CHAPTER I
INTRODUCTION

Agriculture of citrus fruits is an important segment of world food production and nutrition. In Thailand, tangerine or Som Kheaw Wan (*Citrus reticulata* Blanco) is one of the most grown citrus. Total production of tangerines in Thailand was around 600,000 metric tons in 2003 (DOAE, 2003). Although most of the fruits are consumed fresh, its juice has become increasingly popular and gains a significant market share and has evolved over the years from fresh juice to the processed juice. With this growing potential, processing and packaging technologies to enhance the quality of the beverage for consumer acceptance are essential.

However, excessive bitter taste in citrus juice, is a major problem in citrus industry worldwide because it reduces the flavor quality and commercial value of the product. The two principal bitterness compounds in citrus fruits are naringin and limonin. Naringin is found in the membrane and albedo of pomelo, grapefruit and sour orange. On the other hand this flavonoid does not occur in a number of citrus species such as sweet orange (*Citrus sinensis)*, lemon (*Citrus limon)*, lime (*Citrus aurantifolia)* and tangerine *(Citrus reticulata)* (Nagy, Shaw and Veldhuis, 1977). Its concentration is amount in ripened fruit and its taste threshold in orange juice is approximately 600 ppm (Kimball, 1991a). Limonin, the other bitter compound, is found in all citrus species and is exceedingly bitter component with taste threshold of 5-6 ppm in orange juice

(Guadagni, Maier and Turnbaugh, 1973). Consequently, the major bitter compound of Thai tangerine (*Citrus reticulata* Blanco) is also limonin (Savitree Jungsakulrujirek, 1997). Limonin is the primary cause of "delayed bitterness" in which the fruit or its juice is not bitter if consumed fresh but gradually become bitter upon storage, even when refrigerated or frozen. This phenomenon is due to the presence of non-bitter precursor of limonin – limonoate A-ring lactone (LARL) – in the segment and juice sac membrane. When the membrane is ruptured during juice extraction, LARL comes in contact with the acidic juice medium and is converted to limonin by limonin D-ring lactone hydrolase (Kimball, 1991b). The level of limonin varies with cultivars, degree of ripeness, climatic condition, horticulture practices, and processing and storage conditions.

The negative impact created by bitter taste in citrus juice has made debittering a generally incorporated step in industrial juice processing technology. Several methods to reduce or control the bitter compounds had been developed, mostly in the laboratory scale (Puri, 1989; Puri *et al.*, 1996). They include blended bitter juice with non-bitter juice, addition of sweetener or other chemicals to mask the bitter off-taste, selective breeding of less bitter cultivars, use of plant growth regulators to inhibit the synthesis of naringin or LARL. Debittering of the juice by selective or combination removal of naringin and limonin had been widely explored. Some of them are extraction with supercritical carbon dioxide, treatments with bacteria or specific enzymes. Using adsorptive and/or ion-exchange resins are the preferred methods due to easy handling and possibility of regeneration for long term use. Several natural and synthetic, hydrophobic and hydrophillic adsorbents were tested. Current commercial debittering unit (first installed in the U.S. in 1988) uses styrene-divinylbenzene copolymer as the hydrophobic adsorbing resin due to its high debittering efficiency, easy regeneration, and stability (Konno *et al.*, 1981). Reports for debittering citrus juice with cyclodextrins are quite limited because they were still present in the finished product and could result in rejection by some countries. To increase acceptable level, Shaw and Wilson (1983) used insoluble β-cyclodextrin polymer to remove limonin and naringin from navel orange and grapefruit. They purposed that β-cyclodextrin polymer could reduce the bitterness by about 50% without significantly affect the soluble solids, total acid, or ascorbic content of the juice. Flavor evaluation also showed that debittered juice was more acceptable. Moreover, the insoluble cyclodextrin could be removed by filtration and regenerated by ethanol. This led to a scale-up application of the β-CD polymer on a pilot-scale fluidized bed column, enhancing the possibilities of using such a system for commercial operations (Wagner, Wilson and Shaw, 1988).

In recent work, the insoluble β-cyclodextrin polymer was used to reduce limonin in Thai tangerine juice (Piriya Rodart, 2001). In these studies, both batch and column process were applied. The purpose of this further study is to investigate the optimum condition of using insoluble β-cyclodextrin polymer to debitter Thai tangerine *Citrus reticulata* Blanco juice in a laboratory-scale fluidized bed column. A large amount of tangerine juice, fast feed rate and simple process with low cost is aimed for small scale orange juice producers.