



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

FSTM 2007 2

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AND PEELING DIFFICULTY DISORDERS IN 'MAS' BANANA
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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 perantuan 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 perantuan. 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

TABLE OF CONTENTS

DEDICATION	Page
ABSTRACT	ii
ABSTRAK	iii
ACKNOWLEDGEMENTS	vi
APPROVALS	ix
DECLARATION	xi
LIST OF TABLES	xii
LIST OF FIGURES	xvi
LIST OF ABBREVIATIONS	xvii
	xxiii

CHAPTER

1	GENERAL INTRODUCTION	1.1
2	LITERATURE REVIEW	2.1
2.1	Banana	2.1
2.2	Fruit Development	2.3
2.2.1	Fruit Growth and Maturation	2.3
2.2.2	Ripening and Senescence	2.6
2.3	Physiological Disorder	2.11
2.3.1	Fruit Splitting	2.13
2.3.2	Peeling Difficulty	2.24
2.4	Fruit Anatomy	2.29
3	IDENTIFICATION OF THE CAUSAL FACTORS OF PEEL-PULP SPLITTING DISORDER IN ‘MAS’ BANANA	3.1
3.1	Introduction	3.1
3.2	Materials and Methods	3.4
3.2.1	Fruit Source	3.4
3.2.2	Determination of the Effect of Harvest Dates and Fruiting Seasons on Incidence of Peel-pulp Splitting Disorder (PPSD) and Physical Characteristics	3.4
3.2.3	Determination of Chemical Characteristics of PPSD and Normal Fruits at Different Harvest Dates	3.7
3.2.4	Determination of Anatomical Structure of PPSD and Normal Fruits	3.10
3.2.5	Data Analysis	3.12



3.3	Results and Discussion	3.13
3.3.1	Effect of Harvest Dates and Fruiting Seasons on Incidence of PPSD and Physical Characteristics	3.13
3.3.2	Effect of Harvest Dates and Fruit Types on Chemical Characteristics and Nutrient Contents	3.34
3.3.3	Anatomical Structure of PPSD and Normal Fruits	3.48
3.3.4	Conclusion	3.57
4	IDENTIFICATION OF THE CAUSAL FACTORS OF PEELING DIFFICULTY DISORDER IN ‘MAS’ BANANA	4.1
4.1	Introduction	4.1
4.2	Materials and Methods	4.4
4.2.1	Fruit Source and Treatments	4.4
4.2.2	Determination of the Occurrence of Peeling Difficulty Disorder (PDD) and Physico-chemical Characteristics	4.5
4.2.3	Determination of Peel Anatomical Structure of in relation to PDD	4.8
4.2.4	Experimental Design and Data Analysis	4.9
4.3	Results and Discussions	4.10
4.3.1	Occurrence of PDD and Physico-chemical Characteristics	4.10
4.3.2	Peel Anatomical Structure of in relation to PDD	4.34
4.4	Conclusion	4.45
5	GENERAL CONCLUSION AND RECOMMENDATIONS	5.1
	BIBLIOGRAPHY	6.1
	APPENDICES	7.1
	BIODATA OF THE AUTHOR	8.1
	LIST OF PUBLICATIONS	8.2

LIST OF TABLES

Table		Page
3.1	Main and interaction effects of harvest date (4 to 9 weeks after flower emergence) and fruiting season on incidence of peel-pulp splitting disorder of Mas banana (<i>Musa sapientum</i> cv. Mas).	3.14
3.2	Correlation coefficients between incidence of peel-pulp splitting disorder (PPSD), fruit circumference, fruit, peel and pulp weight, pulp to peel ratio (pulp:peel) and pulp firmness of Mas banana (<i>Musa sapientum</i> cv. Mas) from 6 to 9 weeks after flower emergence.	3.22
3.3	Main and interaction effects of harvest date (6 to 9 weeks after flower emergence) and fruit type (peel-pulp splitting disorder, PPSD and normal fruit) on moisture content, soluble solids concentration (SSC), titratable acidity (TA) and pH of Mas banana (<i>Musa sapientum</i> cv. Mas).	3.35
3.4	Main and interaction effects of harvest date (weeks after flower emergence) and fruit type (peel-pulp splitting incidence, PPSD and normal fruits) on potassium (K) and calcium (Ca) content of peel and pulp of Mas banana (<i>Musa sapientum</i> cv. Mas).	3.42
4.1	Main and interaction effects of relative humidity ($50 \pm 5\%$, low; $70 \pm 5\%$, medium and $90 \pm 5\%$, high) and ripening day (days 5, 6, 7 and 8) on the occurrence of peeling difficulty disorder (PDD), weight loss, peel thickness, moisture content and sugar/ acid ratio and of Mas banana (<i>Musa sapientum</i> cv. Mas).	4.11
4.2	Correlation coefficients between occurrence of peeling difficulty disorder (PDD), weight loss, peel thickness, moisture content, sugar to acid ratio (sugar:acid) and peel colour of Mas banana (<i>Musa sapientum</i> cv. Mas) from 6 to 8 ripening days at low ($50 \pm 5\%$) and medium relative humidity ($70 \pm 5\%$).	4.18
4.3	Main and interaction effects of relative humidity ($50 \pm 5\%$, low; $70 \pm 5\%$, medium and $90 \pm 5\%$, high) and ripening day (days 5, 6, 7 and 8) on peel colour (lightness, chroma and hue) of Mas banana (<i>Musa sapientum</i> cv. Mas).	4.29

LIST OF FIGURES

Figure		Page
2.1	Fruit development renders to the changes in fruit angularity. In immature fruit, the angle is clearly seen, while in mature fruit, the shape has become rounded (Acedo and Pantastico, 1989).	2.5
3.1	Mas banana with peel-pulp splitting disorder (PPSD). PPSD is characterized by a longitudinal split from the stem-end to the blossom-end of the fruit. The depth of the split could extend from the epidermis of the peel to the endocarp of the pulp. Note the parts of a fruit: blossom-end, middle and stem-end.	3.2
3.2	The transverse section of five planes of a Mas banana (<i>Musa sapientum</i> cv. Mas) used as sample for scanning electron microscope studies was always obtained from the concave region of the fruit as recommended by Ding (2004).	3.11
3.3	Relationship between the incidence of peel-pulp splitting disorder (PPSD) and harvest date (weeks after flower emergence, WAFE) of Mas banana (<i>Musa sapientum</i> cv. Mas) over three fruiting seasons (FS) during which the experiment was carried out. FS1 = Aug-Oct 2003, FS2 = Oct-Dec 2003 and FS3 = Jan-Mac 2004. Data were log-transformed prior to ANOVA. Solid lines represent significant linear and quadratic models, $P \leq 0.05$.	3.15
3.4	Average monthly rainfall (mm) in Raub, Pahang from July 2003 to June 2004 over three fruiting seasons (FS) during which the experiment was carried out. FS1 = Aug-Oct 2003, FS2 = Oct-Dec 2003 and FS3 = Jan-Mac 2004. Source: Perkhidmatan Kajiucaca Malaysia, Jalan Sultan, 46667 Petaling Jaya, Malaysia. 2005.	3.18
3.5	Relationship between fruit circumference and harvest date (weeks after flower emergence, WAFE) of Mas banana (<i>Musa sapientum</i> cv. Mas) over three fruiting seasons (FS) during which the experiment was carried out. FS1 = Aug-Oct 2003, FS2 = Oct-Dec 2003 and FS3 = Jan-Mac 2004. Solid lines represent significant linear and quadratic models, $P \leq 0.05$.	3.20

Figure	Page
3.6 Relationship between fruit weight and harvest date (weeks after flower emergence, WAFE) of Mas banana (<i>Musa sapientum</i> cv. Mas) over three fruiting seasons (FS) during which the experiment was carried out. FS1 = Aug-Oct 2003, FS2 = Oct-Dec 2003 and FS3 = Jan-Mac 2004. Solid lines represent significant linear and quadratic models, $P \leq 0.05$.	3.24
3.7 Relationship between pulp to peel ratio and harvest date (weeks after flower emergence, WAFE) of Mas banana (<i>Musa sapientum</i> cv. Mas) over three fruiting seasons (FS) during which the experiment was carried out. FS1 = Aug-Oct 2003, FS2 = Oct-Dec 2003 and FS3 = Jan-Mac 2004. Solid lines represent significant linear and quadratic models, $P \leq 0.05$.	3.28
3.8 Relationship between peel firmness and harvest date (weeks after flower emergence, WAFE) of Mas banana (<i>Musa sapientum</i> cv. Mas) over three fruiting seasons (FS) during which the experiment was carried out. FS1 = Aug-Oct 2003, FS2 = Oct-Dec 2003 and FS3 = Jan-Mac 2004. Solid lines represent significant linear and quadratic models, $P \leq 0.05$.	3.30
3.9 Relationship between pulp firmness and harvest date (weeks after flower emergence, WAFE) of Mas banana (<i>Musa sapientum</i> cv. Mas) over three fruiting seasons (FS) during which the experiment was carried out. FS1 = Aug-Oct 2003, FS2 = Oct-Dec 2003 and FS3 = Jan-Mac 2004. Solid lines represent significant linear and quadratic models, $P \leq 0.05$.	3.32
3.10 Relationship between pulp moisture content and harvest date (weeks after flower emergence, WAFE) in peel-pulp splitting disorder (PPSD) and normal Mas banana (<i>Musa sapientum</i> cv. Mas) fruits. Solid lines represent significant linear and quadratic models at $P \leq 0.05$.	3.37
3.11 Relationship between soluble solids concentration and harvest date (weeks after flower emergence, WAFE) in peel-pulp splitting disorder (PPSD) and normal Mas banana (<i>Musa sapientum</i> cv. Mas) fruits. Solid lines represent significant linear models at $P \leq 0.05$.	3.39

Figure	Page
3.12 Relationship between titratable acidity and harvest date (weeks after flower emergence, WAFE) in peel-pulp splitting disorder (PPSD) and normal Mas banana (<i>Musa sapientum</i> cv. Mas) fruits. Solid lines represent significant linear models at $P \leq 0.05$.	3.42
3.13 Relationship between peel calcium content and harvest date (weeks after flower emergence, WAFE) in peel-pulp splitting disorder (PPSD) and normal Mas banana (<i>Musa sapientum</i> cv. Mas) fruits. Solid lines represent significant linear and quadratic models at $P \leq 0.05$.	3.47
3.14 Transverse section (TS) and longitudinal section (LS) of Mas banana (<i>Musa sapientum</i> cv. Mas) when viewed by scanning electron microscopy (SEM). The epidermal cells on the surfaces of the banana fruit sections were readily distinguished. Three major parts are peel, peel-pulp transition and pulp. TS = x 33; LS = x 32.	3.50
3.15 SEM micrograph of Mas banana peel transverse section with peel-pulp splitting disorder (PPSD). Vascular bundles (VB) and laticifers (LC) with coagulated latex intersperse within the hypodermal cells. Arrows showed the intercellular spaces at the peel-pulp transition layer (PPTL). A dotted line measures the size of a VB. x 55.	3.51
3.16 SEM micrograph of normal Mas banana peel transverse section (control). The normal fruit was obtained from the same bunch as the PPSD fruit. Arrows showed the intercellular spaces at the PPTL, hypodermal cells and VB. x 55.	3.51
3.17 SEM micrograph of Mas banana pulp transverse section with peel-pulp splitting disorder (PPSD fruit). The PPSD fruit was from a fruit bunch harvested at 7 weeks after flower emergence. Starch granules (SG) were seen heavily deposited the pulp cells. The pulp cell walls (CW) were turgid at mature green stage. x 200.	3.53

Figure		Page
3.18	SEM micrograph of a normal Mas banana peel transverse section (control). The normal fruit was from the same bunch with the peel-pulp splitting disorder (PPSD) fruit harvested at 7 weeks after flower emergence. Starch granules (SG) were seems heavily deposited the pulp cells. The pulp cell walls (C2) were turgid at mature green stage. Arrows showed the intercellular spaces at the peel region. x 200.	3.53
4.1	Relationship between occurrence of peeling difficulty disorder (PDD) and ripening day in Mas banana ripened at low, medium and high relative humidity (RH). Low RH = 50 ± 5%, medium RH = 70 ± 5% and high RH = 90 ± 5%. Solid lines represent significant linear and quadratic models at P≤0.05. Data were log-transformed prior to ANOVA.	4.12
4.2	Effect of ripening day on weight loss of Mas banana ripened at low, medium and high relative humidity (RH). Low RH = 50 ± 5%, medium RH = 70 ± 5% and high RH = 90 ± 5%. Mean separation within each RH is by LSD, P≤0.05.	4.16
4.3	Effect of ripening day on peel moisture content of Mas banana ripened at low, medium and high relative humidity (RH). Low RH = 50 ± 5%, medium RH = 70 ± 5% and high RH = 90 ± 5%. Mean separation within each RH is by LSD, P≤0.05.	4.21
4.4	Relationship between sugar to acid ratio and ripening day in Mas banana ripened at low, medium and high relative humidity (RH). Low RH = 50 ± 5%, medium RH = 70 ± 5% and high RH = 90 ± 5%. Solid and dotted lines represent significant and non-significant linear and quadratic models at P≤0.05, respectively.	4.25
4.5	Relationship between peel lightness and ripening day in Mas banana ripened at low, medium and high relative humidity (RH). Low RH = 50 ± 5%, medium RH = 70 ± 5% and high RH = 90 ± 5%. Solid and dotted lines represent significant and non-significant linear and quadratic models at P≤0.05, respectively.	4.30

Figure	Page
4.6	Relationship between peel chroma and ripening day in Mas banana ripened at low, medium and high relative humidity (RH). Low RH = $50 \pm 5\%$, medium RH = $70 \pm 5\%$ and high RH = $90 \pm 5\%$. Solid and dotted lines represent significant and non-significant linear and quadratic models at $P \leq 0.05$, respectively. 4.32
4.7	Peel longitudinal section of mature green Mas banana ripened at $90 \pm 5\%$ RH, 25°C . The green peel was separated from the firm pulp after cutting the fruit longitudinally. Two continuous vascular bundles (VB) below the epidermis (EP) and laticifers (LC) with coagulated latex were clearly noted. Intercellular spaces (IS) were apparent at hypodermal (HP) above the peel-pulp transition layer (PPTL). x 55. 4.35
4.8	Peel longitudinal section of a readily peeled Mas banana at fully ripe stage, ripened at $90 \pm 5\%$ RH, 25°C . There were two continuous vascular bundles (VB) below the epidermis (EP). Intercellular spaces (IS) were apparent at hypodermal (HP) layer above the peel-pulp transition layer (PPTL). Pulp cells (P) attached to the innermost layer of the peel. x 60. 4.35
4.9	Peel transverse section of a Mas banana at an edible stage, ripened at $50 \pm 5\%$ RH, 25°C . Single-ended arrows indicated the direction of the peel and pulp tissues at the region of peel-pulp transition layer (PPTL) when the fruit was peeled. EP, epidermis; VB, vascular bundle; LC, laticifer; P, pulp. x 50. 4.39
4.10	Peel transverse section of a Mas banana at an edible stage, ripened at $50 \pm 5\%$ RH, 25°C . Dotted circle indicated the epidermal (EP) and hypodermal (HP) cells torn above the vascular bundles (VB) manifested peeling difficulty disorder. x 55. 4.39
4.11	Peel transverse section of Mas banana at fully ripened stage, ripened at $50 \pm 5\%$ RH, 25°C . The fruit manifested peeling difficulty disorder, where the unremovable peel broke at the vascular bundles (VB) area. The break exposed the continuous conducting cells (CC) of tracheary elements of vascular bundles. Note the contracted peel layer: epidermis (EP), hypodermis (HP) and peel-pulp transition layer (PPTL). P, pulp. x 120. 4.40

Figure		Page
4.12	Peel transverse section of Mas banana at fully ripened stage, ripened at $50 \pm 5\%$ RH, 25°C . Adhered peel (AP) on the pulp (P) was torn above a layer of vascular bundles (VB), exposing the conducting cells (CC) of the VB. Note the intercellular space (IS) at the pulp region. x 65.	4.40
4.13	Top view of a torn peel surface of Mas banana ripened at $50 \pm 5\%$ RH, 25°C . The parenchymatous cells (PC) were observed to be torn at a same level as the smooth surface of conducting cells (CC) of the vascular bundles. x 55.	4.42
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

