

CHAPTER 1

Introduction

1.1 Principles and rationale

Tangerine (*Citrus reticulata* Blanco cv. Sai Nam Pung) is an economically important fruit of Thailand. Tangerine is the famous fruit that has the highest consumption in Thailand. Tangerine can be grown in every area in Thailand. In 2009, tangerine plantation was about 56,000 ha, estimated production of tangerines was 800,000 tons, domestic consumption was 99%. The important regions for tangerine production are Chiang Mai, Chiang Rai and Phrae. Chiang Mai has the biggest plantation for 16,000 ha (Jamroenma *et al.*, 2009). Tangerines are exported to many countries such as Malaysia, Singapore, Hong Kong and Brunei Darussalam.

Tangerine can be produced all year round and caused the pest epidemic during production period. The important pests in tangerine production are Asian citrus psyllid (*Diaphorina citri* Kuwayama: Psyllidae) the carrier of greening; and citrus aphid (*Toxoptera* sp.), chilli thrips (*Scirtothrips dorsalis* Hood: Thripidae) and African red mite (*Eutetranychus africanus* (Tucker); Tetranychidae), causing the unpreferable products. So the growers have to apply a lot of chemical pesticides every week, even at the harvesting time to improve the tangerine appearance (EK-Amnuay, 2007).

Jamroenma *et al.* (2009) reported that due to there are several batches of tangerine in one plant at time, therefore in one batch, the chemical pesticides were applied to tangerine, this will unavoidably affect other batches, and led to cause the chemical residue problems. It was found that the important pests were *Thrips dorsalis* Hood and *Eutetranychus africanus* (Tucker). The insecticides used for controlling thrips were ethion, abamectin, imidacloprid, methomyl and carbosulfan respectively; the acaricides were ethion, propagite, amitraz, pyridaben and fenbutatinoxide (Sutthiarom *et al.*, 2010).

There are several common names for ethion; Siamthion, Ethanox, Ethiol, Hylemox, Nialate, Rhodiocide, Rhodocide, RP-Thion, Tafethion, Vegfru Fosmite. Ethion is the pesticide belongs to organophosphate group and used for controlling aphids, mites and thrips. It plays an important role in disturbing cholinesterase enzyme in insect nervous system (Department of Agriculture, 2002). Currently, growers widely use ethion (PAN, 2011), then causes the chemical residues on the surface of fruits and vegetables, and some can be absorbed into plant tissues. Jamroenma *et al.* (2009) reported that tangerines consisted of ethion over Maximum Residue Limits (MRL) level(1.0 mg kg⁻¹), and 31.8% of the sampling were contaminated with ethion, cypermethrin, profenophos, carbaryl, chlorpyrifos and carbosulfan but lower than MRL. Wongkaew *et al.* (2009,2010) got the tangerine sampling from the growers, fresh market and super market in Chiang Mai, Lamphun and Lampang Provinces from November 2008 to December 2009, for 50 samples. Then peel and flesh were analysed according to the Office of Thai Agricultural Commodity and Food Standard (2006) . The content of pesticides, i.e. ethion, profenofos and triazofos were higher than MRL level. Ethion was found 1.14 mg kg⁻¹ for 92% of the sample. In tangerine flesh sample for 50% found ethion 0.01 mg kg⁻¹.

Growers normally avoid chemical application before harvesting. However, it is hardly practiced in tangerine production because many batches of tangerine are grown in the same area, so pesticides can be easily contaminated to the harvested tangerine. Although, the most common method for reducing chemical residues is nowadays washing with detergents, sodium hypochlorite or potassium permanganate, this method creates chemically polluted water as a by-product, and has a high cost and limited effectiveness. The Good Agricultural Practices)GAPs (certification program has been a strategy for limiting pesticide residues on crops. However, ethion contamination of tangerines is still a critical problem to be solved because of over usages used by growers (Bhoomborplub, 1999). Titanium dioxide (TiO₂) photocatalysis has been reported as an effective treatment for removal of organic and inorganic contaminants. Titanium dioxide has also been reported as an effective treatment by oxidizing contaminants. This method does not require hazardous chemicals and may be used to remove residual ethion on tangerine surface.

TiO₂ photocatalysis should be a high potential technology in chemical residues reduction in export tangerine before waxing. The effective method and the possibility of chemical residues reduction by TiO₂ photocatalysis will be studied in order to achieve the safe products with the acceptable condition for customers in each country. Moreover, the properties in disinfection of microorganisms by TiO₂ photocatalysis may extend the storage life of tangerines. Therefore, data obtained from this study may help elucidating problems involved in tangerine export.

1.2 General objectives

1.2.1 To study the effectiveness of TiO₂ photocatalysis for ethion removal *in vitro*.

1.2.2 To study the oxidative decomposition and the toxicity of degradation products of ethion.

1.2.3 To evaluate the degradation of ethion contaminated in tangerine and wastewater after washing.

1.3 Usefulness of research

1.3.1 New knowledge about the degradation of ethion in harvested tangerine by TiO₂ photocatalysis will be obtained.

1.3.2 A potential method can be implemented practically for example the model for removal of other chemical residues in other fresh products.