



**UNIVERSITI PUTRA MALAYSIA**

***PECTIN CHARACTERIZATION AND FACTORS AFFECTING PECTIN  
EXTRACTION FROM *Citrus grandis* L. OSBECK (PUMMELO) PEELS***

***NOOR JANNAH FIRDOUSE BINTI ISMAIL @ KHORI***

**FSTM 2015 14**



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By

**NOOR JANNAH FIRDOUSE BINTI ISMAIL @ KHORI**

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

**April 2015**

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This is a gift...

**DEDICATED TO...**

Me;  
for being persistent  
and  
for not giving up

Mohd. Syahril Baharuddin, dear husband  
for being there  
as my pillar

Mom and Dad;  
My sis;  
My bro;  
your love and trust  
strengthen me  
to the end of this chapter

My son;  
a bless  
a happiness.

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

**PECTIN CHARACTERIZATION AND FACTORS AFFECTING PECTIN EXTRACTION FROM *Citrus grandis* L. OSBECK (PUMMELO) PEELS**

By

**NOOR JANNAH FIRDOUSE BINTI ISMAIL**

**April 2015**

**Chairman : Associate Professor Badlishah Sham bin Baharin**  
**Faculty : Food Science and Technology**

Microwave-assisted extraction (MAE) and ultrasound-assisted extraction (UAE) have been developed to increase the yield and quality of various plant-based constituents with shorter time of extraction. This research aimed to study the effect of four (4) factors towards the quantity and quality of pectin extracted from pummelo peels, using two (2) level factorial designs, utilizing UAE, MAE and water bath extraction (WBE) methods. Factors manipulated were time, pH, sample-to-solvent ratio and temperature. MAE, UAE and conventional methods were able to extract pectin up to 78.98 % in a minute, 38.7% in 10 minutes and 68.26% in 30 minutes, respectively. Pectin from MAE method significantly has the highest DE ( $60.41 \pm 0.37$ ) followed by WBE method ( $55.99 \pm 1.22$ ) and UAE method ( $54.64 \pm 0.503$ ). The galacturonic acid (GalA) content of pectin extracted using MAE was significantly the highest ( $82.71\% \pm 1.77$ ) compared to UAE and WBE methods ( $67.37 \pm 1.88$  and  $55.99 \pm 1.22$  respectively). This study showed that pummelo peels of Ledang variety contained high methoxyl pectin (DE > 50%) with GalA content of more than 65%. MAE was the most efficient method to produce high methoxyl pectin with high content of GalA.

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

**PENCIRIAN PEKTIN DAN FAKTOR-FAKTOR YANG MEMPENGARUHI  
PENGEKSTRAKAN PEKTIN DARIPADA KULIT *Citrus grandis* L.  
OSBECK (LIMAU BALI).**

Oleh

**NOOR JANNAH FIRDOUSE BINTI ISMAIL**

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**Pengerusi : Profesor Madya Badlishah Sham bin Baharin**  
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Pengekstrakan berbantu gelombang mikro (MAE) dan berbantu ultra-bunyi (UAE) telah dibangunkan untuk meningkatkan kuantiti dan kualiti pelbagai bahan berasaskan tumbuh-tumbuhan melalui pengekstrakan yang lebih pantas. Kajian ini mengkaji kesan empat (4) faktor terhadap kuantiti dan kualiti pektin yang diekstrak daripada kulit limau bali, menggunakan reka bentuk faktorial 2 aras menggunakan kaedah pengekstrakan UAE, MAE dan rendaman air (WBE). Faktor-faktor yang dikaji adalah masa, pH, nisbah sampel terhadap pelarut serta suhu. MAE, UAE dan WBE masing-masing telah berjaya mengekstrak sehingga 78.98% pektin dalam satu (1) minit, 38.7% dalam 10 minit dan 68.26% dalam 30 minit. Secara signifikannya, pektin yang diekstrak melalui kaedah MAE mempunyai DE yang paling tinggi ( $60.41 \pm 0.37$ ), diikuti dengan WBE ( $55.99 \pm 1.22$ ) dan kaedah UAE ( $54.64 \pm 0.503$ ). Kandungan asid galakturonik (GalA) bagi pektin yang diekstrak menggunakan kaedah MAE adalah yang paling tinggi ( $82.72\% \pm 1.77$ ) secara signifikan berbanding kaedah UAE dan WBE ( $67.37 \pm 1.88$ ,  $55.99 \pm 1.22$ ). Kajian ini telah membuktikan bahawa kulit limau bali variasi Ledang mengandungi pektin tinggi kandungan metoksil ( $DE > 50\%$ ), dengan kandungan asid galakturonik (GalA) melebihi 65%. MAE terbukti sebagai kaedah yang paling efisien untuk menghasilkan pektin tinggi metoksil dengan kandungan GalA yang tinggi.

## ACKNOWLEDGEMENTS

My sincere gratitude to the chairman of the supervisory committee, Assoc. Prof. Badlishah Sham bin Baharin, for his guidance, kindness and understanding that have helped me through this research. I also wish to thank the members of the supervisory committee, Prof. Dr. Russly bin Abd. Rahman and Dr. Norhayati binti Husain for their advices and supervisions.

Special thanks to my dear friends Siti Suhara binti Ramli and Nor Nadiah binti Abdul Karim Shah, who have been of much help and encouragements throughout my time of completing this study.



I certify that a Thesis Examination Committee has met on April 2015 to conduct the final examination of Noor Jannah Firdouse binti Ismail on her thesis entitled “Pectin characterization and factors affecting pectin extraction from *citrus grandis* L. Osbeck (pummelo) peels” in accordance with the Universities and University Colleges Act 1971 and the constitution of the Universiti Pertanian Malaysia [P.U.(A) 106] 15 March 1998. The Committee recommends that the student be awarded the degree of Master of Food Technology.

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## LIST OF ABBREVIATIONS

GalA	Galacturonic acid
MAE	Microwave Assisted Extraction
UAE	Ultrasound Assisted Extraction
WBE	Water Bath Extraction
FAO	Food and Agriculture Organisation
EU	Europe United
DE	Degree of Esterification
HMP	High Methoxyl Pectin
LMP	Low Methoxyl Pectin
MHz	Mega Hertz
GHz	Giga Hertz
°C	Degree Celcius
EtOH	Ethanol / Ethyl Alcohol
HCl	Hydrochloric acid
%	Percentage
WBE	Water Bath Extraction
t	Time
T	Temperature
SR	Sample-to-solvent Ratio
P	Microwave Power
w/v	Weight per volume
Y	Yield of pectin
ml	Millimeter
kHz	KiloHertz
rpm	Revolution per minutes
FCC	Food Chemical Codex
NaOH	Sodium Hydroxide
M	Molarity
min	Minute (s)
μl	Microlitre
nm	Nanometer
H <sub>2</sub> SO <sub>4</sub>	Sulphuric Acid

## CHAPTER I

### INTRODUCTION

Pectin is a complex polysaccharide found numerously in plants such as apple pomace and citrus fruits (Bemiller, 1986; Fishman, Chau, Hoagland, & Ayyad, 2000; Kulkarni & Vijayanand, 2010). Pectin is considered as a nutritionally rich diet (Voragen, 1995; Yamada, 1996), and used as a thickener, texturizer, emulsifier and stabilizer (Liu, Shi, & Langrish, 2006).

*Citrus grandis* or *Citrus maxima* belongs to citrus family and its local name is pomelo or pummelo which is native to Southeast Asia, mainly in Indonesia, and Thailand and also in China (Orwa et al., 2009). In Malaysia, pummelo is known as 'Limau Bali' (Balinese Lemon). Pummelo in Malaysia is cultivated to fulfill the demand during festive seasons. Its potential has not been harnessed to its maximum. As the largest citrus fruit, pummelo contributes large amount of by-products in the form of peels and pulp. The juicy pulp is either eaten raw or pressed to extract its juice, while the peel is a potential resource of pectin to be used in numerous industries such as food and beverages, cosmetics and pharmaceutical (Emaga et al., 2008; Liu et al., 2006; Pagan, Ibarz & Llorca, 2001)

Pectin production commonly involved hydrolyzing the organic material using mineral acid along with high temperature, separation of pectin from slurry and pectin purification or precipitation (Migliori et al., 2011). Industrial pectin extraction usually utilizes high temperature (60-100°C) in acidified water, and took long hours to complete (Sharma et al., 2006). This research aimed to reduce the extraction time and to overcome the labour cost during pectin extraction. Since pummelo is locally cultivated and also included as one of an important cultivar in Malaysia, extracting pectin from pummelo peels will help to maximize the usage of its waste.

While study of pectin extraction was not new to the food industry, but the study of pectin extraction from pummelo of Malaysian varieties were still limited. Therefore, the objectives of this study were:

- i. To determine factors that affect pectin extraction using ultrasound, microwave and water bath extraction methods.
- ii. To characterize pectin extracted from pummelo peel using the ultrasound-assisted, microwave-assisted and water bath extraction methods.

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