



UNIVERSITI PUTRA MALAYSIA

**IDENTIFICATION OF CAUSAL FACTORS OF PEEL-PULP SPLITTING
AND PEELING DIFFICULTY DISORDERS IN 'MAS' BANANA
[*MUSA SAPIENTUM* CV. MAS (AA)]**

WO SOEK MENG

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AND PEELING DIFFICULTY DISORDERS IN 'MAS' BANANA
[*MUSA SAPIENTUM* CV. MAS (AA)]**

By

WO SOEK MENG

**Thesis Submitted to the School of Graduate Studies, Universiti Putra
Malaysia, in Fulfilment of the Requirements for the
Degree of Master of Science**

April 2007



This thesis is especially dedicated to my beloved

HUSBAND

For his unconditional patience, love & support.

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in
fulfilment of the requirements for the degree of Master of Science

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Chairman: Associate Professor Azizah Osman, PhD

Faculty: Food Science and Technology

‘Mas’ banana is among the most favoured of all the local dessert bananas because of its fascinating golden peel and light orange, aromatic and sweet pulp. However, this dessert cultivar was found to be susceptible to peel-pulp splitting disorder (PPSD) and peeling difficulty disorders (PDD). Thus, study was conducted to identify the causal factors of PPSD and PDD of Mas banana during fruit development and ripening, respectively.

Incidence of PPSD and the physical characteristics of the fruits were determined at harvest dates of 4, 5, 6, 7, 8 and 9 weeks after flower emergence (WAFE) for three fruiting seasons (FS1, FS2 and FS3). Chemical characteristics and nutrient contents in PPSD and normal fruits harvested at 6, 7, 8 and 9 WAFE were determined. The anatomical characteristics of the PPSD and normal fruits were also studied. Incidence of PPSD was found to be the most severe at FS3 which was a rainy season after a drought season. Incidence of PPSD was significantly ($P \leq 0.05$) and positively correlated to fruit circumference, pulp weight and pulp to

peel ratio. This suggested that the increase in fruit splitting was related to a rapid increase in fruit size. Significant ($P \leq 0.05$) increases in pulp moisture content and significantly ($P \leq 0.05$) higher peel moisture content of PPSD fruits suggested that rapid increase in pulp volume had put stress on the peel and caused the fruit to split. Significantly lower peel calcium in PPSD fruits also suggested that PPSD was a Ca-deficiency disorder which had caused a lower cell wall turgidity and intercellular strength in the fruits. Results obtained for soluble solids concentration, titratable acidity and pH of the fruits indicated that the fruits had achieved harvest maturity at 6 to 7 WAFE. As shown in the scanning electron micrographs (SEM), the intercellular space of PPSD fruits had been fully occupied due to the rapid cell expansion, imposing stress on the peel which rendered the fruit to split.

Occurrence of PDD was determined on fruits ripened at three levels of RH (high – $90 \pm 5\%$, medium – $70 \pm 5\%$, low – $50 \pm 5\%$) during 5 to 8 ripening days. The corresponding quality and anatomical characteristics of the fruits in relation to PDD were also determined. Fruits ripened at low and medium RH conditions manifested PDD. There was an advanced ripening in fruits ripened at low RH as compared to fruits ripened at medium and high RH. This was shown by the significant ($P \leq 0.05$) linear and quadratic relationships between peel colour (L^* and C^*) and ripening day. Occurrence of PDD was significantly ($P \leq 0.05$) and positively correlated to weight loss and sugar: acid, but was negatively correlated to peel thickness and peel moisture content. These indicated that PDD increased with an increase in moisture loss when ripened at RH lower than 70%. SEM showed that severe water loss in fruits caused the cells to contract and loss turgor,

resulting in loss of cell wall turgidity and reduced intercellular spaces. Thus, peel-pulp transition layer was not readily separated from the outermost layer of the pulp because of absence of intercellular spaces to facilitate peeling.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia
sebagai memenuhi keperluan untuk ijazah Master Sains

**PENCIRIAN PUNCA MASALAH TAK-TERTIB REKAHAN KULIT-ISI
DAN KESUKARAN PENGUPASAN KULIT
DALAM PISANG MAS [*MUSA SAPIENTUM* CV. MAS (AA)]**

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Pisang ‘Mas’ adalah sejenis pisang tempatan yang paling digemari disebabkan oleh kulitnya yang kuning-keemasan dan isinya yang jingga cerah, berbau harum dan manis. Walau bagaimanapun, buah ini senang mengalami masalah tak-tertib rekahan pada kulit-isi (PPSD) dan kesukaran pengupasan kulit (PDD). Oleh itu, kajian dijalankan untuk mengenali punca masalah tak-tertib PPSD semasa pertumbuhan buah Pisang Mas serta mengenali punca masalah tak-tertib PDD semasa perenuman.

Kejadian PPSD dan ciri-ciri fizikal dalam buah ditentukan pada masa penuaian 4, 5, 6, 7, 8 dan 9 minggu selepas pembungaan (WAFE) bagi tiga musim pembuahan (FS1, FS2 dan FS3). Ciri-ciri kimia dan kandungan nutrisi dalam buah PPSD dan biasa (yang tidak mengalami PPSD) ditentukan pada buah yang dituai pada 6, 7, 8 dan 9 WAFE. Ciri-ciri anatomi pada buah PPSD dan biasa juga dikaji. Kejadian PPSD didapati paling ketara pada FS3 yang merupakan musim kemarau yang

diikuti oleh musim hujan. Kejadian PPSD dihubung-kait secara positif dan nyata dengan ukur lilit buah, berat isi buah dan nisbah kulit kepada isi. Ini mencadangkan bahawa peningkatan dalam kejadian PPSD adalah dikaitkan dengan peningkatan saiz buah yang mendadak. Peningkatan kandungan air dalam isi buah yang nyata serta kandungan air dalam kulit yang nyatanya lebih tinggi mencadangkan bahawa isipadu isi telah memberi tekanan ke atas kulit dan menyebabkan buah menjadi rekah. Kandungan kalsium pada kulit yang nyatanya lebih rendah juga mencadangkan bahawa PPSD ialah satu masalah tak-tertib kekurangan kalsium, di mana kekuatan dinding sel dan kekuatan antara sel dalam buah-buah tersebut adalah kurang. Data bagi kepekatan pepejal terlarut, keasidan tertitrat dan pH menunjukkan bahawa buah-buah tersebut telah mencapai kematangan penuaian pada 6 hingga 7 WAFE. Melalui gambar mikroskop pengimbasan electron (SEM), ruang antara sel dalam buah PPSD telah menjadi padat akibat daripada pengembangan sel, justeru mengenakan tekanan ke atas kulit dan akhirnya menyebabkan buah menjadi rekah.

Kewujudan PDD telah ditentukan atas buah yang diranumkan pada keadaan kelembapan relatif (RH) yang berlainan (tinggi - $90 \pm 5\%$, sederhana - $70 \pm 5\%$, rendah - $50 \pm 5\%$) semasa hari peranaman kelima hingga kelapan. Ciri-ciri kualiti dan anatomi buah yang berkaitan dengan PDD juga dikaji. PDD wujud pada buah yang diranumkan pada RH rendah dan sederhana. Buah yang diranumkan pada RH rendah ranum lebih awal berbanding dengan buah yang diranumkan pada RH sederhana dan tinggi, seperti yang ditunjukkan oleh hubungan nyata yang linear dan kuadratik antara warna kulit (L^* dan C^*) dengan hari peranaman. Kewujudan PDD adalah berhubungan positif dengan kehilangan berat dan nisbah gula kepada

asid, tetapi berhubungan negatif dengan ketebalan kulit dan kandungan air dalam kulit. Ini bermakna kewujudan PDD meningkat dengan kehilangan air yang ketara semasa diranumkan dalam RH yang kurang daripada 70%. SEM pula menunjukkan bahawa kehilangan air yang sangat ketara akan menyebabkan sel-sel mengecut dan kehilangan ruang antara sel. Tanpa ruang antara sel yang boleh membantu dalam pengupasan, lapisan perantaraan isi-kulit tidak dapat dipisahkan dengan mudah daripada lapisan paling luar isi buah pisang.

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APPROVALS

I certify that an Examination Committee has met on 9 April 2007 to conduct the final examination of Wo Soek Meng on her degree thesis entitled "Identification of the Causal Factors of Peel-Pulp Splitting and Peeling Difficulty Physiological Disorders in 'Mas' Banana [*Musa sapientum* cv. Mas (AA)]" in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulations 1981. The Committee recommends that the candidate be awarded the relevant degree. Members of the Examination Committee are as follows:

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DECLARATION

I hereby declare that the thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at UPM or other institutions.

WO SOEK MENG

Date: 7 JUNE 2007

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4.14	Top view of adhered peel (AP) cells from the peel-pulp transition layer on a fully ripe Mas banana ripened at $50 \pm 5\%$ RH, 25°C . The peel adhered on the outermost layer of the pulp (P). Note that the adhering peel cells at the area X were shrunken. x 170.	4.42

LIST OF ABBREVIATIONS

FAMA	Federal Agricultural and Marketing Authority
PPSD	Peel-pulp Splitting Disorder
WAFE	Weeks after Flower Emergence
HD	Harvest Date
FS	Fruiting Season
FT	Fruit Type
FS1	Fruiting Season 1
FS2	Fruiting Season 2
FS3	Fruiting Season 3
SSC	Soluble Solids Concentration
N	Nitrogen
P	Phosphorus
K	Potassium
Ca	Calcium
Mg	Magnesium
SEM	Scanning Electron Microscope
PDD	Peeling Difficulty Disorder
RH	Relative Humidity
RD	Ripening Day
CRD	Completely Randomized Design
RCBD	Randomized Complete Block Design
ANOVA	Analysis of Variance
LSD	Least Significant Difference



SAS	Statistical Analysis System
L*	Lightness
C*	Chroma
H°	Hue