



UNIVERSITI PUTRA MALAYSIA

**OPTIMIZATION OF SPRAY DRYING PROCESS AND STORAGE  
STABILITY OF PITAYA, *Hylocereus polyrhizus* (WEBER)  
BRITTON & ROSE PEEL POWDER**

EE SHU CHEE

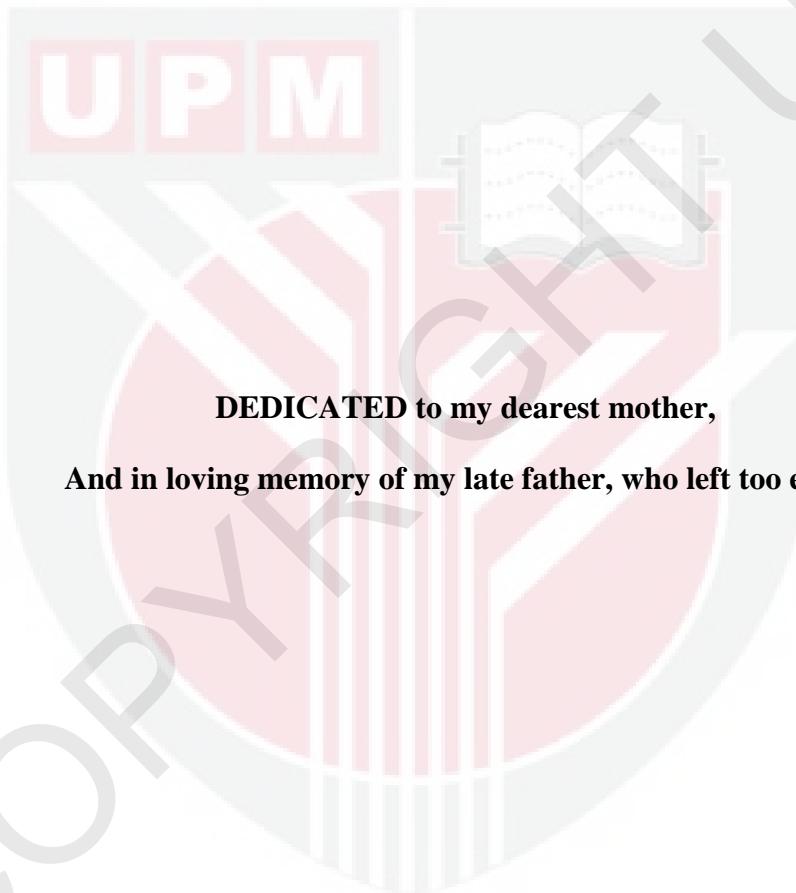
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ROSE PEEL POWDER**



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

**June 2011**



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

**OPTIMIZATION OF SPRAY DRYING PROCESS AND STORAGE  
STABILITY OF PITAYA, *Hylocereus polyrhizus* (WEBER) BRITTON &  
ROSE PEEL POWDER**

By

**EE SHU CHEE**

**June 2011**

**Chairman : Prof. Jamilah Bt. Bakar, PhD**

**Faculty : Food Science and Technology**

Pitaya peel (*Hylocereus polyrhizus*), which consists approximately 22% of the whole fruit weight, is discarded during juice processing. Physico-chemical properties of the discarded pitaya peel were determined in order to evaluate its potential for recovery of any value-added materials. The moisture content of the peel was approximately 92.7% and it was low in total soluble solids, protein, ash and fat content. Betacyanin pigment ( $150.46 \pm 2.19$  mg/100 g) and pectin (10.8%) were high in the peel. Glucose, maltose and fructose were detected in the peel but not sucrose and galactose. The peel also had very high insoluble and soluble dietary fibre which had exhibited a good ratio of insoluble dietary fibre to soluble dietary fibre (3.8: 1.0). Therefore, it would be an economic advantage to the food industry if pitaya peel

could be reutilized instead of being discarded. In our study, pitaya peel was converted into spray dried powder since it was a good source of fibre, pectin and natural colorant. Optimization of the spray dried conditions was carried out using response surface methodology (RSM). A central composite design (CCD) was employed to study the effect of inlet air temperature (155-175 °C), outlet air temperature (75-85 °C) and maltodextrin DE10 concentration (8-22% w/w) on the pitaya peel powder. The powders were analyzed for betacyanin retention, color, moisture, water activity, hygroscopicity and solubility. Spray dried pitaya peel powders were pink in color, high in betacyanin pigment retention, low in moisture content and had a water activity of 0.233-0.380. The significant ( $p < 0.05$ ) response surface models with high coefficients of determination values ( $R^2 > 0.85$ ), ranged from 0.896 to 0.979 were fitted for the experimental data, thus indicating a satisfactory adjustment of the reduced response models for predicting the characteristic of pitaya peel powder as a function of spray dryer conditions. The result also indicated that linear term of maltodextrin concentration was found to be the most significant ( $p < 0.05$ ) variable influencing the powder characteristics. Outlet temperature had the least effect on the studies variables. The overall optimum region resulted in desirable pitaya peel powder was predicted at a combined level of inlet air temperature (165 °C), outlet air temperature (80 °C) and maltodextrin DE10 (15% w/w). No significant difference ( $p > 0.05$ ) was found between the experimental values and predicted values for all responses indicated that the optimum region obtained was valid. The storage stability of packed spray-dried pitaya peel powder during accelerated storage ( $45 \pm 2$  °C, 14 weeks) and room temperature ( $28 \pm 2$  °C, 6

months) were studied. Aluminium laminated polyethylene (ALP), amber glass bottle (GL) and low density polyethylene (LDPE) were used as packaging materials. The betacyanin pigment retention, moisture content, water activity, solubility, hygroscopicity and the color of peel powder were evaluated throughout the storage period. Storage temperatures and the type of packaging materials significantly ( $p < 0.05$ ) affected all the studied parameters. Degradation of betacyanin pigment in the powders followed the first order reaction kinetics. The half life of betacyanin in peel powder kept at both accelerated and room temperature storage were calculated to be [ALP ( $t_{1/2} = 93.65$  weeks), GL ( $t_{1/2} = 87.72$  weeks) and LDPE ( $t_{1/2} = 76.15$  weeks)] and [ALP ( $t_{1/2} = 103.43$  months), GL ( $t_{1/2} = 62.43$  months) and LDPE ( $t_{1/2} = 38.29$  months)], respectively. The results demonstrated that pigment retention of peel powder after storing at both 45 °C (86.96-89.61%) and room temperature (89.04-95.84%) was high and thus implied that the spray-dried pitaya peel powders maybe used as a commercial food colorant. ALP was the best packaging material for keeping spray-dried pitaya peel powders.

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

**PENGOPTIMUMAN PROSES PENGERINGAN SEMBURAN DAN  
KESTABILAN PENYIMPANAN SERBUK KULIT PITAYA, *Hylocereus*  
*polyrhizus* (WEBER) BRITTON & ROSE**

By

**EE SHU CHEE**

**Jun 2011**

**Pengerusi : Prof. Jamilah Bt. Bakar, PhD**

**Fakulti : Sains dan Teknologi Makanan**

Kulit pitaya (*Hylocereus polyrhizus*) merangkumi 22% daripada buah pitaya. Ianya dibuang semasa aktiviti pemprosesan jus. Ciri-ciri fizikal-kimia kulit pitaya telah ditentukan untuk menilai potensinya sebagai sumber bahan nilai tambah. Kandungan kelembapan kulit pitaya adalah sebanyak 92.7% dan ianya mengandungi kandungan pepejal terlarut, protein, abu dan lemak yang rendah. Kulit pitaya didapati mengandungi pigmen betacyanin dan kandungan pectin yang tinggi iaitu sebanyak  $150.46 \pm 2.19$  mg/100 g dan 10.8% masing-masing. Glukosa, maltosa dan fruktosa didapati hadir dalam kulit pitaya manakala tiada sukrosa atau galaktosa ditemui. Kulit pitaya juga didapati mengandungi serat makanan yang sangat tinggi. Nisbah yang baik wujud antara serat tidak larut dengan serat larut iaitu 3.8: 1.0. Oleh sebab itu, ia akan menjadi satu kelebihan kepada industri makanan dari segi ekonomi jika

kulit pitaya dapat digunakan semula dan bukannya dibuang. Dalam kajian ini, kaedah pengeringan sembur telah digunakan untuk menghasilkan serbuk daripada kulit pitaya memandangkan kulit pitaya merupakan sumber serat, pektin dan sumber pewarna semulajadi yang baik. Kaedah respons permukaan (RSM) yang melibatkan reka bentuk komposit memusat (CCD) telah digunakan untuk mengoptimumkan dan mengkaji kesan suhu udara masuk ( $155\text{-}175\text{ }^{\circ}\text{C}$ ), suhu udara keluar ( $75\text{-}85\text{ }^{\circ}\text{C}$ ) dan kepekatan maltodekstrin DE10 (8-22%) terhadap serbuk kulit pitaya hasilan pengeringan sembur. Serbuk kulit pitaya yang terhasil kemudiaanya dianalisis untuk retensi pigmen betacyanin, warna, kandungan kelembapan, aktiviti air, penyerapan air dan kelarutan. Serbuk kulit pitaya yang disembur kering berwarna merah jambu dan mempunyai aktiviti air dalam lingkungan 0.233-0.380. Serbuk ini rendah dalam kandungan kelembapan dan menunjukkan retensi pigmen betacyanin yang tinggi. Nilai koefisien determinasi yang tinggi ( $R^2 > 0.85$ ), iaitu daripada 0.896 to 0.979 telah dicapai oleh data eksperimen menunjukkan bahawa model regresi yang dihasilkan menerangkan variasi data dengan mencukupi. Keputusan juga menunjukkan bahawa kesan linear kepekatan maltodekstrin merupakan faktor yang paling signifikan ( $p < 0.05$ ) dalam mempengaruhi ciri-ciri serbuk pengeringan sembur kulit pitaya. Suhu udara keluar menunjukkan kesan yang paling sedikit terhadap ciri-ciri serbuk pitaya yang terhasil. Suhu udara masuk pada  $165\text{ }^{\circ}\text{C}$ , suhu udara keluar pada  $80\text{ }^{\circ}\text{C}$  dan 15 % maltodekstrin DE10 telah dikenalpasti sebagai keadaan optimum untuk menghasilkan serbuk kulit pitaya dengan ciri-ciri fizikal-kimia yang baik. Tiada perbezaan yang signifikan ( $p > 0.05$ ) didapati antara nilai uji kaji dan nilai ramalan untuk semua respons. Ini menunjukkan keadaan optimum

yang diperolehi adalah sah. Kestabilan serbuk kulit pitaya yang telah dibungkus semasa penyimpanan dalam semasa kajian penyimpanan dipercepat ( $45 \pm 2$  °C, 14 minggu) dan kajian penyimpanan suhu bilik ( $28 \pm 2$  °C, 6 bulan) telah dikaji. Aluminium polietilena dilaminasi (ALP), botol kaca amber (GL) dan polietilena berketumpatan rendah (LDPE) telah digunakan sebagai bahan pembungkus. Kandungan kelembapan, retensi pigmen betacyanin, aktiviti air, kelarutan, penyerapan air dan warna serbuk kulit pitaya dinilai sepanjang tempoh kajian penyimpanan. Jenis bahan pembungkus dan suhu penyimpanan menpengaruhi secara signifikan ( $p < 0.05$ ) semua parameter yang dikaji. Degradasi pigmen betacyanin dalam serbuk kulit pitaya didapati adalah jenis kinetika reaksi orde pertama. Separuh hayat pigment betacyanin dalam serbuk kulit pitaya yang telah terdedah kepada kajian penyimpanan dipercepat dan kajian penyimpanan suhu bilik telah ditentukan [ALP ( $t_{1/2} = 93.65$  minggu dan 103.43 bulan, masing-masing), GL ( $t_{1/2} = 87.72$  minggu dan 62.43 bulan, masing-masing) dan LDPE ( $t_{1/2} = 76.15$  minggu dan 38.29 bulan, masing-masing)]. Keputusan menunjukkan bahawa retensi pigmen betacyanin dalam serbuk kulit pitaya selepas penyimpanan pada kedua-dua suhu 45 °C (86.96-89.61%) dan suhu bilik (89.04-95.84%) adalah tinggi. Ini menunjukkan serbuk kulit pitaya hasilan pengeringan sembur mungkin boleh digunakan sebagai pewarna makanan komersial. ALP merupakan bahan pembungkus terbaik untuk menyimpan serbuk kulit pitaya hasilan pengeringan sembur.

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I certify that a Thesis Examination Committee has met on 7 June 2011 to conduct the final examination of Ee Shu Chee on her thesis entitled “Optimization Of Spray Drying Process And Storage Stability Of Pitaya, *Hylocereus polyrhizus* (Weber) Britton & Rose Peel Powder” in accordance with the Universities and University Collages 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.

Member of the Thesis Examination Committee were as follows:

**Roselina Karim, PhD**

Associate Professor

Faculty of Food Science and Technology

Universiti Putra Malaysia

(Chairman)

**Russly Abdul Rahman, PhD**

Professor

Faculty of Food Science and Technology

Universiti Putra Malaysia

(Internal Examiner)

**Seyed Hamed Mirhosseini, PhD**

Senior Lecturer

Faculty of Food Science and Technology

Universiti Putra Malaysia

(Internal Examiner)

**Mohamad Yusof Maskat, PhD**

Associate Professor

Faculty of Science and Technology

Universiti Kebangsaan Malaysia

Malaysia

(External Examiner)

---

**NORITAH OMAR, PhD**

Associate Professor and Deputy Dean

School of Graduate Studies

Universiti Putra Malaysia

Date: 23 August 2011

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:

**Jamilah Bakar, PhD**

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)

**Noranizan Mohd Adzahan, PhD**

Faculty of Food Science and Technology

Universiti Putra Malaysia

(Member)

**Dzulkifly Mat Hashim**

Faculty of Food Science and Technology

Universiti Putra Malaysia

(Member)

---

**HASANAH MOHD GHAZALI, PhD**

Professor and Dean

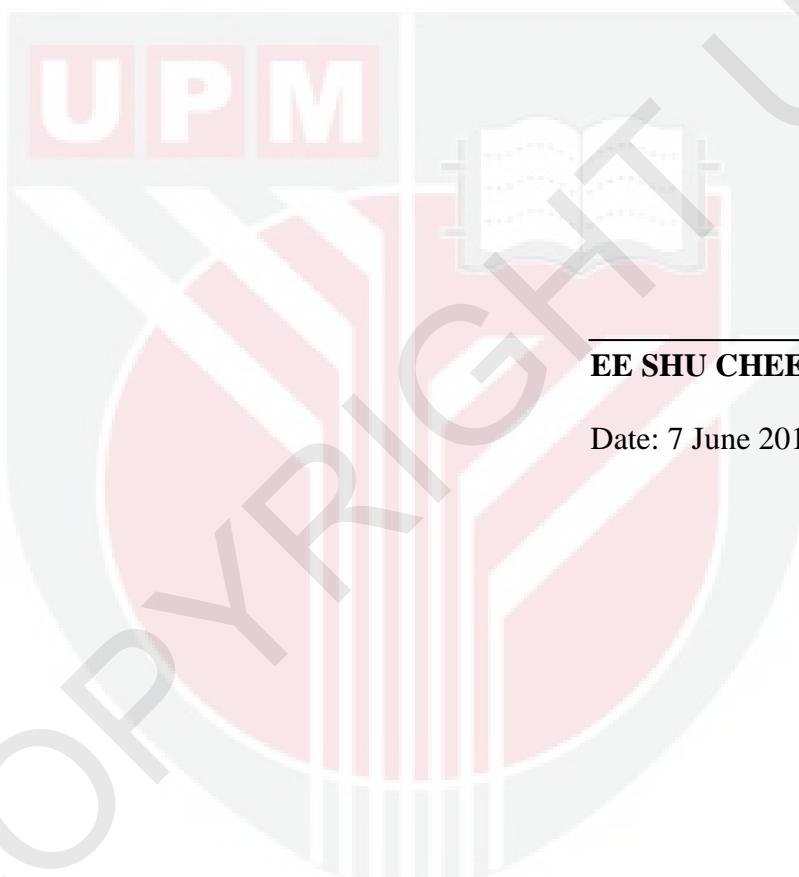
School of Graduate Studies

Universiti Putra Malaysia

Date:

## **DECLARATION**

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



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**EE SHU CHEE**

Date: 7 June 2011

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