JOURNAL OF AGRICULTURE & SOCIAL SCIENCES
1813–2235/2006/02–4–225–226
http://www.fspublishers.org

# Application of Thermal Properties to Predict Chilling Injury of Mango Fruits

RACHIT SUWAPANICH[1] AND METHINEE HAESUNGCHAROEN†
*Postharvest Technology Institute and †Department of Food Engineering, Faculty of Agro-industry, Chiangmai University, Chiangmai 50202, Thailand*
[1]Corresponding author's e-mail: joomwong@mju.ac.th; kcrachit@kmitl.ac.th; methineeh@hotmail.com

## ABSTRACT

Specific heat (Cp) of pulp from mature mango was examined using differential scanning calorimeter. It was found that specific heat of pulp decreased as the fruit storage prolonged. The Cp decreased faster at 13°C than at 8°C. The Cp increased beyond 40°C during long storage under chilling condition. Electrolyte leakage was increase as a storage time increased, and was greater fruits were ripe.

**Key Words:** Thermal properties; Chilling injury; Mango; Specific heat

## INTRODUCTION

Mango (*Mangifera indica* Linn.) is one of the important economic fruit crops in Thailand. With an increasing demand the storage is mango fruit is of major concern. After harvest, most fruits and vegetables including mangos remain alive and tempertarure during storage plays an important role in its quality (Mohsenin, 1980; Wills *et al*., 1981). Fruits and vegetables are stored at low temperatures are prone to risk of physical injury due to chilling. The symptoms of chilling injury are surface pitting, discoloration, internal breakdown and decay etc (Couey, 1982; Wang, 1990). Evaluation of these injury is made on the basis of browning and electrolyte leakage.

Thermal properties of fruits and vegetables are necessary to predict heating and cooling loads during processing. Chavapradit (1987) used specific heat, thermal conductivity and handling criteria as thermal properties of 'Nam Dorkmai" mango. Recently, Varith *et al*. (2001) used of thermal properties as a non-destructive assesment of apple quality. The objective of this study was to find relationship of thermal properties with chilling injury of mango fruits.

## MATERIAL AND METHODS

Green mature mango 'Nam Dorkmai Sri Tong', were harvested at commercial maturity from Chachoengsao province were used in this study. Fruits were selected for uniformity of shape, color and size and blemished or diseased fruits were discarded. Fruit were divided into two groups. One group was storage at 8°C and another was storage at 13°C. T 5 and 7 days intervals 3 fruits of 8 and 13°C were sampled and determine for specific heat and electrolyte leakage.

**Measurement of specific heat.** The measurement of specific heat was carried out using the Differential Scanning Colorimeter (DSC). Sample was prepared of middle pulp mango with 5.04 mm-diameter cork borer. The cylindrical tissue sample in the cork borer was cut into small pieces by a razor blade to obtain 5.04 mm-diameter, < 1 mm length. The sample disc was placed into hermatic aluminium pan and weighed using an analytical balance. The sample containing the pulp mango tissue disc was sealed with a sealer within 30 sec to prevent moisture loss mango tissue. The sample container was placed into DSC. The sample was first equilibrate at 0°C for 3 min and then heated to 55°C @ of 5°C $min^{-1}$, and kept for 3 min at 55°C. The samples were cooled down to 0°C @ 5°C $min^{-1}$.

**Electrolyte leakage measurement.** For each treatment, five discs (10 x 4 mm length) of the sample tissues were rinse with deionized water for 3 seconds to eliminate the electrolyte at the cut surface two times. The samples were placed in a breaker containing 30 mL of 0.4 m mannitol. After incubation for 3 h at 25°C, electric conductivity was measure in a suspending solution with a electrical conductivity (EC) meter (Sartorious Professional Meter pp-20) as initial reading. These samples were autoclaved (121°C, pressure 15 lb $inch^{-2}$ for 30 min) and EC was measured again (as 100% leakage). The percentage of ion leakage, were calculated as:

$$\%\ total\ leakage = \frac{initial\ \ reading}{final\ \ reading} \times 100 \qquad (1)$$

## RESULT AND DISCUSSION

**Specific heat.** The Cp of pulp mango tissue initially stored at 8°C changed a little up to 40°C, but beyond this limit it increased rapidly for 5 day storage (Fig. 1). However, storage for longer than 15 days produced a little change in Cp at high temperature. Likewise, Cp of pulp mango stored at 13°C was decrease faster than that stored at 8°C. there was little change of Cp at 0 - 40°C and increased rapidly at high temperature. After storage for 14 days, fruit ripening

**Fig. 1. Specific heat of pulp mango 'Nam Dok Mai Si Thong' after storage at 8°C**

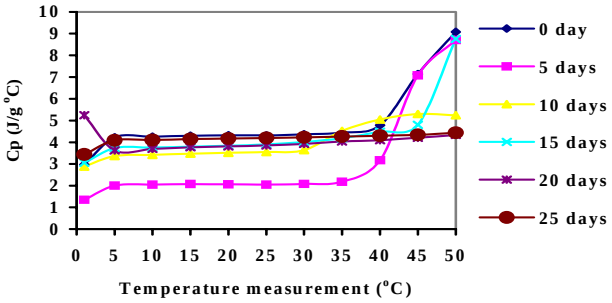



**Fig. 2. Specific heat of pulp mango 'Nam Dok Mai Si Thong' after storage at 13°C**

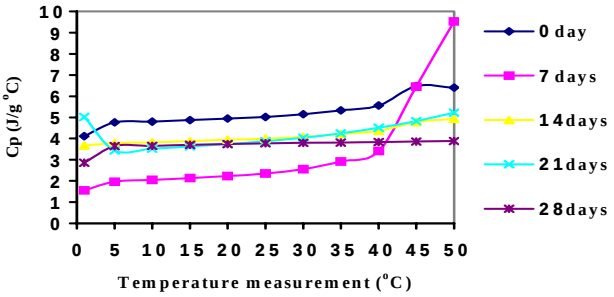
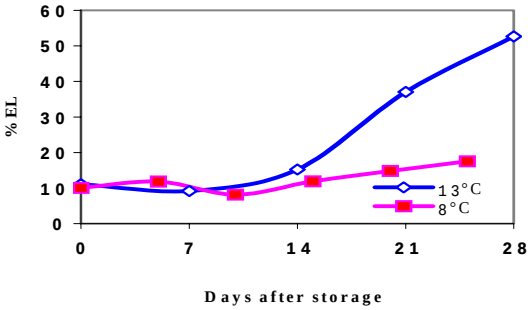



**Fig. 3. Electrolyte leakage of pulp mangos**




initiated as noted from yellow color and increased pulpiness. Here the fruits showed a little increase in Cp value beyond 40°C. After 28 days of storage, fruits were fully ripened with internal browning. At this stage Cp value were constant at 0 - 55°C (Fig. 2).

**Electrolyte leakage.** Electrolyte leakage (EL) increased as the fruit were stored longer at 8 or 13°C, although this increase was greater at 13°C beyond 14 day and fruits were fully ripe showing internal browning (Fig. 3). Wade (1995) demonstrated that electrolyte index increased at the start of the climacteric stage. Chilling temperature had a great effect on the fruit ripening and ionleakage. Mohammed and Wickham (1997) stated that electrolyte leakage provided a measure of onset of chilling injury prior to the appearance of chilling injury symptoms in golden apple (*Spondias dulsic*, Sonn.). Some fruits show no difference in ion during chilling. King and Ludford (1983) found that un-chilled tomato cultivars harvested at the mature green, turning and full ripe stages showed an electrolyte leakage pattern similar to the chilled mature-green cultivar.

In conclusion there exists some relationship between specific heat and chilling injury, which can be used to predict chilling injury in mango fruit.

## REFERENCES

Chavapradit, C., 1987. Dteremination on Physical and Thermal Properties as Harvesting Indices for Mango. *M.S. Thesis in Engineering*, Asia Institute of Technology, Bangkok Thailand Reading

Couey, H.M., 1982. Chilling Injury of Crops of Tropical and subtropical Origin. *Hort. Sci.*, 17: 162–4

King, M.M. and P.M. Ludford, 1983. Chilling Injury and Electrolyte Leakage in Fruits of Different Tomato Cultivars. *J. American Soc. Hort. Sci.*, 108: 74–7

Mohsenin, N.N., 1980. *Thermal Properties of Food and Agricultural Materials*. Gordon and Breach, Science Publishers, Onc. Paris

Varith, J., 2001. Uses of Thermal Properties for Non-Destructive Assessment of Apple Quality. *Ph. D. Dissertation*, Washington State University, Pullman, WA

Wade, N.L., 1995. Membrane Lipid Composition and Tissue Leakage of Pre- and early-climacteric Banana Fruits. *Postharvest Bio. Technol.*, 5: 139–47

Wang, C.Y., 1990. *Chilling Injury of Horticultural Crops*. CRC Press, Florida

Wills, R.B.H., T.H. Lee, D. Graham, W.B. Mcglasson and E.G. Hall, 1981. *Postharvest: An Introduction to the Physiology and Handling of Fruit and Vegetables*. New South Wales University Press Limited, New South Wales

**(Received 16 September 2006; Accepted 10 October 2006)**