EXTRACTION AND CHARACTERIZATION OF LOW METHOXYL PECTIN FROM DURIAN RIND

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DEDICATION

This thesis is dedicated to my Lord and Saviour, Jesus Christ.
For from Him and through Him and to Him are all things.
May all the glory be to God.

I dedicate this thesis to my beloved parents,
who have been my greatest support.

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ABSTRACT

Durian is a tropical fruit in Southeast Asia. Durian rind, comprising 65-70% of durian total weight, may serve as a potential source of pectin, a gelling agent commonly used in the food and pharmaceutical industries. This study aims to optimize the pectin extraction from durian rinds and characterize its physicochemical and rheological properties. The factors affecting pectin extraction: durian rind parts and varieties, acid type and concentration, temperature, duration, and solid-to-liquid ratio (S:L) were screened and optimized based on yield, esterification degree (DE), and purity (AUA). Pectin was characterized by intrinsic viscosity, molecular weight, structural, thermal, morphological, and rheological analysis. The durian rind's white part has higher pectin yield than the rind with thorns, while variety D168 has lower yield than other varieties. The parts and varieties did not significantly affect DE and AUA. Pectin yield and DE deteriorated at higher acid concentrations (0.1, 1.0 M). Mineral acids (hydrochloric, sulphuric, and nitric acids) were more effective in extracting pectin of higher purity (AUA > 65%). Organic acids-extracted pectins (citric, acetic, and tartaric acids) had AUA < 65%, indicating poor purity. 0.001M sulphuric acid was selected for extraction optimization due to its good yield (9.13%) and purity (AUA = 66.72%) of low-methoxyl pectin (LMP) (DE = 20.11%). According to response surface methodology, temperature was the most significant variable affecting yield and purity. DE was not pronouncedly affected by temperature (75 – 95 ℃), time (30 – 270 minutes), and S:L (1:20 – 1:60 g/mL). The optimal extraction conditions (93.3 ℃, S:L 1:50, 185 minutes) yielded 12.12% pectin with AUA = 77.01%, DE = 18.99%, intrinsic viscosity = 148.74 mL/g, and molecular weight = 42.12 kDa. The strongest gel was obtained with 3% (w/v) pectin at pH 3, showing better gel strength than commercial LMP. The gel showed good thermal stability throughout heating and cooling. Therefore, durian rind is a potential LMP source, which could be a gelling and thickening agent for weak-acid-low-calorie food and pharmaceutical applications. Future studies could be done to explore durian rind pectin’s applications in the pharmaceutical and food industries.

ABSTRAK

Durian ialah buah tropika di Asia Tenggara. Kulit durian, terdiri daripada 65 – 70% berat buah durian, berpotensi menjadi sumber pektin, agen pembentuk gel yang biasa dipakai dalam industri makanan dan farmaseutikal. Objektif kajian ini adalah untuk mengoptimumkan pengekstrakan pektin daripada kulit durian dan mencirikan sifat fizikokimia dan reologinya. Faktor-faktor yang menpengaruhi pengekstrakan pektin: bahagian dan varieti kulit durian, jenis dan kepekatan asid, suhu, tempoh dan nisbah pepejal kepada cecair (S:L) telah disaring dan dioptimumkan berdasarkan hasil, darjah pengesteran (DE) dan ketulenan (AUA) pektin. Analisis pektin yang dilakukan adalah termasuk analisis kelikatan intrinsik dan berat molekul, struktur, terma, morfologi dan reologi. Bahagian putih kulit durian mempunyai hasil pektin yang lebih tinggi daripada kulit berduri, manakala varieti D168 mempunyai hasil yang lebih rendah berbanding varieti lain. Bahagian dan varieti tidak mempengaruhi DE dan AUA dengan ketara. Dapatan kajian juga menunjukkan hasil dan DE pektin menurun pada kepekatan asid yang lebih tinggi (0.1, 1.0M). Selain itu, asid mineral (asid hidroklorik, sulfurik dan nitrik) lebih berkesan dalam mengekstrak pektin dengan ketulenan yang lebih tinggi (AUA > 65%). Pektin yang diekstrak oleh asid organik (asid sitrik, asetik dan tartarik) mempunyai AUA < 65%, ini menunjukkan ketulenan yang rendah. Asid sulfurik 0.001M telah dipilih untuk proses pengoptimuman pengekstrakan disebabkan oleh perolehan hasil (9.13%) dan ketulenan (AUA = 66.72%) pektin metoksil rendah (LMP) (DE = 20.11%) yang baik. Menurut kaedah permukaan tindak balas, suhu adalah faktor yang paling ketara dalam mempengaruhi hasil dan ketulenan pektin. DE tidak menunjukkan perubahan yang ketara pada suhu (75 – 95 °C), masa (30 – 270 minit) dan S:L (1:20 – 1:60 g/mL). Keadaan pengekstrakan optimum (93.3 °C, S:L 1:50, 185 minit) memperolehi 12.12% pektin dengan AUA = 77.01%, DE = 18.99%, kelikatan intrinsik = 148.74 mL/g dan berat molekul = 42.12 kDa. Gel yang paling teguh telah diperolehi pada 3% (w/v) pektin dan pH 3 dan gel tersebut mempunyai keteguhan yang lebih baik daripada LMP komersial. Gel ini juga menunjukkan kestabilan haba yang

baik sepanjang pemanasan dan penyejukan berterusan. Oleh itu, kulit durian merupakan sumber LMP yang berpotensi dan boleh dipakai sebagai agen pembentuk gel dan pemekat produk makanan dan farmaseutik yang berciri asid lemah-rendah kalori. Kajian masa depan boleh dilakukan untuk meneroka aplikasi pektin kulit durian dalam industri farmaseutikal dan makanan.

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%	-	Percentage
℃	-	Celsius
AA	-	Acetic acid
ADI	-	Acceptance daily intake
AGA	-	Apiogalacturonan
AIR	-	Alcohol insoluble reside
ANOVA	-	Analysis of variance
AUA	-	Anhydrouronic acid
CA	-	Citric acid
Ca^{2+}	-	Calcium ion
CAGR	-	Compound annual growth rate
CCRD	-	Central composite rotatable design
CeDS	-	Centre for Diploma Studies
CLMP	-	Commerical low methoxyl pectin
D	-	Desirability function
DE	-	Degree of esterification
DOA	-	Department of Agriculture of Malaysia
DP	-	Durian rind pectin
DTG_{max}	-	Maximum decomposition rate temperature
EtOH	-	Ethanol
FAST	-	Faculty of Applied Sciences and Technology
FCC	-	Food Chemical Codex 1996
FT-IR	-	Fourier Transform Infrared spectroscopy
FTK	-	Faculty of Engineering Technology
g	-	gram
G’	-	Storage modulus
G”	-	Loss modulus

GalA	-	Galacturonic acid
GRAS	-	Generally recognized as safe
GTMP	-	Green Technology Master Plan
H_2SO_4	-	Sulphuric acid
H_3PO_4	-	Phosphoric acid
HCl	-	Hydrochloric acid
HG	-	Homogalacturonan
HMP	-	High methoxyl pectin
HNO_3	-	Nitric acid
INS	-	International Numbering System
IV	-	Intrinsic viscosity
LA	-	Lactic acid
LMP	-	Low methoxyl pectin
LVR	-	Linear viscoelastic region
M	-	Molarity
mg	-	milligram
MHDP	-	Metahydroxyldiphenyl
min	-	Minutes
Mt	-	Metric tonnes
MW	-	Molecular weight
N	-	Normality
NaOH	-	Sodium hydroxide
pKa	-	Acid dissociation constant
rad/s	-	Radian per second
RM	-	Ringgit Malaysia
RGI	-	Rhamnogalacturonan I
RGII	-	Rhamnogalacturonan II
Rha	-	Rhamnose
RSM	-	Response surface methodology
s^{-1}	-	Per second
S:L	-	Solid to liquid ratio
SEM	-	Scanning electron microscopy
$T_{50\%}$	-	Temperature at which 50% mass loss

TA	-	Tartaric acid
TGA	-	Thermogravimetric analysis
USD	-	United States Dollar
UTHM	-	Universiti Tun Hussein Onn Malaysia
VMW	-	Viscosity-average molecular weight
w/w	-	Weight/weight
w/v	-	Weight/volume
XGA	-	Xylogalacturonan

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