Ultra structural Description of Young Corn (*Zea mays* L) Ear

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ABSTRACT

Young corn (*Zea mays* L) ears are small, immature indehiscent fruits that do not open spontaneously at maturity to release seeds. The present ultra structural study was conducted to examine detailed surface structure topography of the young corn ear. Macroscopic observation was done on fresh young corn ears prior to dry-gross sectioning. They were viewed using variable pressure scanning electron microscope (VPSEM). Observation of the longitudinal and horizontal section shows manifestation of anomalous appearances of the pedicel of the cotyledon. The actual area of growth of the corn silk base mimics the structured formation of matured corn fruit were seen in all micrographs. The ultra structures of the young corn ears consist of the pith cell, pedicel, corn silk roots and pericarp of the cotyledon. Corn silks also present as a single hollow tubular strand with longitudinally-oriented array tubes at every pedicel. The size of these corn silks strands vary between 6-8 µm in diameter. These findings are the first recording describing the VPSEM analysis of the surface ultra structure topography of young corn ears.

Keywords: Young corn ears, Variable Pressure Scanning Electron Microscope (VPSEM)

INTRODUCTION

Young corn (baby corn) is a vegetable obtained from the fruiting corn (*Zea Mays*) plant harvested early, while the ear are very small and immature. Young corn consists of the husked ear, harvested two or three days after emergence of the silk (Almeida *et al*. 2005; Lund *et al*. 1958). Many regular corn varieties have been used to grow baby corns. However, the resulting baby corns are often in a relatively poor condition. The stalk grows to about 61 cm high. The baby corn kernel are uniform in shape and petite in size while the ears are typically 4.5 cm to 10 cm in length and 7 mm to 17 mm in diameter (Chutkaew *et al*. 1994). Young corns are most commonly used in Asia. Many varieties of the specialized corn plants were developed to just produce baby corn. This production, being a recent development, has proven to be enormously successful venture and has become one of the most important crop in Thailand and Taiwan (S.Kasikranan *et al*. 2001).

Baby corns are used as salad, vegetable and cooked as soup and are also pickled. There is no difference in taste between young corns of the sweet corn type and the field corn type (Bar-Zur *et al*. 1993). In the ultra structural study of plant, detailed structure of a various parts of the plant specimen, such as cells, tissues, organs including cellular structures that are too small to be seen with an optical microscope. These structures are then observed under electron microscopy (Amesz *et al.* 2004). To our knowledge, the ultra structural description of baby corn ears has not been reported to date.

MATERIALS AND METHODS

Sample preparation

Fresh cereal grain of *Zea mays* L (dried cut kernel of *Zea mays* L) were harvested from Bachok, a coastal district area of Kota Bharu, in the state of Kelantan, Malaysia. 10 young corns (approximate 500g) were selected, cleaned and their corn silk removed and gently washed under running tap water. Excessive water was drained off before the samples were subjected to morphological characterization.

Scanning Electron Microscopy

100 grams of the freshly prepared young corn ear samples were either (a) slowly dried in hot air oven with a consistent temperature of 45ºC until completely dried (without any treatment) (b) treated by soaking and agitation (Rotamax 120, Heidolph, German) for 24 hours in 4.5% sodium hypochlorite solution. Cross-sections and longitudinal sections of kernels were made and the endosperm cells were studied using Variable Pressure Scanning Electron Microscope (VPSEM). The samples were then slowly dried in a hot air oven with a constant temperature until completely dried. The dried samples were affixed to aluminium specimen stubs using carbon paint. The dried samples were coated with a thin layer of gold in a vacuum evaporator (Baltex SCD005 Sputter Coater, Hi-Tech Germany) and their structure and morphology were studied by a LEO 1455 VPSEM under 5.5 Pascal pressure, using the secondary electron mode, at a working distance of 16-17 mm at 5.0 kV (WanRosli *et al*. 2007).

RESULTS AND DISCUSSION

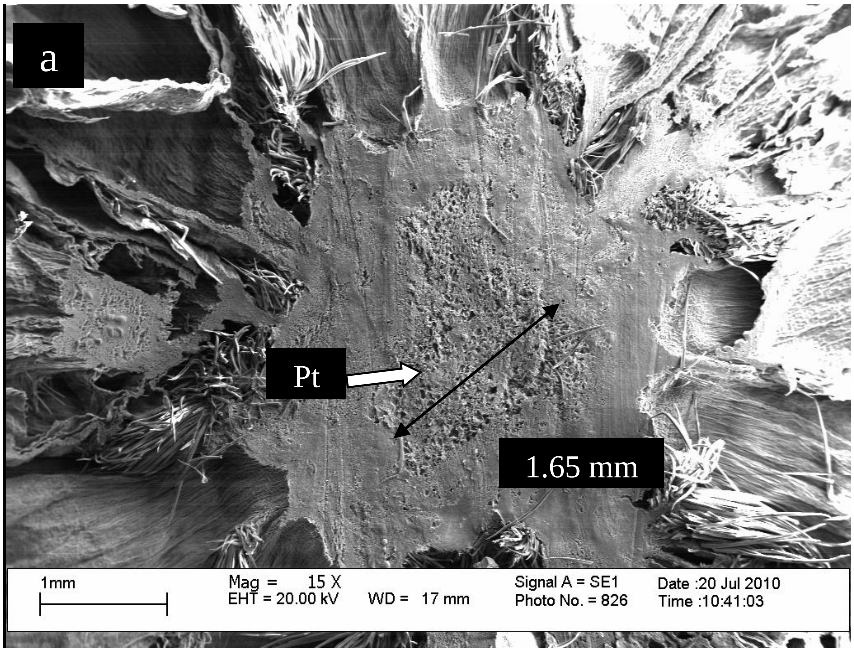
The general morphology of young corn ear shows neatly aligned rows of vestigial grain with ends evenly tapering (fig. 1.). The cross-section of the young corn kernel shows asymmetries of form in a complex manner. The core of the young fruits is round but show variability in relation to its convolutions and pith width.

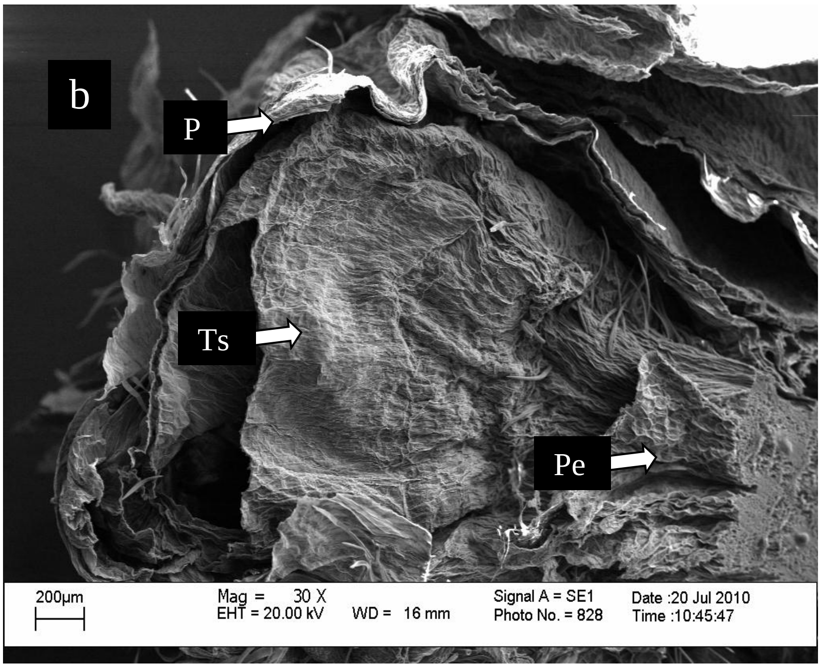
Fig. 1. Yong corn ear

Fig. 2. Is an electron photomicrographs at low magnification (15-100X) of the young corn kernel. The sample ware dried without any treatment. From the horizontal section, pith (pt) is shown as (a) in Fig. 2. The pith region of corn stems is basically made up of large cells

surrounded by a lignified primary cell wall with variable numbers of inner vascular bundles dispersed among them (Hatfield and Chaptman 2009). The pith cells are a defined shape, and positioned in the centre of corn kernel and adjacent to the xylem cell wall. The cotyledons seen in longitudinal section appeared circumferentially oriented. A single cotyledon (Fig. 2b.) is clearly shown with all the important features including testa (Ts), pericarp (P) and pedicel (Pe). This is in agreement with research done by others (Carpita *et al*. 2001).

Fig 2c. show the structure of the pedicel (Pe) where they are closely bound to cell membranes by febrile substances and connected with each other by long, hyphae-like strings (Goyal and Srivastava 2009). The root of corn silk also can be found in this area. In the photomicrographs examined, hair-like filaments appears in cross-section. The filaments with large numbers of prominent thin, but uniform structure suggest that it belongs to a meristematic root cell of the corn silk. The basis for this undeterminate corn silk growth is unknown. One possible mechanism is that it is controlled by the meristem alone, in which case meristematic cells are developmentally restricted to particular fates (Irish and Nelson 1988). Thus, the pedicel is the origin of corn silk or if the development of corn grains or cotyledon are the directive the formation of these structures persist. Where the directive comes from is conjectural. It may well be hormonal (abscisic acid or auxin) in nature as not all of the corn cobs in a particular plant form the baby corn at the time of maturity.





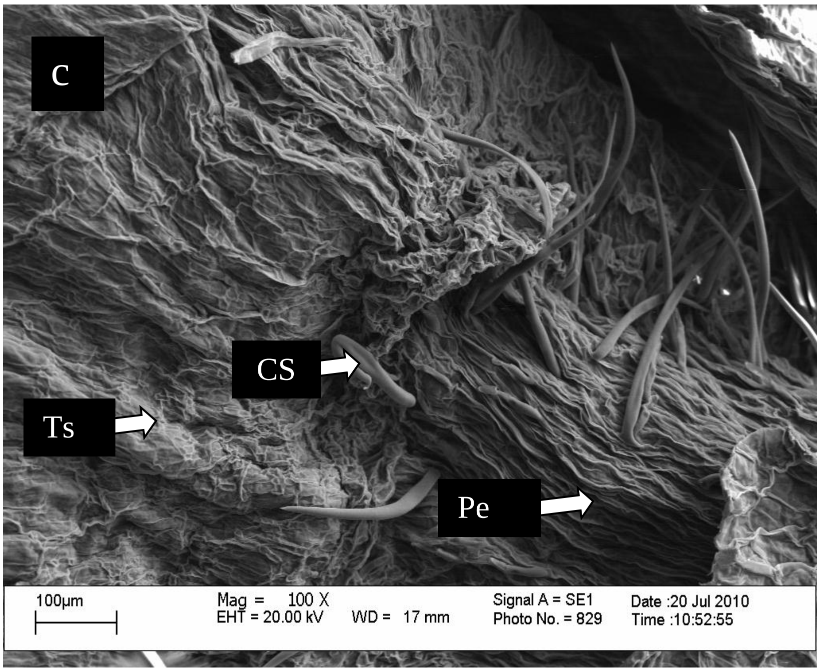
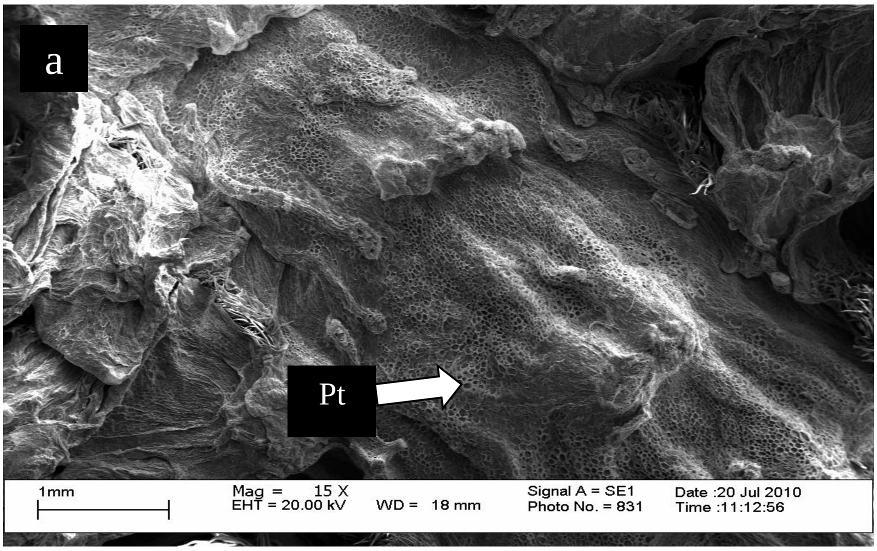
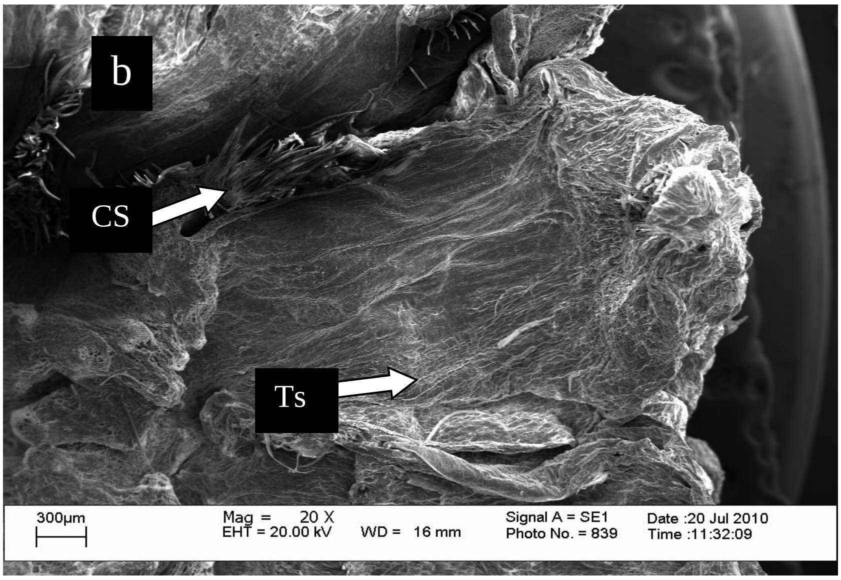


Fig. 2. (a,b,c) are scanning electron photomicrographs in low magnification (15-100X) of young corn ears. Photomicrographs 2a is representative of cells from young corn ears dried without any treatment in a horizontal section showing the pith (Pt) located at the centre of the kernel 15X. Photomicrograph 2b shows a single cotyledon with testa (Ts) pedicel (Pe) and pericarp (P). Photomicrograph 2c showing pedicel (Pe) and root of corn silk (CS) of the cotyledon at 100X.

Fig. 3 (a,b,c) shows scanning electron photomicrographs of representative cells from of young corn kernel treated with 4.5% sodium hypochlorite solution. The solution was used as a bleach to wash out the epidermis layer of the sample. The pith shows hexagonal scaffolding structure forming the majority of the space, here seen in low magnification (15-

100X). The morphology of pith (Pt) is shown in Fig. 3a. It contains mostly of undifferentiated cells, usually large thin-walled parenchyma cells. The cells at the outer layer of the cortex often acquire irregularly thickened cell walls, and are called collenchymas cells (Russell and Evert 1985). The epidermis layer of the cotyledons structure perished upon treatment with sodium hypochlorite. The testa (Ts) is here seen exposing the endosperm (Fig. 3b.). This endosperm is a tissue that nourishes the embryo (Charlton *et al*. 1995). *Zea mays* being monocotyledon have a helobial endosperm, during an endosperm formation, the cell-wall formation coincide with nuclear divisions. In helobial endosperm formation, a cell wall is laid down between the first two nuclei, after which one half develops endosperm along the cellular pattern and the other half along the nuclear pattern (Carpita *et al*. 2001). The root of corn silk also can be found in this area. Fig. 3c elucidates the analogous structure made from single pith (Pt) in the cortex cell wall. These made up of three to four layers of sclerenchyma cells called hypodermis.





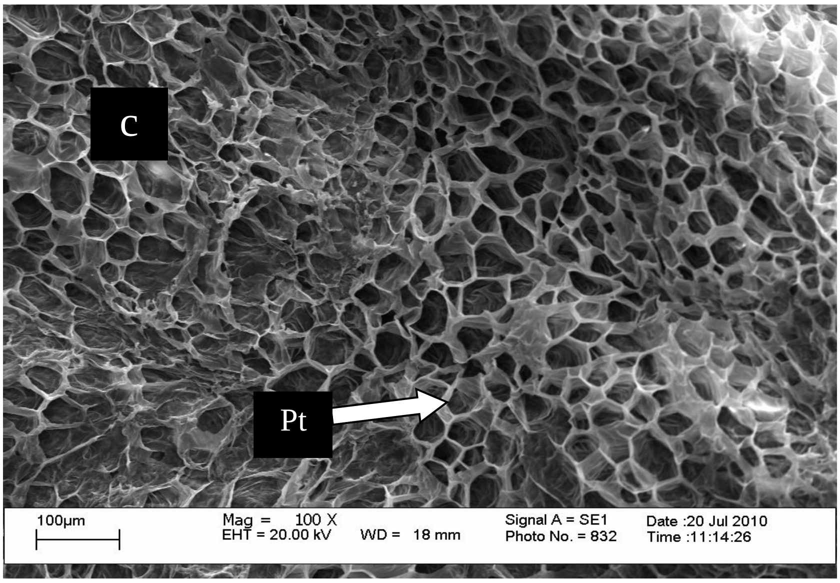


Fig. 3. (a,b,c) are scanning electron photomicrographs in low magnification (15X-100X) of young corn ears. Photomicrographs 3a representative cells from of the young corn kernel treated with 4.5% sodium hypochlorite solution from horizontal section showing pith (Pt) region located centre of the kernel 15X. Photomicrograph 3b shows a single cotyledon showing corn silk (CS) and testa (Ts) of cotyledon 30X. Scanning electron photomicrograph 3c shows the analogous structure of single pith (pt) in the cortex cell wall 100X.

Table 1 Tabulation of the size of the baby corn ears freshly dried and post-treated by NaHClO

Features	**Fresh Dried**	**NaHClO**
Cotyledon size (mm)	1.8-2.5	1.6-2.0
Corn silk size (µm)	15-20	15-20
Pith diameter (mm)	1.55-1.65	1.45-1.55

- Size is average of three readings

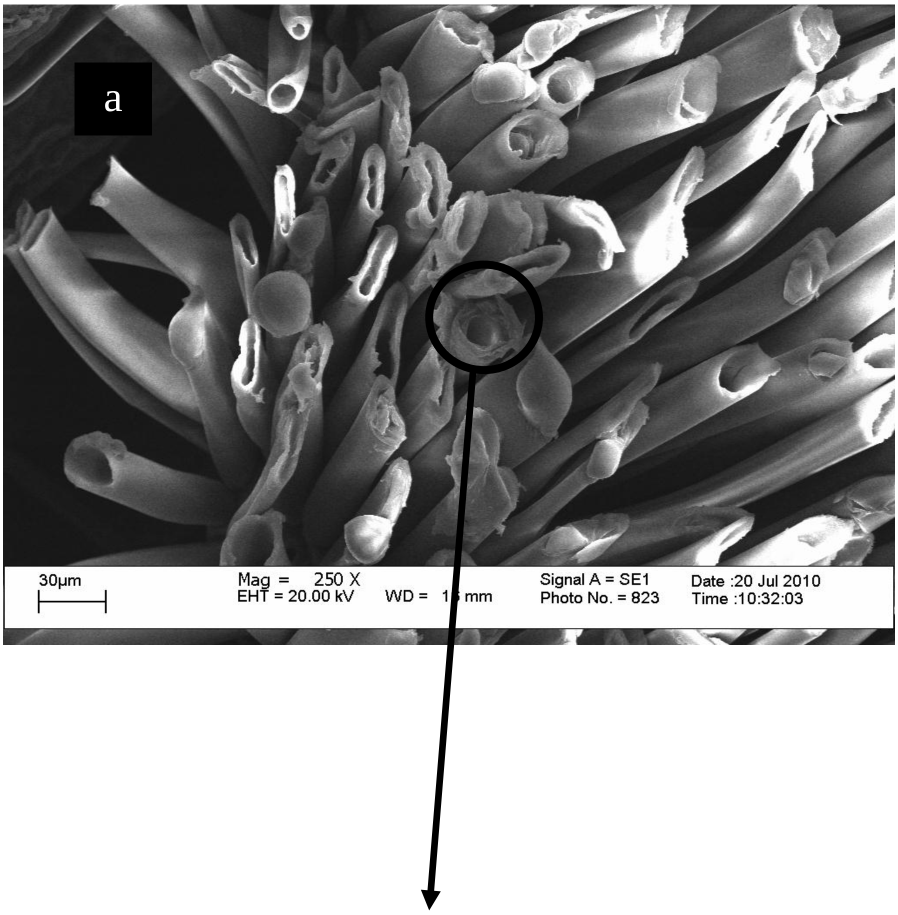
The size of the baby corn ears post-treated with 4.5% sodium hypochlorite solution decreases in size due to the destroyed epidermis layer of cotyledon. Corn silk size and pith diameter, nonetheless, doesn’t have any significant changes.

Figure 4 (a,b) shows electron photomicrographs in high magnification (2000X) of representative corn silk from of young corn kernel dried but without any treatment. Fresh corn silk threads from the matured corn sample were measured. The diameter ranges from 654 – 627 µm (Wan Rosli et al. 2007) while the size of these corn silks strands vary between 6-8 µm in diameter. Cross section of fresh young corn silk sample shows a single hollow tubular microtubule strand with longitudinally-oriented array tubes at every pedicel showing variability in size. The surface texture of the corn silk thread filaments was silky and smooth.

Each one of them emanates from a single surface cell to increase the area of pedicel. The filaments with large numbers of prominent thin, but uniform structure is suggesting that it belongs to a meristematic root cell of the corn silk. The basis for this determinate corn silk growth is unknown. One possible mechanism is that it is controlled by the meristem alone, in which case meristematic cells are developmentally restricted to particular fates.

CONCLUSION

The scanning electron microscope survey of the baby corn ears shows that there is a well developed organisation of structures conferring integrity to the baby corn. While at the same time interesting structures revealing the nature of corn silk together with baby corn may show evidence that the development of corn silk and mature corn could be controlled by some undetermined element probably hormonal in nature. This mean the formation of baby corn could be to ensure nutrient are directed to the dominant cob and this remain to be analysed further. Thus, the structures observed under SEM are showing a well developed architectural design giving the young corn strength. However, the reason why the corn plant produce baby corn, in the first place need further evaluation.



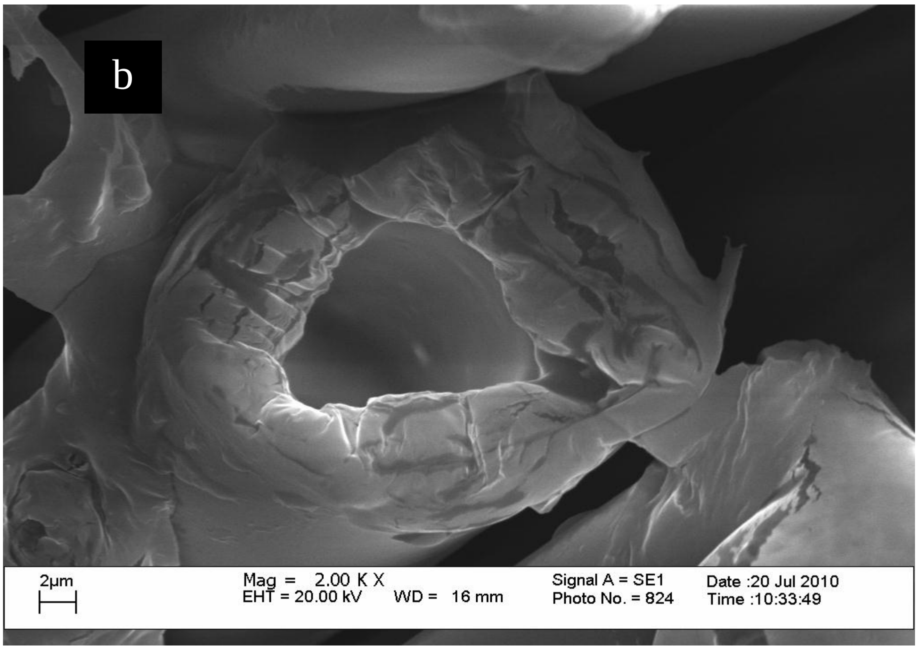


Fig 4 (a,b) are scanning electron photomicrographs in high magnification (2000X) of representative corn silk from of young corn kernel dried without any treatment.

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