
**UNIVERSITI PUTRA MALAYSIA**

***EXTRACTION AND CHARACTERIZATION OF CRUDE PECTIN FROM JACKFRUIT (Artocarpus Heterophyllus Lam.) AND CEMPEDAK (Artocarpus Integer Spreng.) FRUIT RIND***

**LEONG CHIA MING**

**FSTM 2016 25**

# EXTRACTION AND CHARACTERIZATION OF CRUDE PECTIN FROM JACKFRUIT (*Artocarpus Heterophyllus* Lam.) AND CEMPEDAK (*Artocarpus Integer* Spreng.) FRUIT RIND

**By**

**LEONG CHIA MING**

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

**July 2016**

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## DEDICATION

This thesis is dedicated to all my beloved family members, my partner and in memory of my dog who has given me continuous support and company all this while. Thank you.

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfillment of the requirement for the degree of Master of Science

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**LEONG CHIA MING**

**July 2016**

**Chairman : Noranizan Mohd Adzahan, PhD**
**Faculty : Food Science and Technology**

Jackfruit and cempedak are one of the largest tree-borne fruits and about half of it is the rind. Useful compound such as pectin can be obtained from the rinds of these fruits. Not only that this will reduce byproducts from fruit processing, but also will boost local pectin production industry and contributes to the economy growth. Therefore, the aims of this study were: (i) to determine the most desirable extractant to extract pectin from jackfruit and cempedak fruit rind; (ii) to optimize the extraction process and investigate the physicochemical and rheological properties of the extracted pectin. High methoxyl (HM) pectins with uronic acid content more than 65% were successfully extracted from jackfruit and cempedak fruit rinds using three different acids. Sulfuric acid was the best acid to extract pectin from jackfruit and cempedak rinds as it yielded high amount of pectin (18.6 ± 1.8% and 20.5 ± 0.1%, respectively) and the pectin solution produced has the highest brightness and less coloured (red and yellow). Following this, the pectin extraction process was optimized using Response Surface Methodology. The extraction parameters studied (pH, time, temperature) only showed significant effects on the yield of pectin from jackfruit and cempedak fruit rinds. The optimum parameter for extraction of pectin from jackfruit and cempedak fruit rinds was pH 2, 30 min, 90 $^{o}$C and pH 2, 60 min, 90 $^{o}$C, respectively. Using the optimum extraction parameter, the yield, uronic acid content and degree of esterification of jackfruit and cempedak fruit rind pectin were 19.84 ± 0.77% and 19.51 ± 0.35%, 70.67 ± 0.35% and 70.43 ± 1.80%, and 80.96 ± 0.11% and 69.98 ± 0.66%, respectively. The information of jackfruit and cempedak fruit rind pectin from this research made these rinds potential new sources of pectin. This could decrease the waste generated from processing of fruits and at the same time creates opportunity for manufacturer to expand their market as jackfruit and cempedak fruit rind pectin were different than existing commercial citrus peel pectin and its natural-occurring colour was superior for certain industry.

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

**PENGEKSTRAKAN DAN CIRI-CIRI PEKTIN MENTAH DARIPADA KULIT BUAH NANGKA (*Artocarpus Heterophyllus* Lam.) DAN CEMPEDAK (*Artocarpus Integer* Spreng.)**

Oleh

**LEONG CHIA MING**

**Julai 2016**

**Pengerusi : Noranizan Mohd Adzahan, PhD**
**Fakulti : Sains dan Teknologi Makanan**

Saiz buah nangka dan cempedak amat besar dan lebih kurang separuh daripada buah ini terdiri daripada kulitnya. Bahan yang berguna seperti pektin boleh diekstrak daripada kulit buah-buahan ini. Ini bukan sahaja dapat mengurangkan sisa buangan yang dihasilkan selepas memproses buah-buahan, tapi juga boleh memperkembangkan industri penghasilan pektin tempatan dan meningkatkan hasil dan pertumbuhan ekonomi negara. Tujuan penyelidikan ini adalah: (i) untuk mengenalpasti asid yang paling sesuai untuk mengekstrak pektin daripada kulit nangka dan cempedak; (ii) untuk mengoptimumkan proses pengekstrakan pektin dan mengkaji sifat fizikokimia dan reologi pektin yang diekstrak. Pektin bermetoksil tinggi dengan kandungan asid uronik melebihi 65% berjaya diekstrak daripada kulit buah nangka dan cempedak menggunakan tiga jenis asid yang berlainan. Asid sulfurik adalah asid yang paling sesuai dimana ia boleh mengekstrak 18.6 ± 1.8% pektin daripada kulit nangka dan 20.5 ± 0.1% pektin daripada kulit cempedak. Larutan pektin yang dihasilkan dengan pektin ini adalah yang paling cerah dan kurang berwarna (merah dan kuning). Proses pengekstrakan pektin telah dioptimumkan melalui kaedah Response Surface Methodology. Parameter pengekstrakan (pH, jangka masa, suhu) didapati hanya mempengaruhi kuantiti pektin yang diekstrak daripada kulit nangka dan cempedak. Parameter pengekstrakan optimum yang diperolehi bagi kulit buah nangka adalah pH 2, 30 min dan 90 $^{o}$C manakala untuk kulit buah cempedak adalah pH 2, 60 min dan 90 $^{o}$C. Hasil, kandungan asid uronik, dan darjah esterifikasi pektin daripada kulit buah nangka dan cempedak yang diekstrak menggunakan parameter pengekstrakan optimum adalah 19.84 ± 0.77% dan 19.51 ± 0.35%, 70.67 ± 0.35% dan 70.43 ± 1.80%, dan 80.96 ± 0.11% dan 69.98 ± 0.66%. Maklumat yang diperolehi daripada penyelidikan ini memberi ruang untuk pertimbangan kepada pengeluar pektin tempatan untuk menggunakan kulit buah nangka dan cempedak sebagai sumber baru untuk mendapatkan pektin. Ini akan mengurangkan sisa buangan yang dihasilkan daripada pemprosesan buah-buahan. Pada masa yang sama, pengeluar pektin tempatan boleh meluaskan pasaran mereka kerana pektin kulit buah nangka dan cempedak ini

berlainan daripada pektin komersial, iaitu pektin kulit buah sitrus. Di samping itu, warna semulajadi pektin kulit buah nangka dan cempedak adalah suatu kelebihan bagi sesetengah industri.

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Last but not least, my sincere appreciation goes to all my fellow labmates for their help, support, company, and brainstorming sessions when working together. To those who were not mentioned, their help is truly appreciated by heart.

I certify that a Thesis Examination Committee has met on 22 July 2016 to conduct the final examination of Leong Chia Ming on his thesis entitled "Extraction and Characterization of Crude Pectin from Jackfruit (*Artocarpus heterophyllus* Lam.) and Cempedak (*Artocarpus integer* Spreng.) Fruit Rind" in accordance with the Universities and University Colleges Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U.(A) 106] 15 March 1998. The Committee recommends that the student be awarded the Master of Science.

Members of the Thesis Examination Committee were as follows:

**Tan Chin Ping, PhD**
Professor
Faculty of Food Science and Technology
Universiti Putra Malaysia
(Chairman)

**Seyed Hamed Mirhosseini, PhD**
Associate Professor
Faculty of Food Science and Technology
Universiti Putra Malaysia
(Internal Examiner)

**Maaruf Abd. Ghani, PhD**
Associate Professor
National University of Malaysia
Malaysia
(External Examiner)

**NOR AINI AB. SHUKOR, PhD**
Professor and Deputy Dean
School of Graduate Studies
Universiti Putra Malaysia

Date: 3 November 2016

This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfillment of the requirement for the degree of Master of Science. The members of the Supervisory Committee were as follows:

**Noranizan binti Mohd Adzahan, PhD**
Associate Professor
Faculty of Food Science and Technology
Universiti Putra Malaysia
(Chairman)

**Sharifah Kharidah Syed Muhammad, PhD**
Associate Professor
Faculty of Food Science and Technology
Universiti Putra Malaysia
(Member)

**Choo Wee Sim, PhD**
Senior Lecturer
School of Science
Monash University Malaysia
(Member)

**BUJANG KIM HUAT, PhD**
Professor and Dean
School of Graduate Studies
Universiti Putra Malaysia

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This is to confirm that:

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Signature : _____
Name of Chairman of Supervisory Committee : Assoc. Prof. Dr.Noranizan binti MohdAdzahan,

Signature : _____
Name of Member of Supervisory Committee : Assoc. Prof. Dr.Sharifah Kharidah Syed Muhammad

Signature : _____
Name of Member of Supervisory Committee : Dr. Choo Wee Sim

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## LIST OF ABBREVIATIONS

| | |
|---|---|
| AIS | Alcohol insoluble solids |
| ANOVA | Analysis of variance |
| CRP | Cempedak fruit rind crude pectin |
| $R^2$ | Coefficient of determination |
| DA | Degree of acetylation |
| DE | Degree of esterification |
| DM | Degree of methylation |
| C=O | Ester carbonyl groups |
| EU | European Union |
| FAO | Food and Agriculture Organization |
| FCC | Food Chemical Codex |
| FT-IR | Fourier transform infrared |
| HM | High methoxyl |
| O-H | Hydroxyl group |
| JRP | Jackfruit rind crude pectin |
| G″ | Loss modulus |
| LM | Low methoxyl |
| LMA | Low methoxyl amidated |
| RSM | Response surface methodology |
| NaOH | Sodium hydroxide |
| G′ | Storage modulus |
| $H_2SO_4$ | Sulfuric acid |
| TPU | Universiti Putra Malaysia's Agriculture Park |

# CHAPTER 1

## INTRODUCTION

Pectin is a nutritious component in human diet. Besides that, it has the ability to form a continuous three-dimensional network of cross-linked polymers which is a condition known as gel (Lotzkar *et al.,* 1946) and this made pectin an important ingredient in foods, beverages, pharmaceutical and a number of other industries.

Pectin can be obtained from most of the plant cell wall but one that suit commercial manufacturing industry is very limited. This is because pectin from different source has different characteristics in which some of them may suit in certain industry while others do not. Most common sources of pectin are from apple pomace and citrus fruit peel. Besides apple pomace and citrus fruit peel, other sources of pectin that have been investigated were such as sugar beet pulp (Renard and Thibault, 1993), sunflower seed head (Miyamoto and Chang, 1992), cocoa husk (Mollea *et al.*, 2008), passion fruit rind (Yapo and Koffi, 2006) and others. Some of them showed potential as good source of pectin but some do not due to their poor gelling ability or unfavourable processing conditions for pectin extraction.

Jackfruit (*Artocarpus heterophyllus* Lam.) and cempedak (*Artocarpus integer* Spreng.) are fruits that are available in Malaysia. The parts of jackfruit and cempedak trees and their fruits can be used as sources of food, as timbers for furniture, as feeds for livestock and others. According to statistics from Ministry of Agriculture and Agro-based Industry Malaysia, the amount of jackfruit and cempedak produced in 2014 were 33,788 tonnes and 35,563 tonnes, respectively. Given that 40-60% of these fruits were the rind (Chadha, 1985), the amount of jackfruit and cempedak fruit rinds produced in 2014 were approximately 13,515 tonnes and 14,225 tonnes, respectively. These rinds were only used as feed for cows and goats. The remaining rinds were normally disposed, which would be a challenge for the environment.

Despite being one of the largest tree-borne fruits in the world, jackfruit and cempedak have never been extensively studied before for its rind's pectin content. Up to the author's knowledge, there are only two studies on pectin from jackfruit rind and none regarding pectin from cempedak fruit rind. Among the two studies on jackfruit rind pectin, one of them screened and characterized pectins from various fruit wastes which include jackfruit waste while another study investigated the effect of different extractants on the characteristics of pectin obtained from jackfruit waste.

Common sources of pectin such as apple pomace and citrus fruit peel are fruits that are unsuitable to be planted in Malaysia in a commercial scale. It was shown that jackfruit rind contained high amount of pectin. Cempedak, which has similar percentage of rind per fruit as jackfruit, should have similar amount of pectin as in jackfruit rind. As jackfruit and cempedak are fruits of different species, it was expected that the extracted

pectins from both rinds have different characteristics. This research is important in investigating new sources of pectin that are locally available. In addition, the physicochemical and rheological properties of pectins extracted from jackfruit and cempedak fruit rinds have never been reported before. Therefore, the objectives of this study are:

1. To determine the effects of citric, nitric and sulfuric acids on the yield and properties of pectins extracted from jackfruit and cempedak fruit rinds.
2. To investigate the effects of pH, time and temperature on the yield, uronic acid content and degree of esterification of pectin from jackfruit and cempedak fruit rinds and determine the physicochemical and rheological properties of the pectins extracted using optimum condition.

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## BIODATA OF STUDENT

The student of this thesis, Leong Chia Ming, is a Malaysian born in Kuala Lumpur on the 14th December 1986. He completed his Bachelor (Hons.) in Food Science and Nutrition at UCSI University late 2009. The author then enrolled for a Master in Science programme in Faculty of Food Science and Technology, Universiti Putra Malaysia on September 2011. Prior to this, the author worked as a chemist in a private contract manufacturing plant for 2 years.

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