Chapter 1
Introduction

1.1 Introduction

Mango (*Mangifera indica* Linn.) is one of the most important agricultural produces of Thailand which shows a great potential for exporting. In 2003 Thailand exported around 8,098 metric ton of fresh mangos, earning 188,556,000 Baths (OAE, 2004). Among all varieties mango cv. Nam Dok Mai and Nang Klang Wan are the most favorites suitable for export due to size, beautiful color, attractive aroma and delicious taste. However, the amount of mango exported from Thailand to the world market is limited, because it is highly perishable, short shelf life, and susceptible to postharvest decay, and is required a short time for ripening, thus it causes a commercial problem for the distant markets (Mitra and Baldwin, 1997).

Low temperature storage is considered to be the most effective method for maintaining the quality of fruits as it retards respiration, ethylene production, ripening and senescence (Kader, 1992). Unfortunately, for chilling sensitive crops such as mango, the low temperature storage is often more detrimental than beneficial. However, if the fruits are not refrigerated, they tend to break down rapidly and have a short storage life. This dilemma thus results in tremendous postharvest losses of mango. It is apparent that alleviating chilling injury in mango is vitally important (Wang, 1994a).

Therefore, the different methods are developed to alleviate chilling injury symptoms. These include various postharvest treatments either with fungicides, plant growth regulators, chemicals, waxing, plastic wrapping, controlled atmosphere, intermittent warming or temperature conditioning (Wang, 1990, 1994b). Nowadays, the chemical usage is prohibited because it causes many effects to the consumers and environment; controlled atmosphere storage can be effective but expensive; on the other hand, heat treatment is an interesting method because it appears to be an effective, inexpensive and safe method; temperature conditioning before heat treatment increases heat tolerance through a reduction or elimination of heat injuries

(Jacobi *et al.*, 1995, 1996, 2000; Joyce and Shorter, 1994; Woolf *et al.*, 1995; Hakim *et al.*, 1996). The use of this technology lies in its ability to prolong storage period required for exporting (McDonald *et al.*, 1999).

Heat treatment used commercially as a postharvest commodity treatment to eliminate unwanted insect from fresh (Shellie and Mangan, 2000; Jacobi *et al.*, 2001; Armstrong *et al.*, 1989; Couey, 1989; Klein *et al.*,1990; Paull, 1994a: Lurie, 1998; McDonald *et al.*, 1999). Postharvest exposure to temperature less than 40-42 °C often increases storage life and improves the flavor for a number of fruits (Liu, 1978; Lurie, 1998; Shellie and Mangan, 1998). On the other hand, at higher temperature, i.e higher than 45 °C, the symptoms occurred are skin scald and failure of the fruit to soften fully, or softening at a reduced rate (Chan *et al.*, 1982; Kerbel *et al.*, 1985; Couey, 1989; Paull and Chen, 1990), the severity of the induced stress is determined by both the treated temperature and the duration of the exposure (Paull, 1994b). There is a need to fully understand the influence of various factors on heat transfer properties of fruit to minimize adverse effects on fruit quality; although heat transfer theory has been well established in many aspects (Incropera and Dewitt, 1996; Dincer, 1997; Holdsworth, 1997). However, in the horticultural literature, there is a limited number of study using this theory to predict or to relate the effect of temperature on postharvest qualities of fresh produce.

Thermal properties such as specific heat (C_p), thermal conductivity (k) and diffusivity (α), had been used as a maturity index and handling criteria for Nam Dok Mai (Chavapradit, 1987); Wang *et al.* (2001) used thermal properties to simulate the internal heating rate for hot air and hot water treatment, it was shown that the most important parameters in the model were fruit size, the heating medium temperature and the heating medium speed; Varith (2001) used thermal properties of apple for non-destructive quality assessment, it was found that C_p values of the sound tissue of the new crop 'Red Delicious' and 'Golden Delicious' apples were significantly higher than that the old crop apple; moreover, bruised apples showed faster heat transfer rate than did the sound tissues, the differences in temperature between bruised and sound tissue during heating and cooling treatments, had been detected by the thermal camera (ThermaCam^{TM}PM 390), thermal images of bruised tissue showed at least 1-2 °C difference from the sound tissue within 30-180 s, this is because of the thermal diffusivity (α) of bruised tissue is lower than that the sound tissue. This technique could be provided a basis for automatic bruise sorting. Recently, it was found that the phase transition temperature of the cuticle membrane of apple and capsicum were shifted to the lower end when the fruit were stored at low temperature, this may indicate that the cuticle membrane may participating in plant tissue chilling injury (Aggalwal, 2001).

There has been much research studying the effect of heat treatment on commodity including optimum temperature, duration and quality, but there is a few research, using thermal property to predict heating rate during heat treatment and the work to predict the commodity response is missing. The objectives of this research were to study the effect of temperature conditioning before heat treatment on thermal properties and quality changes of 'Nam Dok Mai' mango, to establish the correlation between chilling injury and thermal properties, and to predict the heating or cooling rates during heat treatment or refrigeration.

1.2 Research objectives

1. To determine thermal and chemical properties of mango fruit.
2. To predict the temperatures of mango fruit during heat treatment by finite-difference method.
3. To determine the correlation between thermal and chemical properties of mango.
4. To determine the relationship between thermal properties and chilling injury.