mango especially Nam Dok Mai No. 4, an important commercially cultivated product of Thailand for export to international markets and very susceptible to CI (Phakawatmongkol *et al*., 2004). It is necessary to determine the effect of SA and MJ on chilling injury and fruit quality of Nam Dok Mai No. 4 mango fruit during low temperature storage and mode of action of SA and MJ on free radicals, oxidative membrane damage and the antioxidant defense system. In this study, SA and MJ treatments before storage at low temperature (5 °C) can extend

storage life, maintain quality, and drastically reduce CI. The treatments can be applied for the improvement of chilling injury tolerance and maintain the quality of Nam Dok Mai No. 4 mango fruits in order to expand the target markets and increase income from mango exports.

Objectives

To study the effects of SA and MJ on 1) chilling injury and fruit quality, 2) free radicals and oxidative membrane damage and 3) antioxidant defense system of mango fruit cv. Nam Dok Mai No. 4 during low temperature storage.

Usefulness of research

1. The effects and mechanisms of SA and MJ on reducing chilling injury and maintaining fruit quality of Nam Dok Mai No. 4 mango fruit and their relation to free radicals, oxidative membrane damage and antioxidant defense system are elucidated.

2. This research will lead to the improvement of overall quality and marketability of Nam Dok Mai No. 4 mango fruit for export to international markets.

Scope of research

1. The effects of SA and MJ on chilling injury and fruit quality of Nam Dok Mai No. 4 mango fruit were examined during storage at 5 °C for 42 days.

2. The effects of SA and MJ on free radicals including contents of the superoxide radical, hydrogen peroxide and hydroxyl radical, and effects on oxidative membrane damage including lipoxygenase activity, malondialdehyde content and electrolyte leakage of Nam Dok Mai No. 4 mango fruit were investigated during storage at 5 °C for 42 days.

3. The effects of SA and MJ on the antioxidant defense system including enzymatic antioxidants such as the activities and gene expressions of superoxide dismutase, catalase and ascorbate peroxidase, and non-enzymatic antioxidants such as contents of phenolic compounds, ascorbic acid and glutathione, and total

antioxidant capacity of Nam Dok Mai No. 4 mango fruit were determined during storage at 5 °C for 42 days.

Duration of research

June 2010 to June 2013