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Effects of Hydrocooling on the Quality of Fresh Longan Fruits cv. Daw

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Abstract

One-day-old fresh longan fruits (*Dimocarpus longan* Lour. cv. Daw) were selected. The fruits were placed in 3-kg perforated plastic crates of commercial scale for each treatment. The treatments were: no pre-cooling, tap water immersion, pre-cooling with cold water 50, 100 and 200 ppm chlorine and also without chlorine. The cooling was for 10 min, and the final temperature of longan fruits reached 5˚C. The effects of the hydrocooling treatments on the quality and decay of the fruits during storage at 5˚C and 93 % relative humidity (RH) for three weeks were determined. By pre-treatment with cold water plus 50 ppm chlorine, the longan fruits showed significantly decreased peel browning and fruit decay in comparison to no pre-cooling and tap water immersion treatments. With this treatment, the fruits maintained the highest L* value both of the inner and outer peel, soluble solids content (SSC) in flesh, high sensory evaluation and peel desiccation was prevented. Therefore, the treatment could extend the storage life of longan fruits. Pre-cooling with no chlorine did not prevent fruit decay caused by fungi. Higher chlorine concentrations, 100 and 200 ppm, increased peel browning and fruit decay. Weight loss was not affected significantly by any treatments.

Key words: *Dimocarpus longan,* hydrocooling, longan, post-harvest chlorine

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Introduction

Fresh longans are one of the leading exported fruits in Thailand. There are two main post-harvest problems: (1) fruit rot during storage caused by fungi including yeast and bacteria as their flesh contains a lot of sugar and moisture, (2) peel browning caused by either browning enzymes, e.g., polyphenol oxidase - the enzymatic browning occurs rapidly within 3-4 days at an ambient temperature, or chilling injury after cold storage below 5˚C (Boonyakiat *et al*. 2002). Sulfur dioxide fumigation can solve both problems completely, but there have been numerous reports on toxic residues in humans as well as reactions in sensitive individuals and asthmatics (Tongdee 1994). Although some longan-importing countries, such as China, permit residual sulfur dioxide in longan flesh below 50 ppm, most countries, e.g., the U.S.A., Japan, Australia, and others, do not accept its use under the Sanitary and Phytosanitary (SPS) regula tions of the WTO. As an alternative postharvest treatment, hydrocooling (pre-cooled with cold water) has been supported by a number of reports. After the fruits are pre-cooled with cold water at 0-2˚C, they can be kept longer in cold storage with no change in color appearance of the fruit peel. The fruits maintain their freshness and low metabolic and weight loss as well as low peel desiccation (Chen *et al*. 1998). The present work was carried out to obtain further supporting data for the effectiveness of hydrocooling on the postharvest maintenance of Thai longan.

Materials and Methods

Experimental Treatments

Harvested longan fruits ("A" grade) from a Chiang Mai orchard were placed in 3-kg perforated plastic crates. Cold water in a bulk type cooler was prepared at 0-2˚C with or without the addition of 50, 100 and 200 ppm of calcium hypochlorite solution (chlorine). The fruits were immersed in cold water for 10 minutes. The final temperature of the longan fruits reached nearly 5˚C which was measured with a thermocouple. They were, then, air-dried for 5-10 minutes, transferred into a cold storage room and kept at 5˚C and 93 % RH. Samples were taken every 7 days until their shelf life expired.

Measurement of Fruit Responses

L*, a* and b* values of color of both the inner and outer peel of longan were measured by a colorimeter (Color Quest XE). If the color of the object is black, the L* value = 0; if it is white, the value is nearly 100; if it is red, the a* value is plus; if it is green, the a* is minus; if it is yellow, the b* value is plus; and if it is blue, the b* is minus.

The amount of soluble solids content (SSC) in flesh was determined by a hand refractometer (ATAGO, Japan), and fruit firmness was measured by a hardness tester.

Sensory evaluation was performed for both the peel color and taste acceptability. Peel color was expressed by a five-scale measure: 1, 2, 3, 4 and 5 for normal fruit, browning 1-25%, 26-50%, 51-75% and 76-100%, respectively. Taste acceptability was expressed by hedonic scaling (Jiang and Li, 2001) separated into nine levels: 1, 2, 3, 4, 5, 6, 7, 8 and 9, from extremely unacceptable to extremely acceptable.

Percent weight loss was determined as a percentage of the initial fruit weight. Decay percentage was calculated using the number of rotten fruits in each sample.

Results

L*, a* and b* color values of both the inner and outer longan peel were measured after storage for 3 weeks (Table 1). The result showed that pre-

Table 1 L*, a* and b* values of both outer and inner longan peel after a three-week storage

Treatment	Outer peel			Inner peel		
	L*	a*	b*	L*	a*	b*
No pre-cooling	47.39[d]	7.31[b]	14.88[c]	59.93[b]	5.48[a]	24.6[a]
Tap water immersion (pH 7.08)	47.92[cd]	6.98[b]	14.62[c]	59.57[b]	5.47[a]	21.75[bc]
Pre-cooled with iced water, no chlorine (pH 6.56)	49.73[abc]	9.21[a]	26.03[a]	58.83[b]	3.79[a]	18.43[d]
Pre-cooled with iced water + 50 ppm chlorine (pH 7.45)	50.41[ab]	9.17[a]	28.11[a]	70.85[a]	1.66[b]	20.20[cd]
Pre-cooled with iced water + 100 ppm chlorine (pH 10.21)	51.51[a]	8.46[a]	20.54[a]	62.91[ab]	4.60[a]	24.28[ab]
Pre-cooled with iced water + 200 ppm chlorine (pH 10.71)	48.82[bcd]	8.53[a]	19.97[b]	55.37[b]	5.89[a]	23.35[ab]

Table 2 Soluble solids content (SSC), firmness, sensory evaluation (peel color and taste acceptability) scores, percent weight loss and percent decay after a three-week storage at 5˚C, 93%RH

Treatment	SSC	Firmness	Sensory evaluation scores		Weight loss (%)	Decay (%)
			Peel color	Taste		
No pre-cooling	20.05 [ab]	1.01 [a]	2.8 [cd]	6.9	6.09	10 [d]
Tap water immersion	18.38 [bc]	0.73 [b]	2.9 [bc]	6.7	5.41	10 [d]
Pre-cooled with iced water plus no chlorine	19.77 [abc]	0.86 [ab]	3.3 [a]	6.6	6.81	20 [c]
Pre-cooled with iced water + 50 ppm chlorine	20.10 [ab]	0.81 [b]	2.5 [d]	7.0	6.14	10 [d]
Pre-cooled with iced water + 100 ppm chlorine	21.10 [a]	0.77 [b]	3.5 [a]	6.7	5.53	60 [a]
Pre-cooled with iced water + 200 ppm chlorine	18.01 [c]	0.52 [b]	3.2 [ab]	5.0	6.29	30 [b]

Note Values not labeled with the same symbol in the same column indicate significant differences ($p<0.05$).

Figure 1 Effect of chlorine concentration on peel color of longan fruits after a three-week storage at 5˚C, 93%RH. (A) Pre-cooled with cold water + 50 ppm chlorine, (B) pre-cooled with cold water + 100 ppm chlorine, and (C) pre-cooled with cold water + 200 ppm chlorine.

cooling plus 50 ppm chlorine maintained the highest L* values, which indicated the color lightness of both the inner and outer peels to be 50.41 and 70.85, respectively. The values of a* and b* in the outer peel of 9.17 and 28.11, respectively, were also the highest.

The treatment also prevented peel desiccation, maintained both the amount of SSC in the flesh and high sensory evaluation scores, and extended the storage life of longan fruits (Table 2). Higher chlorine concentrations, 100 or 200 ppm, stimulated fruit decay to 60% and 30%, respectively (Table 2), and increased peel browning (Fig. 1).

Although pre-cooling without chlorine resulted in the same scores for L*, a* and b* values and for other measurements as those of pre-cooling with 50 ppm chlorine treatment, the treatment did not effectively prevent fruit decay caused by fungi, and resulted in 20% decay. Weight loss was not significantly affected by any treatments.

Discussion

Pre-cooling with cold water plus 50 ppm chlorine at pH 7.45 showed superior results after storage, such as the highest L* value (corresponding to their peel color scores) and the lowest peel desiccation and decay. The treatment could extend the storage life of the fruits. This is because free chlorine in the form of hypochlorus acid (HOCl) in the cooling solution between pH 6.5-7.5 acts as a good disinfectant. It has been reported that about 80% of free chlorine is in the hypochlorus acid form at pH 7 (Ritenour *et al.* 2002). Higher chlorine concentrations, 100 or 200 ppm, raise pH levels to 10.21 or 10.71 (Table 1) and cause increased peel browning and fruit decay (Fig. 1 and Table 2). Most of the free chlorine is hypochlorite ions (OCl^-) at a pH above 8, and the ions are less active as a disinfectant than hypochlorus acid (Brecht *et al*. 1993, Ritenour *et al.* 2002). The rapid removal of heat from the longan fruits by hydrocooling and the consequent drop in fruit temperature to approximate the storage temperature reduces the vapor pressure deficit (VPD) between the fruit and the surrounding air. The reduction of VPD, the driving force of water loss, causes a corresponding reduction in the rate of water loss from the fruit to the external environment, particularly during the initial part of cold storage (Joyce and Patterson 1994).

Pre-cooling with cold water plus 50 ppm chlorine can keep longan fruits for three weeks on a commercial scale. However, this method was not as effective as sulfur dioxide fumigation. Further research is needed on the determination of the most effective pH range in chlorinated cold water to be used in hydrocooling.

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