A Comparison of Anatomical Changes between Normal and Chilling Injury Longan Fruit Pericarp

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Abstract

The anatomy of pericarp from longan fruit (*Dimocarpus longan* Lour.) cv. 'Daw' has been compared between normal and chilling injury fruits. The normal pericarp thickness was 630-700 μm and consisted of three layers. The exocarp had discontinuous cuticle with many natural openings and some epidermal hairs. The subepidermal sclerenchyma layer was thick. The mesocarp had some parenchyma cells with large intercellular spaces as the main body of the pericarp. The endocarp was made up of a single thin layer of epidermal cells. Pericarp from chilling injury fruit showed flakes from the cuticle, damaged epidermal hairs and fibrous tissue on the exocarp, and damaged parenchyma cell walls appeared in the mesocarp.

INTRODUCTION

Longan fruit (*Dimocarpus longan* Lour.) is a non-climacteric subtropical fruit. It is one of the most economic fruit in Thailand for export (Tongdee, 1997). The fruit is harvested when eating quality and visual appearance are optimal (Paull and Chen, 1987). Longan fruit has a very short postharvest life of 3-4 days under ambient conditions (Jiang, 1997; Tongdee, 1997; Siripanich et al., 1999). The major factors reducing the storage life and marketability of longan fruit are microbial decay and pericarp browning (Jiang et al., 2002). The dark brown skin is a result of desiccation. At 5°C longan fruit can be stored for up to 2 weeks (Kader, 2002). Chilling injury was observed when fruit were stored below 5°C. Symptoms were water-soaking, darkening of the skin color and increased fungal growth upon removal of fruit to ambient temperature. The chilled fruit lost membrane integrity and thus leakage of solutes occured (Boonyakiat et al., 2002). There is no report on ultrastructure of longan peel changes under chilling temperature storage. The objectives of this study were to compare the ultrastructure between normal and chilling injury pericarps of longan fruit as observed with scanning electron microscopy (SEM) and light microscopy (LM).

MATERIALS AND METHODS

Materials

Longan fruits of cultivar 'Daw' were harvested from a commercial orchard in Lamphun Province, in northern Thailand. Undamaged fruit (normal) was observed under SEM on the day of harvest. The remaining fruits were stored at 5°C until chilling symptoms were apparent indicated by water-soaking and darkening of skin color (approximately 10 days after storage). They were prepared for anatomical analysis.

Methods

A modified method of anatomical preparation by Bozzola and Russell (1999) was used. Longan pericarps were sectioned into 0.5 mm square samples and then were fixed in the primary fixative contain 2.5% glutaraldehyde in 0.1 M phosphate buffer pH 7.3 at 4°C for 2 hours. They were then rinsed twice (20-30 minutes per rinse) in the same buffer and post-fixed in 1% osmium tetroxide in the same buffer for 2 hours and then washed twice in phosphate buffer. Tissue sections were dehydrated stepwise by exposure to

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ethanol-buffer mixture for 15 minutes intervals: 30%, 50%, 70%, 80%, 90%, 100% ethanol (twice) and critical point was dried in liquid carbon dioxide. The pericarp was then mounted on specimen stubs and sputter coated with gold. Coated samples were stored in a desiccator until observed. The pericarp was observed in a SEM (JEOL, JSM-840A (JEOL Ltd., Tokyo, Japan) with an accelerating voltage of 15 kV. The same fixative was used for LM (Olympus AX70TF, Olympus optical Co., Ltd, Japan). One-micron sections were cut with an ultramicrotome (Ultra Reichert-Jung, Germany). The sections were stained with 1% toluidine blue and examined with a LM.

RESULTS AND DISCUSSION

The normal longan fruit pericarp was thick about 630-700 μm and composed of three layers. The outer layer is exocarp consisted of natural opening and cracking on the surface when observed under SEM (Fig. 1 A1). It was covered by thin discontinuous layer of cuticle and brown epidermal hair. The mesocarp, main part of the pericarp consisted of about 70% of the pericarp tissue. It contained various sized and shaped cells. They were round and elliptical in shape with thick cell walls. Vascular bundles were observed clearly in the mesocarp layer. The shape of each vascular bundles was tubular and consisted of one layer cell (Fig. 2 A4). There were stone cells in the mesocarp which showed as bluish green color. There were large intercellular spaces between adjacent cells. The endocarp of longan peel was a single layer of cells (Fig. 3A).

When the fruit showed chilling injury symptoms, the dark color of inner and outer peel of longan fruit appeared. SEM observations showed a layer of injured cells in the pericarp. The fibrous tissues that covered the pericarp disappeared. Wax that covered the pericarp and epidermal hair (Fig. 1 A2 and 1 A3) were damaged in the chilling injury peel (Fig. 2 B1 and 2 B2**).** The mesocarp cells were also damaged and had collapsed (Fig. 2 B1, 2 B2 and 2 B3). The destruction of cell membrane was also observed (Fig. 2 B4). These results agreed with the anatomical changes in lychee pericarp during storage. Underhill and Critchley (1993) found that lychee pericarp browning was correlated with moisture loss. Likewise, it is very likely that the natural cracking of longan peel facilitates rapid moisture loss and cause surface browning after harvest and during storage at ambient temperature. The surface cracking of longan peel also helps the chilled air to penetrate through the peel during low temperature storage. These can impair the physiological function of the cuticle and increasing water permeability (Medeira et al., 1999). These factors may cause water soaking at the inner side of the peel. The injured cells also would accelerate the oxidation of phenolic substances and the oxidative products resulted in dark color of inner and outer peel (Abe, 1990). Further studies are needed to clarify the components of normal and chilling injury longan peels.

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Figures

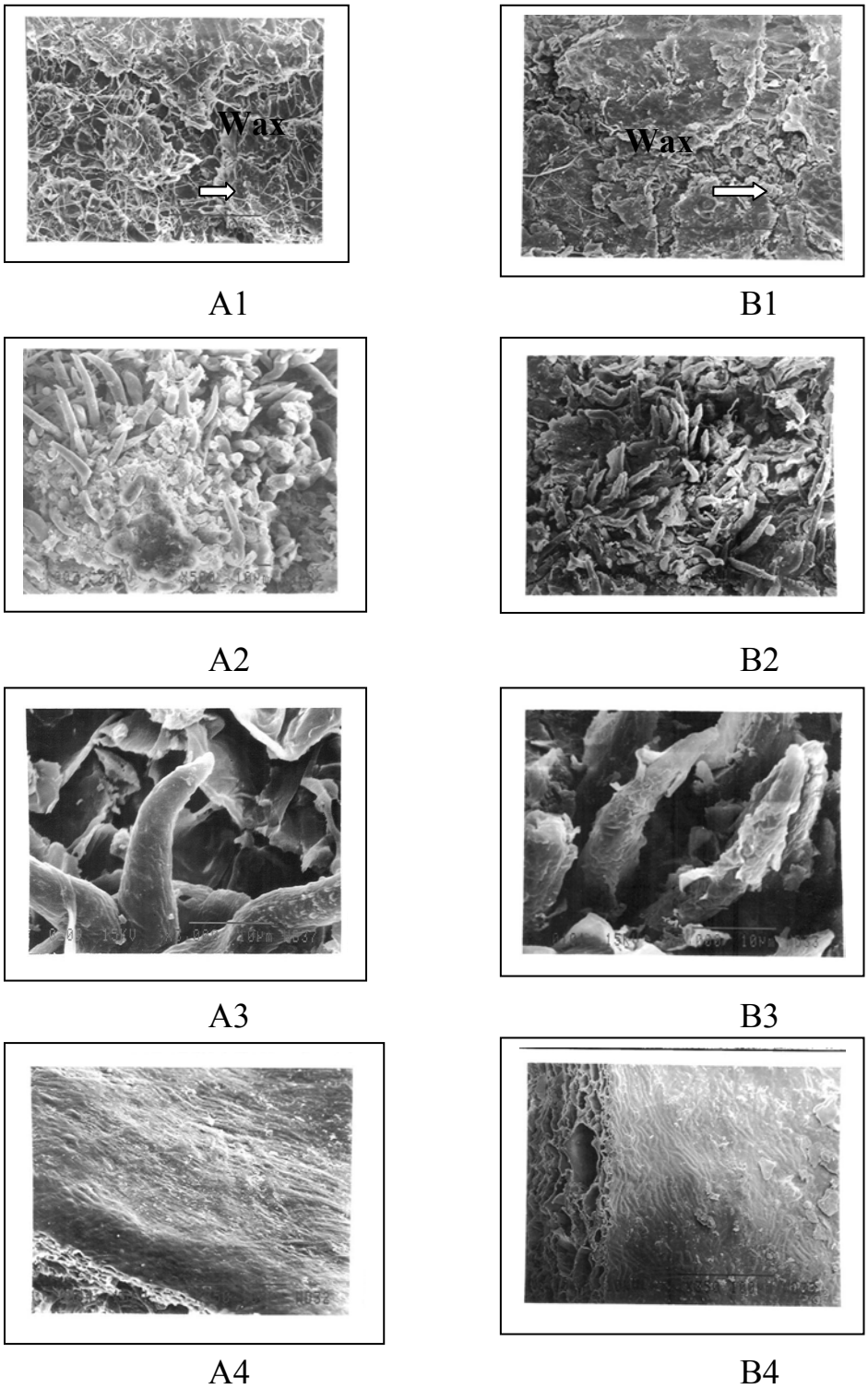

Fig. 1. Scanning electron microscope of normal (A1, A2, A3 and A4) and chilling injury pericarps (B1, B2 and B3). Showed natural cracking. Mag. A1, A4 and B1, B4 (350x); A2 and B2 (500x) and epidermal hairs (A3 and B3; 3,000x).

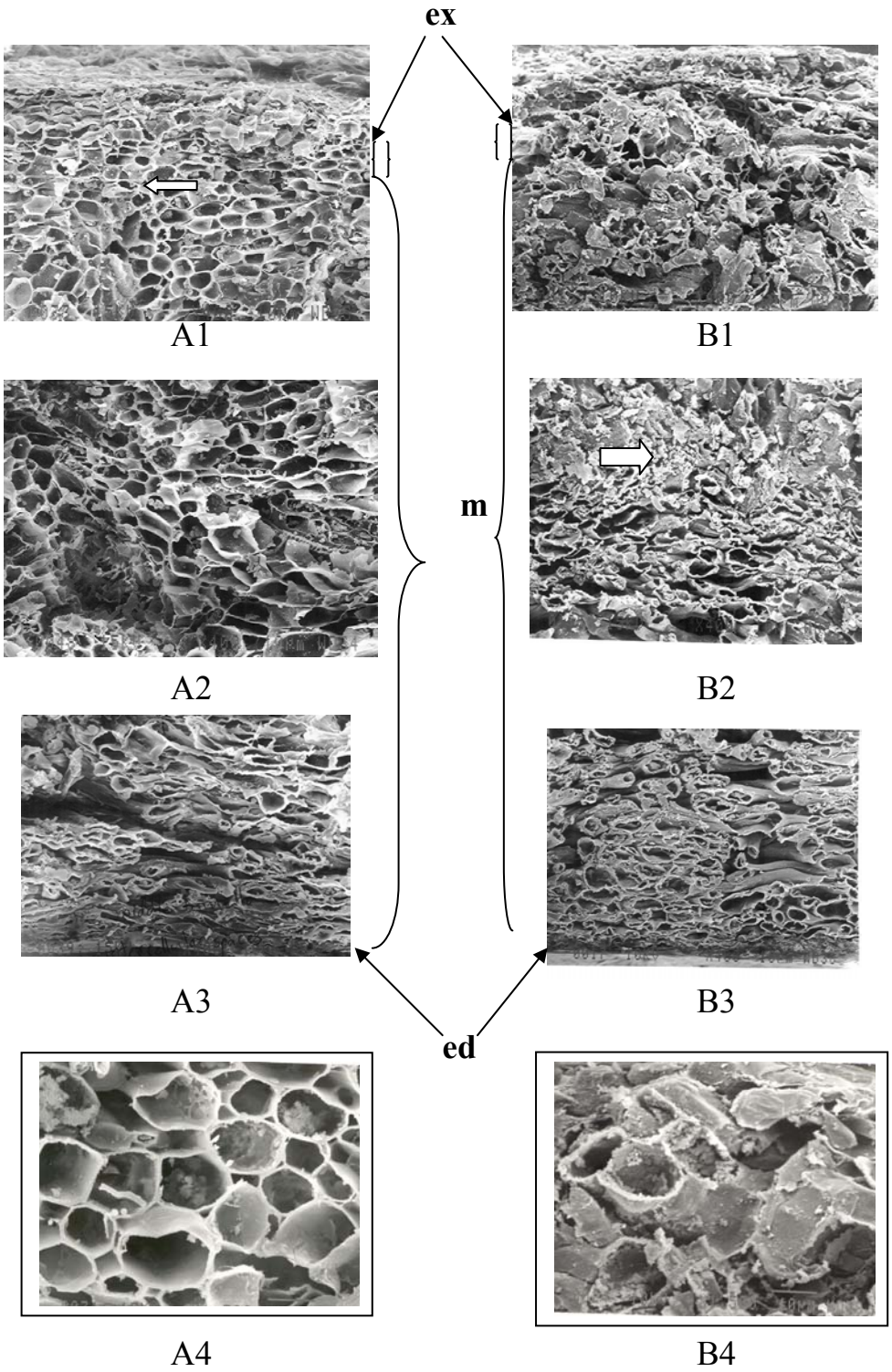

Fig. 2. Scanning electron microscope of normal (A1,A2, A3 and A4) and chilling injury pericarps (B1, B2 and B3). Exocarp (ex); mesocarp (m); endocarp (ed) and sclerenchyma layer (⇨) mag. 400x. Mesocarp (A4 and B4) mag. 1500x.

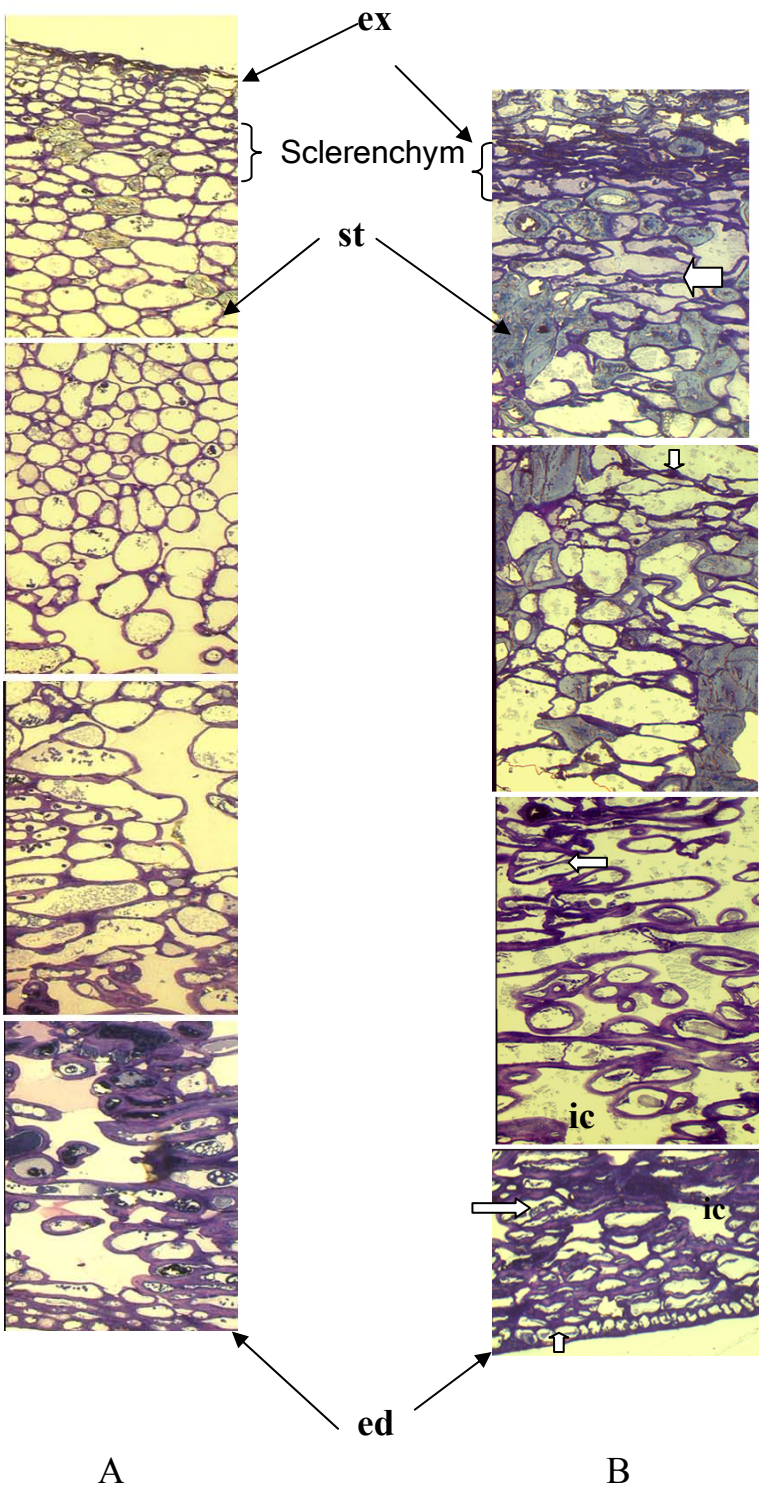

Fig. 3. Normal (A) and chilling Injury (B) of longan fruit pericarp showed sclerenchyma layer; large intercellular space (ic); stone cell (st); cell damage (arrows head) observed by light microscope (mag. 40x).