Cell Structures of the Peel of Mature Green Banana *Musa* AAA 'Berangan'

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Stomatal density/unit area of fifteen different locations on the peel of mature green 'Berangan' banana was determined. The mid region of green mature Berangan was fixed and processed to examine the cell structures using light microscope and scanning electron microscope. Fruit of Berangan consist of the peel, peel-pulp transition and pulp regions. Epidermal cells formed the outer layer of peel and were covered by cuticles and wax. Stomatal density of Berangan was 400 stomata/cm^2. Inclusions that appeared in the peel were i) vascular bundles surrounded by a ring of laticiferous ducts, ii) tannin bodies and iii) cells containing raphide.

Ninety-nine percent of the overseas market for Malaysian banana is confined to two neighbouring countries, Singapore (80%) and Brunei (19%). Only 1% of the banana reached Hong Kong, Taiwan and Japan. The restricted market for Malaysian banana is attributed to the lack of post harvest technology to withstand the long shipping time to the distant market. Several attempts were made to adopt the postharvest technology for Cavendish to local bananas such as 'Mas' and 'Berangan'. However, despite minor modifications to the adopted technology, it appears not be suitable to the local varieties. Very little is known about the relationship between structures and functions of cells in the banana fruit. This paper examined the surface cell structures of Berangan with emphasis on the peel.

Berangan of green mature stage, with fingers weighing 90–100 g each and free from mechanical injury, insect and fungal damage were used in the experiment. Stomatal densities/unit area of fifteen different locations on the peel was assessed using nail varnish technique and counted with optical compound microscope. The peel thickness was measured at the mid region of fruit using vernier calliper. Transverse section at mid region of fresh fruit was observed under Hi-Scope, HIROX, Japan. Samples of the peel and the outer part of the pulp, measuring 0.5 cm x 1 cm, were cut from the mid region of the fruit and fixed in Bouin's fixative. The block was divided into two groups. Only one group was post fixed in 1% osmium tetroxide dissolved in 1% cacodylate buffer. Then, dehydrated through graded series of ethanol to absolute ethanol. Tissues post fixed in osmium tetroxide was CPD and subsequently prepared for SEM viewing under JOEL 6400 SEM. The second group of tissue blocks was processed for wax embedding and sectioned with microtome for histological studies.

The Berangan banana finger is a berry fruit since it develops parthenocarpically from the inferior ovary. The fruit is made of pulp enclosed in a thick layer of peel. The peel is the ovary wall. The peel was 0.35 cm thick and consisted of a layer of epidermal, hypodermal and transition cells linking the peel to the pulp (Plate 1). The hypodermal and transition cells were parenchymatous cells. Intersperse in the rows of hypodermal cells were i) vascular bundles surrounded by a ring of laticiferous ducts, ii) tannin bodies and iii) needle shaped inclusions of cells. The parenchymatous cells at the peel-pulp transition region contained starch granules of irregular shapes, ranging from spheroid to oval or elongated.

SEM examination of the peel revealed that epicuticular cells were arranged in rows with a layer of unstructured ridges of thick wax deposition giving papillae surface topography (Plate 2A). The epicuticular

cells were hexagonal in shape and helped in strengthening cell structures. There was no set pattern of stomatal arrangement. The stomata were elliptical in shape with guard cells surrounded by subsidiary cells (Plate 2B). The extended wings were pronounced.

The vascular bundles consisted of large metaxylem vessels, protoxylem and phloem. Xylem tracheid, which was a water-conducting tissue, form ladder like series called scalariform. The lignified fibers ensheathed the vascular bundle and provided mechanical support for the peel. Laticiferous or latex vessels formed rings around the vascular bundles. These vessels contained tannins and exuded latex when wounded. Idioblast cells could be easily found in Berangan banana peel. These cells contain raphide, a long, thin crystal with pointed end composed of calcium oxalate. Idioblast cells were larger with thicker cell wall than other parenchymatous cells.

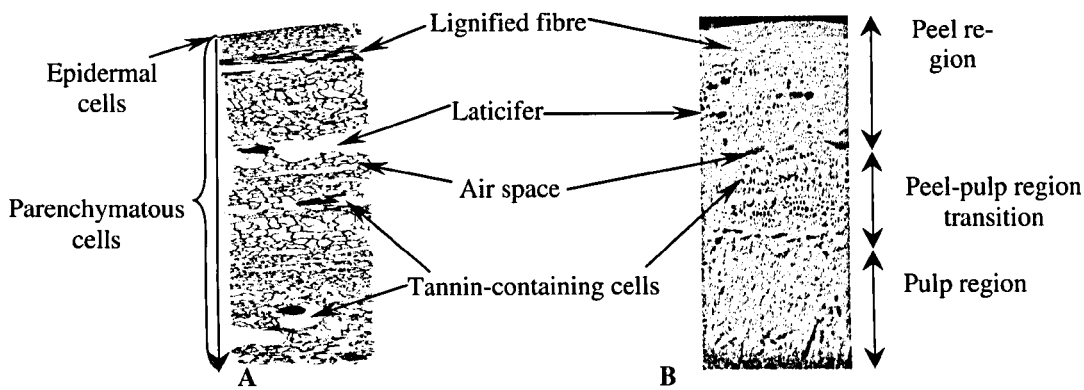

Plate 1. Longitudinal section of mature green Berangan banana
A. Light micrographs-camera lucida drawing (x400)
B. Scanning electron micrographs (x27)

Cells at the innermost portion of the peel showed beehive structures with hexagonal shape when sectioned longitudinally. Tannins were detected also in small-scattered isolated cells with dense contents occurring in the outer and middle peel not associated with vascular bundles. Starch granules and air space appeared in the transition region. Pulp of mature green Berangan was full of starch granules ranging from oval to irregular shapes with oval and elongated forms being predominant. The surface of the mature green banana starch granules appeared smooth. The sizes were also variable, 61% of the granules were 21-35 μm in length and 56% were 6-15 μm in width. Tannins with dense contents were detected also in small-scattered isolated cells in the pulp. Tannin, a polyphenol, contributed to the astringency taste in fruits. The existence of this tannin in Berangan banana also caused severe browning in mature green fruit.

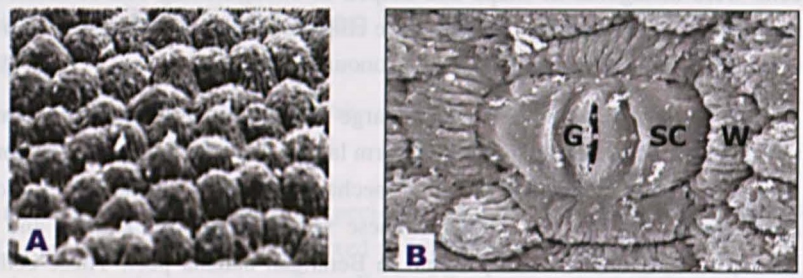

Plate 2. Scanning electron micrographs of the peel of mature green Berangan banana
A. Papillae surface topography (x 400)
B. Stomatal complex
G: guard cell, SC: subsidiary cell, W: extended wing (x1,300)

This study showed that fruit of Berangan consists of peel, peel-pulp transition and pulp regions. The stomatal density of Berangan was less than Cavendish. Stomata were thought to be the principal route for gaseous exchange. The stomatal densities could affect postharvest treatments to control water loss and ripening of the fruit. The peel-pulp transition region contained air spaces that form a demarcation line for the peel and pulp for ease of peeling. Starch granules in the transition region were smaller and more uniform in shape compared to those in the pulp. Cell structures of the fruit could explain the many biochemical functions during fruit ripening, thus affecting postharvest treatments.

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