CHAPTER 1
INTRODUCTION

1.1 Principles and rationale

Chilli (*Capsicum frutescens* Linn.) is an economically important crop because it has been used as an ingredient in food and some drugs, due to the chilli's high nutrient content, bright color and taste in Thailand. Annual chilli export was around 181 million Baht (Plant Breeding Research Center for Sustainable Agriculture, 2008). The most important demand for importing countries is the procurement of high quality chillies. Exporting countries are concerned with increasing crop production with constraints on available agricultural land. Increasing the use of pesticides is one way to achieve this goal, therefore overall pesticides use is likely to increase in the future. Thai Agricultural Commodity and Food Standard in 2006 have reported that the residual pesticides have been detected at the higher concentration than the Maximum Residue Limits (MRLs) by importers. Among chilli exports, chlorpyrifos was the most commonly found residue. Chlorpyrifos is an organophosphate insecticide and is widely used for pest control on vegetable crops (Chen *et al*., 2009). Nowadays, the most common method for reducing the chemical residues is by washing with detergent, sodium hypochlorite or potassium permanganate, but this method creates chemically polluted water as a byproduct, and has a high cost and limited effectiveness. The Good Agricultural Practices (GAPs) certification program has been a strategy for limiting pesticide residue on crops. However, chlorpyrifos contamination of chilli is still a critical problem to be solved because of the over usage use by growers.

Oxidation processes have been developed to remove or destroy organic compounds from waters. Among these processes are ultrasonication and ozonation.

Ultrasonication technology has been reported to be effective in the destruction of a variety of organic and inorganic contaminants (Weavers *et al.*, 1998). It results in acoustic cavitations generating many hot spots with locally high temperatures and

pressures and causes to the sonolysis of water molecules. These molecules form radical species (H, $^{\bullet}$OH, $^{\bullet}$OOH), which the most powerful being the hydroxyl radicals, which react with chlorpyrifos and lead to its destruction.

Ozone is a strong oxidizing agent that reacts with a variety of organic substance by breaking the chemical bonds within compounds. For example, in seawater, ozone reacts rapidly with bromide ion to produce hypobromous acid (HOBr) which is an effective oxidant and further reacts with free ammonium producing hydrogen ions (Whangchai *et al*., 2004b). Wu *et al*. (2007) found that when diazinon, six ozonation byproducts were detected by GC-MS, compared with the blank control. Ku *et al*. (1998) found that diazinon decomposition reaction occurred in the film region by the direct oxidation of ozone molecules.

Chlorpyrifos (*O*,*O*-diethyl *O*-3,5,6-trichloro-2-pyridyl phosphorothioate; $C_9H_{11}Cl_3NO_3PS$) is a toxic organophosphate insecticide, its structure has one benzene ring. Although the decomposition of organic phosphate in aqueous media by ultrasonication and ozonation have been reported by several researchers, Matouq *et al.* (2008) used the high frequency of ultrasound wave at 1.7 MHz to decrease the concentration of diazinon which is organophosphate group and has the same as chlorpyrifos structure. Moreover, ozone water was used to oxidize washing pesticides in Pak Choi (Wu *et al*., 2007). Detailed information on the reaction of chlorpyrifos pollutions (degradation products) decomposition by ultrasonication and ozonation is still unclear.

To solve the problems mentioned above this study was conducted on the following general objectives.

1.2 General objectives

1.2.1 To study the effectiveness and the oxidative decomposition of ultrasonication and ozonation for residual chlorpyrifos removal *in vitro.*

1.2.2 To study the degradation of chlorpyrifos contaminated fresh.

1.2.3 To study the toxicity of degradation products of chlorpyrifos and washing water of chilli.

1.3 Usefulness of research

1.3.1 New knowledge about the degradation of chlorpyrifos after washing fresh chilli by ultrasonication and ozonation will be obtained.

1.3.2 New application could be a practical model for using to remove other insecticide residues in other fresh products.