UNIVERSITI PUTRA MALAYSIA

MICROWAVE VACUUM DRYING CHARACTERISTICS OF NONI FRUITS (*MORINDA CITRIFOLIA* L.) AND THEIR EFFECTS ON *SCOPOLETIN* CONTENT

MINA HABIBI ASR

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By

MINA HABIBI ASR

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

May 2009

In the Name of Allah
The Most Compassionate
The Most Merciful

To My Parents For their love and support

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

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Chairman: Associate Professor Mohd Nordin Ibrahim, PhD

Faculty: Engineering

The main objective of this study was to investigate microwave-vacuum drying characteristics of *Morinda citrifolia* fruit slices and drying effects on *Scopoletin* content. A laboratory microwave-vacuum dryer was designed and fabricated and preliminary tests were conducted to ensure that its operation is satisfactory. *M.citrifolia* fruit slices were dried under different drying techniques such as: microwave-vacuum drying, microwave drying (without applying vacuum) and sun drying. Microwave-vacuum drying of *M.citrifolia* fruit slices were carried out at three levels of microwave power; 180, 300 and 450W and four levels of absolute pressure; 91 kPa, 86 kPa, 71 kPa and 41 kPa, whilst, microwave drying was conducted at atmospheric pressure (101 kPa). Drying was performed in two microwave application namely pulsed and continuous. In pulsed microwave drying mode, the magnetron was alternatively switched on and off in order

to achieve desired pulsing ratio. The magnetron was switched on for 30 s and switched off for 150 s, corresponding to selected pulsing ratio of 6.

M.citrifolia fruit slices having initial moisture content of about 5-6 g water/ g dry matter were dried to final moisture content of approximately 0.5 g water/ g dry matter within 10 to 252 min depending on microwave power, vacuum condition and microwave heating mode. For continuous microwave heating mode, the drying time was within 5 to 45 min, while for pulsed microwave heating mode it was within 33 to 198 min. Higher microwave power level and lower pressure increased the drying rate. The result shows that even though pulsed microwave heating mode was more time consuming overall, but total power-on time was about the same as continuous microwave heating mode; however, in pulsed microwave heating mode drying took place at lower product temperature. Page equation was most satisfactory to describe thin-layer drying characteristic of *M.citrifolia* fruit slices among the three tested thin-layer drying equations, with lower reduced chi-square X^2 and RMSE and higher value for R^2.

Scopoletin was extracted from fresh and dried sample by solvent method using methanol and spectrofluorometric method was used for its determination. The *Scopoletin* content retention of *M. citrifolia* fruit slices dried under different drying techniques was evaluated and was found to be within 5 to 53%. In pulsed microwave heating mode, drying at atmospheric pressure resulted in higher *Scopoletin* content reduction with microwave power set at 450 W power level (20%); however, in continuous microwave heating mode at the atmospheric pressure, the lowest microwave power of 180W resulted in higher *Scopoletin* content reduction (51%). The reason for this, is due to longer drying time required at lower microwave power level, and higher temperature achieved due to longer power-on time during continuous microwave heating mode compared to pulsed microwave heating mode.

Abstrak tesis untuk diserahkan kepada Senat Universiti Putra Malaysia dalam memenuhi keperluan yang diperlukan untuk lulus ijazah Master Sains

SIFAT PENGERINGAN GELOMBANG MIKRO KE ATAS BUAH NONI(*MORINDA CITRIFOLIA*) DAN KESAN PENGERINGAN TERHADAP KANDUNGAN *SCOPOLETIN*

Oleh

MINA HABIBI ASR

Mei 2009

Pengerusi: Professor Madya Mohd Nordin Ibrahim, PhD

Faculty: Kejuruteraan

Objektif utama kajian ini adalah untuk mengkaji ciri-ciri pengeringan gelombang mikro ke atas potongan buah Morinda citrifolia dan kesan pengeringan terhadap kandungan *Scopoletin*. Berdascruan objektif ini, pengeringan gelombang mikro vakum dalam makmal telah direka dan dibina serta ujian percubaan telah dijalankan. Potongan buah *M.citrifolia* telah dikeringkan dibawah beberapa kaedah pengeringan seperti pengeringan gelombang mikro vakum, pengeringan gelombang mikro sahaja (tanpa penggunaan vakum) dan pengeringan di bawah cahaya matahari. Pengeringan potongan buah *M.citrifolia* telah dijalankan di bawah tiga peringkat kuasa gelombang mikro iaitu 180W, 300W dan 450W serta 4 91 kPa, 85 kPa, 71 kPa dan 41 kPa gelombary mikro icendalian pada tekanan atmosfer (101 kPa). Pengeringan turut melibatkan dua mod dinamakan secara denyutan dan secara berterusan. Dalam mod denyutan, suis magnetron secara alternatif telah dihidupkan dan dimatikan berturutan dalam proses mendapatkan

ratio denyutan gelombang yang dikehendaki. Magnetron dihidupkan selama 30 saat dan dimatikan selama 150 saat, berkadaran pada ratio denyutan sebanyak 6.

Potongan buah M.citrifolia mempunyai kandungan lembapan sekitar 5-6 g air/ g berat kering dikeringkan kepada kandungan lembapan terakhir sebanyak 0.5 g air/g berat kering dalam 33-252 bergantung kepada kuasa gelombang mikro, tekanan vakum dan mod pengeringan. Pada peringkat kuasa gelombang mikro yang lebih tinggi dan tekanan vakum yang rendah, kadar pengeringan didapati telah meningkat. Jumlah tempoh pengeringan melalui mod pengeringan berterusan didapati kurang berbanding pengeringan mod denyutan tetapi jumlah tenaga yang digunakan tidak banyak berbeza bagi kedua-dua mod. Keputusan ini menunjukkan bahawa mod denyutan walaupun secara keseluruhan memakan masa tetapi jumlah penggunaan tenaga adalah sama seperti mod berterusan. Walau bagaimana pun pengeringan dilakukan pada suhu produk yang lebih rendah.

Pengiraan adalah amat memuaskan untuk mengambarkan cirri-ciri lapisan nipis potongan buah M.citrifolia di antara 3 pengiraan ujian lapisan nipis dengan chi square (X^2) rendah yang telah dikurangkan dan RMSE serta nilai R^2 yang lebih tinggi.

Scopoletin telah diestrak dengan metanol dan kaedah Spektroflorometrik telah digunakan untuk pengesahan. Pengekalan *Scopoletin* dalam potongan buah *M.citrifolia* yang telah dikeringkan di bawah beberapa kaedah pengeringan dinilai. Dalam pengeringan mod denyutan, pada tekanan atmosfera menunjukkan jumlah pengurangan *Scopoletin* yang paling tinggi dengan kuasa gelombang mikro pada 450W berbanding pengeringan mod berterusan pada kuasa gelombang mikro paling rendah iaitu 180W menunjukkan jumlah pengurangan kandungan *Scopoletin* yang paling tinggi. Ini disebabkan oleh jumlah masa yang lebih panjang untuk pengeringan berlaku pada peringkat kuasa gelombang mikro yang lebih rendah dalam mod berterusan sementara suhu adalah lebih tinggi berbanding kepada pengeringan mod denyutan disebabkan jumlah masa tenaga yang lebih lama.

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I certify that an Examination Committee has met on 22th May 2009 to conduct the final examination of Mina Habibi Asr on her Master of Science thesis entitled 'Microwave-Vacuum Drying Characteristic of Morinda Citrifolia Fruits and Drying Effects on Scopoletin Content' in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulations 1981. The Committee recommends that the student be awarded the relevant degree. Members of Examinations Committee were as follows:

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

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Date: 9 July 2009

DECLARATION

I decelerate that the thesis is my original work except for quotations and citations which have been duly acknowledged. I also declare that is has not been previously, and is not concurrently, submitted for any other degree at University Putra Malaysia or at any other institution.

(Signature)____________

Mina Habibi Asr
Date

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