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EFFECT OF HARVESTING STAGES ON JELLY SEED SYMPTOM OF PLANGO (*Bouae burmanica*) CV. THUNL KLAO FRUITS

*Pattarawan Wattanakeeboot[1] and Usawadee Chanasut[12]

[1]Postharvest Technology Research Center, Faculty of Agriculture, Chiang Mai University, Thailand
[2]Department of Biology, Faculty of Science, Chiang Mai University, Thailand

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ABSTRACT: Plangoor Marian plum (*Bouae burmanica*) has a short harvesting period and usually harvested at fully ripe fruit stage . Therefore, the jelly-seed often occurred inside the fruit . The jelly-seed is a physiological disorder and causes fruit softening and wilting . This symptom will affect the storage period and shelf-life of the fruit . Jelly-seed also found after harvesting . This study was determined the activities of two important cell wall degradation enzymes which werepolygalacturonase (PG) and pectin methyl esterase (PME)from 3harvesting stages of plan go fruits 75, 85 and 95 days after full bloom)DAFB .(Fruits were storage at 10 and 25°C .It was found that the jelly-seed symptom only occurred in the 95 DAFB fruits after harvest and storage at 25°C . This fruits also had the highest activity of PG. The PG activity also increased with the ripening stages and storage period .The activity of PG and PME were delayed when storage at 10°C compared with those of the fruit kept at 25°C.

Keywords :Cell wall degradation, Polygalacturonase, Pectin methyl esterase

1. INTRODUCTION

Plango (Bouea burmanica) in Thai is called Ma-young-chid. The name came from plum mix mango then created the new commercial name as “Plango”. Plango belongs to the same family as mango but the taste is not really the same. It is tastes of flesh a bit like mango, texture rind of fruit a bit like plum. The fruits are similar to Marian plum but bigger with an oblong shape and a mix of sweet and tangy taste, without irritating the throat. Plango flower full blooms during the cool season in December to January and fruits are fully mature in March. The fruit color changes from green to orange and becomes dark orange when fully ripe. The ripe fruit has orange pulp and the color of endosperm inside the stone seed is purple.

Plango has short harvesting period and has to harvest at ripening stage. Harvesting stag is the most important factor affecting the texture of the fruits. Harvesting at the over ripe stage, the fruit will be soft and flesh becomes like jelly around the seed. The major textural changes cause fruit softening, due to enzyme-mediated alteration of the compositions and structure of cell wall polysaccharides such as pectic polysaccharides and cellulose, which leads to their partial solubilization [1]. There are 2 keys enzymes involve in fruit softening, pectin methyl esterase (PME) and polygalacturonase (PG). They are generally recognized as crucial enzymes which effect the fruit texture during ripening [2] and jelly seed disorder in plums. However, these enzymes are very sensitive to low temperature. The low-temperature storage can delay the development of some disorder such as flesh translucency or gel breakdown, internal browning, reddening or bleeding, loss of favor, delayed softening or retarded ripening [3].

Flesh translucency is one of the most frequently observed chilling injury symptoms, it showed as a translucent gelatinous breakdown in mesocarp and related to the presence of water-soluble pectin [4] besides disorder in plum it also found in over ripe mango fruit. Mango fruit qualities are respected to taste, flavor, color, aroma, weight, size and shape [5]. The quality of mangoes depends on the maturity stage at harvest. Mango harvested at over maturity stage is highly susceptible to defects like jelly seeds or jelly pulp [6]. ‘Amrapali’ mango fruit is a physiological disorder of unknown etiology called jelly seed (JS) which adversely affects the eating quality of mature ripe pulp [7]. Therefore, many reports recommended to harvest mango fruits prior to the over ripe stage and allow it to ripe properly after harvest in order to avoid the jelly seed defect. However, placing fruit quality reaches it best at the ripe stage, it is hardly avoiding the over ripe situation and sometimes the jelly seed occurs after harvests as well. In the present study, we focused on the effect of harvesting stage and storage temperature on the occurrence of jelly seed defect in the plango fruits. The qualities changes of the fruits from each harvesting stage will be determined and evaluated in order to find the suitable harvesting stage which gives the best quality plan.

2. MATERIALS AND METHODS

2.1 Fruits harvest and storage

Plango fruits cv.'Thul Klao' (Bouea burmanica) were harvested on 75 (immature ripe), 85 (mature ripe) and 95 (over ripe) DAFB of March 2017, from Dussanee orchard located in Mae Thang district, Chiang Mai province, Thailand. Plango were hand-picked and sorted according to the uniformity of shape, color and size. Fruits were put in foam tray and storage at 10 and 25°C for further study.

2.2 Quality Changes Determination

2.2.1 Color

The color of pulp was determined using the colorimeter (Color Quote XE). The color was measured using the CIE L*, a* and b* scale. The color values were expressed as L* (whiteness or brightness /darkness), a* (redness/greenness) and b* (yellowness/blueness) at any time, respectively. Each sample was scanned with the colorimeter at three different locations to determine the average L*, a* and b* values.

2.2.2 Fruit firmness

The fruit firmness was measured using the Texture analyzer (TA.XT plus), plunger set to pierce 8 mm depth at 3 different positions on each fruit. The fruit firmness was expressed as the maximum force (N).

2.2.3
Total soluble solid (TSS) and titratable acidity (TA)

The TSS of plango flesh was measured using a digital refractometer (Agro Pocket refractometer PAL-1). The results expressed in °Brix. The TA of each fruit was measured from three grams of plango pulp with 100 ml of deionized water. The mixture was titrated with NaOH using an automatic titrator (Schott Titroline easy M2-230V).

2.2.4 Enzymatic activities

PG and PME were extracted from plango fruits every two days during storage at 10°C and room temperature and their activities were determined. PG activity was quantified according to the method by Gross [8]. Plango mesocarp tissues about 1 cm around the seed were collected and were frozen immediately in liquid Nitrogen. Three grams of pulp plango was extracted in 0.1 M sodium phosphate buffer (pH 6.4) and 1 mM EDTA. The extract was centrifuged at 8,000 rpm for 30 min at 4 °C [9]. The protein content of the supernatants as determined using. The reaction mixture composed of 0.1 ml of 200 mM NaCl, 0.5% polygalacturonic acid, 0.1 ml of crude enzyme method and were mixture was incubated at 37 °C for 1 hour and followed by addition of 3,5 dinitrosalicylate (DNS) reagent. The absorbance of the mixture was measured at 540 nm using the UV-VIS spectrophotometer (Analytik Jena AG, SPECORD 40). The activity of PG was expressed as units/mg protein.

PME activity was determined using the method from Nunes [10]. Enzyme extract was adjusted 7.5 ml with 0.01 M NaOH. The assay mixture contained 2 ml of 1% pectin solution (w/v), 0.2 ml of NaCl, 0.15 ml of 0.01% (w/v) bromothymolblue, 0.45 ml of distilled water and 0.2 enzyme extract were prepared to study the PME activity. The absorbance of the mixture was measured at 620 nm. The PME activity was expressed in Units/ mg protein/min.

2.3 Statistical analysis

Data were analyzed by SPSS 18.0, Significant difference was considered at the level of $p < 0.05$.

3. RESULTS

3.1 Quality Changes Determination

3.1.1Pulp color

Lightness (L) of the peel decreased with harvesting stages, immature ripe, mature and over ripe. Lightness value was highest at the immature ripe stage (75 DAFB-Fig 1). Color changes occurred in the pulp. The color of the pulp around the seed area turned dark yellow as a sign of the jelly texture. The pulp color changes of the fruits harvested at 75, 85 and 95 DAFB occurred after storage at 10 °C for 8, 7 and 7 respectively. The pulp color changes were found on the pulp around the seed area of fruits harvested at 75, 85 and 95 DAFB after storage at 25°C for 9, 8 and 6 days respectively (Fig. 1). The pulp of fruits harvested at 95 DAFB had the lowest L value and showed the sign of jelly seed defect. The yellow color (b*) increased with harvesting stages, the pulp of fruits harvested at over ripe stage (95 DAFB) has the highest b* value after storage at 25°C for 6 days.

3.1.2 Firmness

The firmness of plango fruits from all harvest stages rapidly declined during storage at 25°C whereas the fruit softening was delayed when storage at 10°C. The firmness of plango fruit harvested at 75 DAFB and stored at 10°C were decreased slowly, and fruit softening began after kept for 6 days (Fig. 3). The plango fruits harvested at 95 DAFB lost their firmness rapidly during storage at 25°C which was the highest loss of the fruit firmness.

The plango fruit harvested at 95 DAFB has the highest TSS content but it was not significantly different to the TSS of the plango fruits harvested at 85 DAFB (Fig 4). The TSS of plango fruit harvested at 85 and 95 DAFB quickly declined during storage at 25°C whereas the TSS of immature fruit (75 DAFB) slightly decreased when stored at either 10

or 25°C. Low-temperature storage delayed the decline of TSS contents in both plango fruit harvested at 85 and 95 DAFB (Fig. 4)

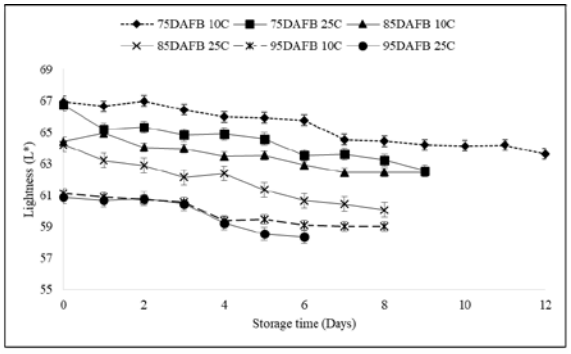

Fig. 1. Changes of L values of the plango pulp harvested at 3 different stages and during storage at 10 and 25 °C.

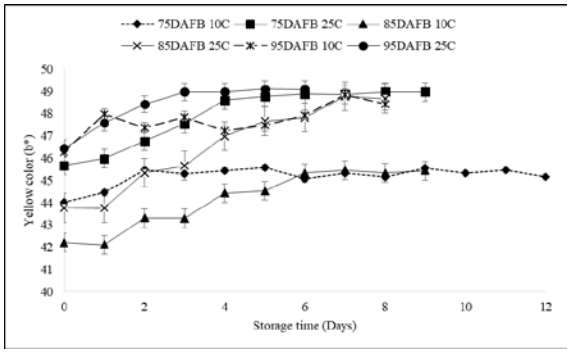

Fig. 2. Changes of b* values of the plango pulp harvested at 3 different stages and during storage at 10 and 25 °C

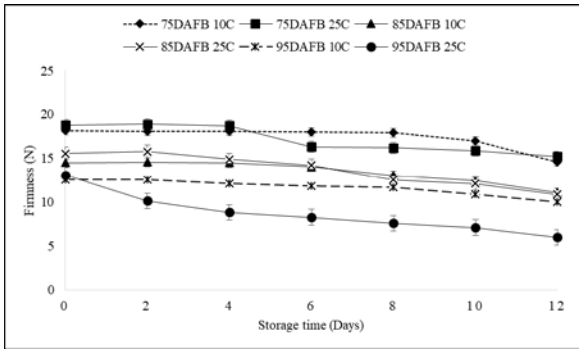

Fig. 3. The fruit firmness of the plango fruit harvested at 75, 85 and 95 DAFB and during storage at 10 and 25 °C.

3.1.3 Enzyme activity

PG activity was lowest when the fruit was at immature ripe stage (75 DAFB). The maximum activity of PG from the fruits harvested at 75 DAFB was 7.99 Unit/mg protein after storage at 10°C for 12 days and unit /mg protein at 25°C for 9 days. The maximum PG activity of the fruits harvested at 85 DAFB) was 15.91 Unit/ mg protein after storage at 10°C for 9 days which was similar to the PG activity of the fruits harvested at 95 DAFB but was storage at 10°C. The highest PG activity was found in the over ripe stage (95 DAFB). The PG activities were 33.68 Unit/ mg protein after storage at 25°C for 6 days (Fig. 6).

The PME activity of the pulp from all harvesting stage fruits was not significantly different. They were slightly changed during the storage period. The activity of PME of the pulp from the fruits harvested at 75, 85 and 95 DAFB and storage at 10°C were 3.34, 3.20 and 3.69 unit/ mg protein, respectively (Fig. 7).

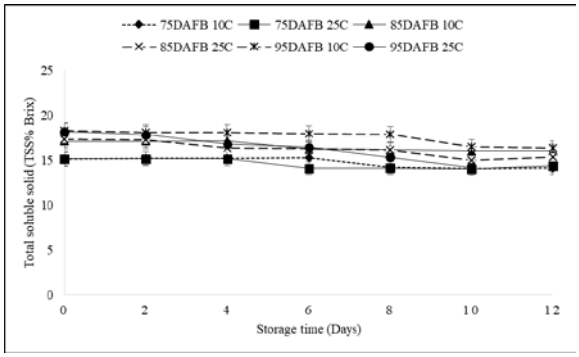

Fig. 4. The TSS (%Brix) of the plango fruit harvested at 75, 85 and 95 DAFB and during storage at 10 and 25°C.

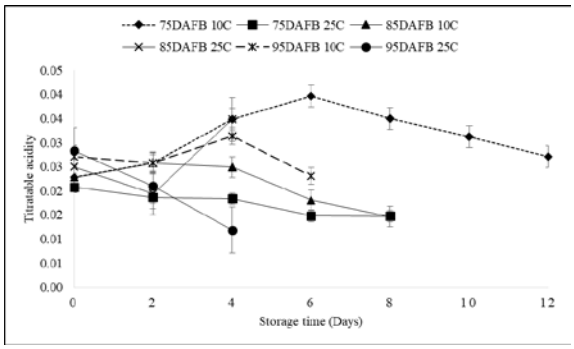

Fig. 5. The TA (Titratable acidity) of the plango fruit harvested at 75, 85 and 95 DAFB and during storage at 10 and 25°C.

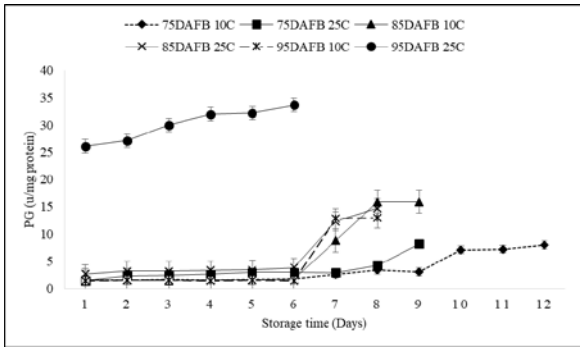

Fig. 6. The activities of PG of the plango pulp harvested at 3 different stages and during storage at 10 and 25 ° C

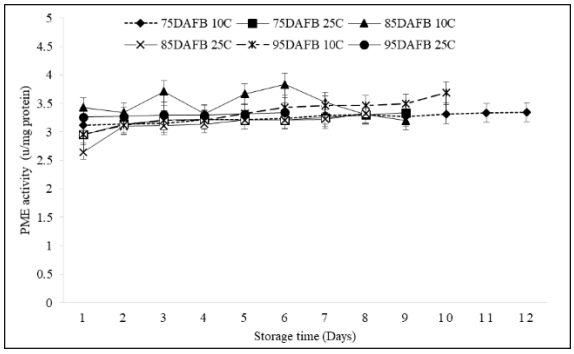

Fig. 7. The activities of PME of the plango pulp harvested at 3 different stages and during storage at 10 and 25°C

4. DISCUSSION

The plango has short harvesting period and the harvesting stages are important for the fruit quality. The fruit harvested at a suitable stage of maturity in order to develop the optimum sensory quality attribute and extend postharvest life [11, 12]. According to Manganaris *et al.* [13], the most common symptoms in chilling injured plums is the development of mealy texture. There is an influence of ripening stage, position on tree and cultivar, as well as the cold storage temperature on severity andextent of chilling injured symptoms in plum [14]. In the present study, plango fruit was harvested at 3 different stages, immature ripe (75 DAFB), mature ripe (85 DAFB) and over ripe (95 DAFB). Normally, plango fruits were harvestedat matureripe stage for the best quality. According to Dharini *et al.* [15], the TSS tend to increase during fruit maturation, while the TA decreases. The jelly seed was not found on inside the fruits that harvested at over ripe stage, but it gradually developed and occurred during storage were 25°C. The pulp color around the seed turned dark yellow and became translucent like jelly. According to Manganaris *et al.* [16], flesh translucency manifests itself as a translucent gelatinous breakdown of the mesocarp of stone fruits and related to the presence of water-soluble pectin in the tissues. According to Jiao *et al.* [17], Plum are very sensitive to storage temperature may be limited by the development of various physiological disorders such as internal browning, flesh translucency (gel breakdown), reddening or bleeding loss of flavor. In this study, the fruits with jelly seed symptom had very high activity of PG during storage, resulting in severe texture change and softening. The increase of PG also contributed to the loss of the fruit firmness. This occurred through the action on cell wall pectic polysaccharide and cellulose, changing their structure and solubilizing cell wall component [18],[19]. PG fall into the group of enzymes termed polysaccharidelyases or polysaccharide eliminated. [20]. PME activity gradually increased but was not significantly different among the 3 different harvesting stages. According to Seshadri *et al.* [21], the PME catalyzes the removal of methy ester groups from pectin chains making them more susceptible to PG-mediated degradation. Subsequently, the rapid increase in PG activity depolymerized cell wall polygalaturonides to produce galacturonic acid [22]. According to Tieman *et al.* [23] and Thakur *et al.* [24], PME activity in this study had little effect on fruit firmness or the appearance of jelly seed symptom. According to Swati *et al.* [25], the PME enzyme activity plays a major role in cell wall degradation leading to fruit softening and loss of texture in staggered-I of 'Santa Rosa' plums.

5. CONCLUSIONS

Harvesting stages and storage temperature can cause the jelly seed symptom in the plango fruits. It was found in fruits harvested at over ripe stage and kept at 25°C. This symptom was not found in the fruits harvested at 75 and 85 DAFB and storage at either 10 or 25°C. Fruits with jelly seed symptom had the highest activity of PG and increased with storage period. The activity of PG and PME were delayed when storage at 10°C, consequently no jelly seed was found.

6. ACKNOWLEDGMENTS

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