FLAVOUR CHARACTERIZATION OF JACKFRUIT (*ARTOCARPUS HETEROPHYLLUS* L.) FROM FIVE CULTIVARS AND OPTIMIZATION OF CANNING CONDITIONS FOR JACKFRUIT PUREE

ONG BEE TEIN

FSTM 2006 11
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By

ONG BEE TEIN

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

May 2006
DEDICATION

To my dearest mother, Yeong Siew Yong,
for being so patient and understanding,

My father, Ong Sin Ken,
for providing me with trust and liberty,

My brothers, Lieh Bin, Lieh Chee and Lieh Yan,
for their strong support and brotherly care,

My sisters-in-law,
for their guidance and advice,

And last but not least my boyfriend,
for being there always in my times of need,

tolerating me with his patience
FLAVOUR CHARACTERIZATION OF JACKFRUIT (*ARTOCARPUS HETEROPHYLLUS* L.) FROM FIVE CULTIVARS AND OPTIMIZATION OF CANNING CONDITIONS FOR JACKFRUIT PUREE

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May 2006

Chairman: Nazimah Sheikh Abdul Hamid, PhD

Faculty: Food Science and Technology

The study concerns flavour characterization of five jackfruit (*Artocarpus heterophyllus* L.) cultivars and optimization of canned jackfruit puree production. In the first part of this study, twenty three volatile compounds extracted using dichloromethane solvent extraction were tentatively identified by gas chromatography (GC) and gas chromatography-mass spectrometry (GC-MS). As ripening progressed, there was an increase in volatile compound formation. Development of new volatile flavour compounds in trace amounts at day 3 after harvest indicated the start of jackfruit ripening. Data obtained showed that the ripening process of jackfruit was at its optimum at day 5 after harvest. Variation of volatile compounds in different portions (top, middle and bottom) of the fruit during ripening was too little to give any significance.
The volatile profiles of jackfruit flavour in five cultivars were established using headspace solid phase microextraction (SPME) and gas chromatography-time of flight mass spectrometry (GC-TOFMS). Qualitative and quantitative analyses were carried out using divinylbenzene/carboxen/polydimethylsiloxane (DVB/CAR/PDMS) fiber with an extraction time of 10 min. Thirty seven compounds were identified from the five cultivars tested. Characteristic aroma which are in higher concentrations and contributed to jackfruit flavour were found to be ethyl isovalerate, 3-methylbutyl acetate, 1-butanol, propyl isovalerate, isobutyl isoalurate, 2-methylbutanol, and butyl isoalurate. The consistent occurrence of these compounds in all cultivars of jackfruit suggested their importance in contributing to the sweet and fruity note of jackfruit. Concentration of the volatile compounds present played an important role in determining the overall flavour of each fruit cultivar. Each cultivar also possessed its own unique compound which distinguished them from one to another.

During the canning of jackfruit puree, optimization of time (10 – 30 min) and temperature (100 – 120°C) was studied using response surface methodology. Response values fitted the second order polynomial model. Effect of the independent variables on sweetness, pH and total soluble solids were insignificant (p>0.05). Analysis of variance (ANOVA) and regression coefficients showed significant positive linear effect of temperature towards cooked flavour (p<0.01), sourness (p<0.05), bitterness (p<0.05) and hue (p<0.05), while negative linear effect was seen in fruity flavour (p<0.05), viscosity (p<0.01) and chroma (p<0.001). Influence of processing time on quality characteristics of jackfruit puree was only found in cooked flavour (p< 0.05) and hue.
(p<0.05). The optimization model generated a desirable region which depicted optimal processing temperature to be in the range of 100 °C and 110 °C while processing time to be in the range of 15 min to 25 min. The loss of nine volatile esters and a decrease in the total flavour were found in canned jackfruit puree as compared to fresh jackfruit puree.
Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk Ijazah Master Sains

PENCIRIAN PERISA LIMA KULTIVAR BUAH NANGKA (ARTOCARPUS HETEROPHYLLUS L.) DAN PENGOPTIMUMAN PROSES PENGETINAN PURI BUAH NANGKA

Oleh

ONG BEE TEIN

Mei 2006

Pengerusi: Nazimah Sheikh Abdul Hamid, PhD
Fakulti: Sains dan Teknologi Makanan

Kajian ini adalah mengenai pencirian perisa lima kultivar buah nangka (Artocarpus heterophyllus L.) dan mengoptimumkan proses penghasilan puri buah nangka yang ditinkan. Di dalam bahagian pertama kajian ini, dua puluh tiga sebatian meruap diekstrak menggunakan cara pengekstrakan pelarut diklorometana dan dikenalpasti secara tentatif dengan kromatografi gas (GC) dan kromatografi gas-spektrometri jisim (GC-MS). Pembentukan sebatian meruap meningkat semasa proses peranuman. Penghasilan sebatian meruap yang baru dalam jumlah yang sedikit pada hari ketiga selepas dituai menandakan proses peranuman buah nangka telah bermula. Data yang didapati menunjukkan bahawa peranuman buah nangka adalah optimum pada hari kelima selepas dituai. Semasa peranuman, variasi sebatian meruap di antara bahagian buah (atas, tengah dan bawah) yang berbeza adalah terlalu sedikit untuk memberikan nilai yang signifikan.

Semasa pengetinan puri nangka, pengoptimuman masa (10 – 30 minit) dan suhu (100 – 120°С) telah dikaji dengan menggunakan kaedah respon permukaan (response surface methodology). Nilai respon didapati sesuai untuk model polinomial arahan kedua. Kesan pembolehubah bebas ke atas kemanisan, pH dan jumlah pepejal larut adalah tidak signifikan (p>0.05). Analisis varians (ANOVA) dan pekali regresi menunjukkan kesan kadar langsung positif yang signifikan akibat kesan suhu terhadap perisa masak
(p<0.01), kemasaman (p<0.05), kepahitan (p<0.05) dan warna (p<0.05), manakala perisa buah (p<0.05), kepekatan (p<0.01) dan kroma (p<0.001) menunjukkan kesan kadar langsung negatif. Masa pemprosesan hanya mempengaruhi perisa masak (p<0.05) dan warna (p<0.05) puri nangka. Model optimum ini menghasilkan julat yang diingini untuk pemprosesan yang optimum, iaitu julat suhu di antara 100 hingga 110°C sementara julat masa pemprosesan adalah di antara 15 hingga 25 minit. Kehilangan sembilan ester meruap dan penurunan kandungan perisa didapati dalam puri nangka yang ditinkan berbanding dengan puri nangka yang segar.
ACKNOWLEDGEMENTS

First and foremost, I would like to express my deepest appreciation and gratitude to my supervisor, Dr. Nazimah Sheikh Abdul Hamid, and my co-supervisors, Associate Professor Dr. Azizah Osman, who has not only given me invaluable advice and guidance from their vast experience, but also for their precious time and supervision. I would also like to extend my heartfelt thanks to Encik Dzulklifi Mat Hashim, for his uncountable advice, time and constructive suggestions throughout the course of my research study.

I'm forever indebted to my mother and father, for their infinite support, love, care and understanding. I am also very thankful for having brothers who were ever so helpful and caring during the difficult times. I would also like to extend my greatest appreciation to my boyfriend, Keng Fei who had been with me through the hard times with his patience and support throughout all these years of studies.

I'm also indebted to Sung Tong, Yit Yang, Chun Kiat, Tuck Keong and Horng Eng for their infinite support, help and their friendship; without them, working in the lab would not have been as enjoyable and memorable.

I would also like to express my deepest appreciation and thanks to all the staff of Department of Food Science and Technology for providing the research facilities and technical assistance. I would like to acknowledge the financial support provided by IRPA grant (01-02-04-0789 EA001) awarded to Dr. Nazimah Sheikh Abdul Hamid for
this study. Acknowledgement is also due to the GRA scholarship for granting me the opportunity to pursue my master degree.

To all my fellow friends, your companion and care has helped me pulled through those difficult times. Remember that you will always have a special place in my heart.
I certify that an Examination Committee has met on 31 May 2006 to conduct the final examination of Ong Bee Tein on her Master of Science thesis entitled “Flavour Characterization of Jackfruit (Artocarpus heterophyllus L.) from Five Cultivars and Optimization of Canning Conditions for Jackfruit Puree” 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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Date: 14 SEP 2006
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.

ONG BEE TEIN

Date: 20 AUG 2006
TABLE OF CONTENTS

DEDICATION 2
ABSTRACT 3
ABSTRAK 6
ACKNOWLEDGEMENTS 9
APPROVAL 11
DECLARATION 13
LIST OF TABLES 17
LIST OF FIGURES 19
LIST OF ABBREVIATIONS 21

CHAPTER

I GENERAL INTRODUCTION 24

II LITERATURE REVIEW 28
Jackfruit (Artocarpus heterophyllus L.) 28
   Characteristics of the fruit and tree 29
   Harvest maturity 30
   Chemical composition of jackfruit 32
Flavour volatiles and its importance in tropical fruits 33
   Factors that Affects Flavour of Fruits and Vegetables 38
Volatile in jackfruit 50
Tropical fruit puree and its application 54
Thermal Processing 56
   Canning as a method of preservation for fruit puree 56
   Effect of thermal processing on the properties of fruit products 58
Rheological properties of fruit puree 61
Flavour extraction 67
   Liquid-liquid / solvent extraction 74
   Solid Phase Microextraction (SPME) method 75
Measurements of Flavour Volatiles 80
Quantitative description analysis (QDA) 81
Response Surface Methodology (RSM) 82

III FLAVOUR CHANGES DURING RIPENING OF JACKFRUIT 84
(Artocarpus heterophyllus L.) CULTIVAR J3 84
Introduction 84
Materials and Methods 86
   Plant materials 86
   Sampling of fruit 87
   Flavour extraction 87
   Gas Chromatography analysis 88
REFERENCES/BIBLIOGRAPHY
APPENDICES
BIODATA OF THE AUTHOR

151
179
199
### LIST OF TABLES

<table>
<thead>
<tr>
<th>Table</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>List of volatile compounds identified in jackfruit (<em>Artocarpus heterophyllus</em> L.) by Sword et al. (1978), Rasmussen (1983) and Maia et al. (2004)</td>
<td>53</td>
</tr>
<tr>
<td>2</td>
<td>Processing parameters of various fruit and vegetable products in literature</td>
<td>59</td>
</tr>
<tr>
<td>3</td>
<td>Published data on extraction and analysis methods used in determination of volatile flavour compounds of various fruits and its products</td>
<td>68</td>
</tr>
<tr>
<td>4</td>
<td>Volatile compounds of <em>A. heterophyllus</em>, cultivar J3 tentatively identified using Supelcowax-10 capillary column</td>
<td>90</td>
</tr>
<tr>
<td>5</td>
<td>Coefficient of variation (CV) on the peak areas of selected volatile compounds detected in the three fibers after triplicate extraction</td>
<td>106</td>
</tr>
<tr>
<td>6</td>
<td>Concentrations of flavour volatile compounds detected in cultivars J31, J1, J6, J30 and J3 using DVB/CAR/PDMS fiber</td>
<td>109</td>
</tr>
<tr>
<td>7</td>
<td>Volatile compounds and their flavour descriptors of five jackfruit (<em>Artocarpus heterophyllus</em> L.) cultivars separated based on principal components 1, 2 and 3</td>
<td>112</td>
</tr>
<tr>
<td>8</td>
<td>Design of experimental runs and experimental data for the dependent variables sensory evaluation, viscosity, colour, total soluble solids and pH of jackfruit puree under different canning conditions</td>
<td>129</td>
</tr>
<tr>
<td>9</td>
<td>Analysis of variance on independent variables as linear, quadratic and interaction terms on the response variables</td>
<td>131</td>
</tr>
<tr>
<td>10</td>
<td>Regression coefficients of predicted quadratic polynomial models for the ten responses of jackfruit puree</td>
<td>133</td>
</tr>
<tr>
<td>11</td>
<td>Volatile flavour compounds identified in fresh and processed jackfruit puree</td>
<td>136</td>
</tr>
<tr>
<td>12</td>
<td>Percent loss in concentration of important volatile ester compounds in jackfruit puree under different canning conditions</td>
<td>137</td>
</tr>
</tbody>
</table>
13 Consistency coefficient, $K$, flow behaviour, $\eta$ and $r^2$ in Power-Law equation at different processing time and temperature combination

14 Evaluation of microbial growth and spore formers in canned jackfruit puree under a series of canning condition after storing at accelerated temperature ($40 ^\circ C$) for six months

A-1 Numerical values for scores plot of PC1 and PC2 in the analysis of flavour changes during jackfruit ripening

A-2 Numerical values for loadings plot of PC1 and PC2 in the analysis of flavour changes during jackfruit ripening

A-3 Numerical values for loadings plot of PC1, PC2 and PC3 in the analysis of flavour in five different cultivars of jackfruit

A-4 Numerical values for scores plot of PC1, PC2 and PC3 in the analysis of flavour in five different cultivars of jackfruit
## LIST OF FIGURES

<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>A general schematic of the biosynthetic pathways for volatile aromas of plant products</td>
<td>42</td>
</tr>
<tr>
<td>2</td>
<td>Chromatograms of flavour compounds from middle portions of jackfruit cultivar J3 at days 1, 3, 5, and 6 after harvest</td>
<td>92</td>
</tr>
<tr>
<td>3</td>
<td>The score plots of changes in volatile compounds during ripening process</td>
<td>93</td>
</tr>
<tr>
<td>4</td>
<td>The X-loadings of volatile compounds present in fruits from days 1, 3, 5 and 6 after harvest</td>
<td>94</td>
</tr>
<tr>
<td>5</td>
<td>Comparison of different SPME fibers (PDMS, PDMS/DVB and DVB/CAR/PDMS) after extraction for 10 min at 30°C and separated using Supelco Wax-10 (10 m x 0.1 mm i.d., 0.1µm film thickness)</td>
<td>105</td>
</tr>
<tr>
<td>6</td>
<td>Effect of extraction time at 30°C on the extraction efficiency of flavour compounds using DVB/CAR/PDMS fiber</td>
<td>107</td>
</tr>
<tr>
<td>7</td>
<td>Bi-plots of principal components 1 and 2 of the volatile compounds of five jackfruit cultivars</td>
<td>111</td>
</tr>
<tr>
<td>8</td>
<td>Bi-plots of principal components 1 and 3 of the volatile compounds of five jackfruit cultivars</td>
<td>114</td>
</tr>
<tr>
<td>9</td>
<td>Response surface plot for the effect of independent variables on the sensory quality (a) fruity flavour, (b) cooked flavour, (c) sourness and (d) bitterness of processed jackfruit puree as significantly affected (at p &lt; 0.05) by the canning conditions</td>
<td>135</td>
</tr>
<tr>
<td>10</td>
<td>Response surface plot of (a) hue, (b) chroma and (c) viscosity of the processed jackfruit puree as significantly affected (at p &lt; 0.05) by the canning conditions</td>
<td>140</td>
</tr>
<tr>
<td>11</td>
<td>Behaviour of processed jackfruit puree as a solid</td>
<td>141</td>
</tr>
<tr>
<td>12</td>
<td>Superimposed contour plots for optimization of significant response variables of fruity flavour, cooked flavour, sourness, bitterness, hue,</td>
<td>144</td>
</tr>
</tbody>
</table>
chroma and viscosity

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>B-1</td>
<td>Sensory evaluation forms for discrimination test during screening of respondents. Similar forms were</td>
<td>183</td>
</tr>
<tr>
<td></td>
<td>generated for sweetness, saltiness, bitterness and astringency</td>
<td></td>
</tr>
<tr>
<td>B-2</td>
<td>Odour description test form for screening of respondents</td>
<td>184</td>
</tr>
<tr>
<td>B-3</td>
<td>Texture description test form for screening of panelist</td>
<td>185</td>
</tr>
<tr>
<td>B-4</td>
<td>Terms of attributes provided to panelist during round table training sessions</td>
<td>186</td>
</tr>
<tr>
<td>B-5</td>
<td>Sensory evaluation forms for panelist during sample assessments</td>
<td>188</td>
</tr>
</tbody>
</table>
LIST OF ABBREVIATIONS

% percent
\degree C degree centigrade
\degree F degree Fahrenheit
\mu l microliter
\mu m micrometer
\textastemarrow a\textsuperscript{*} colorimetric a\textsuperscript{*}
ANOVA analysis of variance
\textastemarrow b\textsuperscript{*} colorimetric b\textsuperscript{*}
C carbon chain
CI chemical ionization
cm centimeter
CV coefficient of variation
FDHS Dynamic Headspace Sampling
DVB/CAR/PDMS divinylbenzene/carboxen/polydimethylsiloxane
EI electron ionization
eV electron voltage
FC Flash Chromatography
g gravity
G' storage modulus
G'' loss modulus
GC Gas Chromatography
<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>GC/FTIR</td>
<td>Gas Chromatography/Fourier transform infrared</td>
</tr>
<tr>
<td>GC/IR</td>
<td>Gas Chromatography / Infrared</td>
</tr>
<tr>
<td>GC/MS</td>
<td>Gas Chromatography / Mass Spectrometry</td>
</tr>
<tr>
<td>GC/O</td>
<td>Gas Chromatography / Olfactometry</td>
</tr>
<tr>
<td>GC-FID</td>
<td>Gas Chromatography – Flame Ionization Detector</td>
</tr>
<tr>
<td>GC-TOFMS</td>
<td>Gas Chromatography – Time of Flight Mass Spectrometry</td>
</tr>
<tr>
<td>GLC</td>
<td>Gas Liquid Chromatography</td>
</tr>
<tr>
<td>GLC/MS</td>
<td>Gas Liquid Chromatography / Mass Spectrometry</td>
</tr>
<tr>
<td>HRGC</td>
<td>Capillary Gas Chromatography</td>
</tr>
<tr>
<td>HRGC/MS</td>
<td>Capillary Gas Chromatography / Mass Spectrometry</td>
</tr>
<tr>
<td>hrs</td>
<td>hours</td>
</tr>
<tr>
<td>i.d.</td>
<td>internal diameter</td>
</tr>
<tr>
<td>kg</td>
<td>kilogram</td>
</tr>
<tr>
<td>L</td>
<td>liter</td>
</tr>
<tr>
<td>L*</td>
<td>lightness</td>
</tr>
<tr>
<td>LLE</td>
<td>Liquid-Liquid Extraction</td>
</tr>
<tr>
<td>m</td>
<td>meter</td>
</tr>
<tr>
<td>m/z</td>
<td>mass spectra</td>
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<td>min</td>
<td>minute</td>
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<td>min-l</td>
<td>per minute</td>
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<tr>
<td>ml</td>
<td>milliliter</td>
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<tr>
<td>mm</td>
<td>millimeter</td>
</tr>
<tr>
<td>mPa</td>
<td>mili Pascal</td>
</tr>
</tbody>
</table>
ND  not detected
PC  principal component
PDMS / DVB  polydimethylsiloxane / divinylbenzene
PDMS  polydimethylsiloxane
ppm  parts per million
PTR-MS  proton transfer reaction – mass spectrometry
QDA  quantitative descriptive analysis
rad/s  radius per second
RH  relative humidity
rpm  revolution per minute
RSM  response surface methodology
s  second
s-1  per second
SDE  Simultaneously Distillation Extraction
SDEV  Simultaneously Distillation-Extraction under Pressure
SPME  Solid Phase Microextraction
TLC  Thin Layer Chromatography
VHS  Vacuum Headspace Sampling
CHAPTER I

GENERAL INTRODUCTION

Jackfruit, a dicotyledonous compound fruit of the jacktree (*Artocarpus heterophyllus* L.), is grown in most tropical countries such as Sri Lanka, Burma, Malaysia, Indonesia and Brazil, but it is particularly abundant in India and Bangladesh. The complex fruit, which matures 4 to 5 months, turn yellowish green with a golden yellow flesh surrounded by yellow fibers. Jackfruit is consumed both as a vegetable in the unripe stage and also as a fruit when ripe. The popularity of jackfruit as a commercial fruit has been restricted to the growing regions. Generally, there is very little research available on jackfruit. The gross composition of jackfruit, its vitamin content (Bose, 1985; Ahmed et al., 1986; Bhattacherjee, 1986), water-soluble sugar (Wills et al., 1986; Selvaraj and Pal, 1989), starch (Bobbio et al., 1978; Hossain et al., 1990; Rahman et al., 1995; Rahman et al., 1999), free sugar and fatty acids (Chowdhury et al., 1997), and flavour volatiles (Swords et al., 1978; Rasmussen, 1983; Maia et al., 2004) have been documented.

Maturity indices for various horticultural crops have relied on different features of the commodity, such as duration of development, size, colour, firmness, etc., which provide an adequate estimation of maturity (Shewfelt, 1993). Mature jackfruit contains between 35-40% edible fleshes (Crane, 2002). However, it is not easy to determine the exact time when the fruit is ripe. Most fruits do not have characteristic aromas or flavours