



UNIVERSITI PUTRA MALAYSIA

**POWDER PROPERTIES AND PREBIOTIC ACTIVITY OF WHITE DRAGON
FRUIT (HYLOCEREUS UNDATUS) JUICE SPRAY-DRIED
USING RESISTANT MALTODEXTRIN**

NORZAIDA YUSOF

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**MASTER OF SCIENCE
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2013**



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By

NORZAIDA YUSOF

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

Mei 2013

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DEDICATION

This dissertation is dedicated especially to my beloved husband, Asmadi and parents, Hj Yusof and Hajah Wan Zabidah for their constant doa', encouragement and support.

Norzaida Yusof

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirements for the degree of Master of Science

POWDER PROPERTIES AND PREBIOTIC ACTIVITY OF WHITE DRAGON FRUIT (*HYLOCEREUS UNDATUS*) JUICE SPRAY-DRIED USING RESISTANT MALTODEXTRIN

By

NORZAIDA YUSOF

May 2013

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Faculty : Food Science and Technology

Prebiotics which have been found effective in gastrointestinal normal flora proliferation and pathogen suppression occur naturally in fruits and vegetables including white dragon fruit (*Hylocereus undatus*). A study was, therefore conducted to produce white dragon fruit (WDF) powders through spray drying using resistant maltodextrin (RMD) and maltodextrin (MD) as wall materials. Resistant maltodextrin, which is a soluble fiber, was selected as a wall material to produce free-flowing WDF powder while MD was selected as the common wall material used in spray drying of fruit juice. Wall materials and drying conditions were assumed to influence powder properties and therefore, the objectives of this study were to investigate the effects of spray-drying conditions and two different wall materials, namely, MD and RMD, and to obtain optimum conditions for the production of the

WDF powders by evaluating the physicochemical properties of the produced powders. To produce powder with RMD (WRMD), the following spray drying conditions were evaluated: an inlet temperature from 140 °C to 160 °C, an outlet temperature from 75 °C to 85 °C, and 20% to 30% RMD concentration. To produce powder with MD (WMD), the following spray drying conditions were studied: an inlet temperature from 150 °C to 170 °C, an outlet temperature from 75 °C to 85 °C, and 15% to 30% MD concentration. The produced powders were then evaluated for process yield, moisture content, water activity, solubility, hygroscopicity and bulk density. Results of the study demonstrated that the process yield of WDF powders increased with increasing inlet temperature and decreasing RMD and MD concentrations. Their moisture content and water activity decreased with increasing outlet temperature and increasing RMD and MD concentrations. Their solubility increased with increasing inlet and outlet air temperatures and increasing RMD and MD concentrations. Hygroscopicity of the powders increased with increasing inlet and outlet temperatures for both powders and decreased with increasing MD concentration for WMD powder. Bulk density of the powders decreased with increasing inlet and outlet temperatures for WRMD powder, whereas it decreased with increasing inlet temperature and MD concentration for WMD powder. RMD had nearly no effect on hygroscopicity and bulk density of the WDF powder. The optimum conditions to obtain a free-flowing WDF powder were at an inlet temperature of 153°C, outlet temperature of 82°C and 20% of RMD concentration, whereas 150 °C of inlet temperature, 75 °C of outlet temperature and 18% of MD concentration were the optimum conditions for production of WMD powder. The WDF powders produced using both RMD and MD at optimum spray drying conditions were then analysed for their physical properties, morphologies and glass

transition temperatures, T_g . The results showed that RMD reduced the water activity and moisture content of the powder better than MD, while bulk density and true density of WRMD powder was higher than that of WMD powder. In addition, the particle size of WRMD powder was smaller than that of WMD powder and the morphology of the WRMD powder showed that it had a smooth surface compared to WMD powder where shrinkage and dent surfaces were observed. Although the T_g value of WMD powder was higher than that of WRMD powder, but their values were not significantly different ($p>0.05$). The potential of both powders as new prebiotic sources was then investigated whereby both powders were produced using the optimum spray drying conditions and then investigated for their ability to support the growth of *Bifidobacterium longum* BB536 and *Lactobacillus casei* Shirota. The growth of the 2 bacteria strains was determined every 6 h for 24 h with anaerobic incubation at 37 °C in six MRS media containing glucose, RMD, MD, WRMD, WMD and fructooligosaccharides (FOS) as substrates. The results indicated that all the substrates significantly ($p<0.05$) increased the growth of the probiotic bacteria; *B.longum* BB536 and *L.casei* Shirota and WRMD powder gave the highest bacterial count. Thus, the results indicated that WRMD has the potential as a new prebiotic source for the functional food industry.

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

**CIRI FIZIKAL DAN AKTIVITI PREBIOTIK SERBUK BUAH NAGA PUTIH
(*HYLOCEREUS UNDATUS*) YANG TERHASIL DARI SEMBURAN KERING
MENGUNAKAN MALTODEKSTRIN RINTANG**

Oleh

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Prebiotik yang terbukti berkesan sebagai penggalak pertumbuhan mikroflora di dalam usus serta melawan patogen boleh didapati secara semulajadi di dalam buah-buahan dan sayur-sayuran termasuk buah naga putih. Oleh itu, satu kajian telah dijalankan untuk menghasilkan serbuk naga putih menggunakan maltodekstrin rintang (RMD) dan maltodekstrin (MD) sebagai agen pengering melalui proses pengeringan-sembur. RMD merupakan serbuk yang mengandungi fiber terlarut telah dipilih sebagai salah satu agen pengering untuk menghasilkan serbuk naga putih dengan sifat yang tidak melekit, manakala MD pula dipilih sebagai agen pengering kerana MD selalu digunakan untuk menghasilkan serbuk buah menggunakan kaedah pengeringan-sembur. Agen pengering dan keadaan proses pengeringan dijangkakan memberi kesan kepada sifat serbuk yang terhasil. Oleh itu, objektif pertama kajian

ini ialah untuk mengkaji kesan daripada proses pengeringan- sembur dengan menggunakan dua jenis agen pengering, RMD dan MD, bagi mendapatkan keadaan yang optimum untuk menghasilkan serbuk naga putih serta menilai sifat fizikal serbuk naga yang terhasil. Kajian ini telah dijalankan menggunakan kaedah *response surface* dengan respon pemboleh ubah bagi serbuk naga bersalut RMD (WRMD) ialah suhu udara masuk (140 °C-160 °C), kepekatan RMD (20%-30%) dan suhu udara keluar (75 °C-85 °C). Bagi serbuk naga bersalut MD (WMD), suhu udara masuk ialah (150 °C-170 °C), kepekatan MD (15%-30%) dan suhu udara keluar ialah (75 °C-85 °C). Serbuk naga putih yang dihasilkan kemudian dianalisis untuk hasil proses, kandungan air, aktiviti air, higroskopisiti dan ketumpatan pukal. Keputusan analisis menunjukkan jumlah serbuk naga putih yang terhasil meningkat apabila suhu udara masuk meningkat dan kepekatan RMD dan MD berkurang; penambahan kepekatan RMD dan MD serta suhu udara keluar secara signifikan ($p < 0.05$) mengurangkan aktiviti dan kandungan air serbuk naga putih; kelarutan serbuk naga didalam air meningkat apabila semua respon pemboleh ubah meningkat. Higroskopisiti untuk kedua- dua serbuk meningkat apabila suhu udara keluar dan masuk meningkat tetapi menurun apabila kepekatan MD meningkat bagi serbuk WMD. Ketumpatan pukal bagi serbuk WRMD menurun apabila suhu udara masuk dan keluar menurun tetapi bagi serbuk WMD, ketumpatan pukal menurun apabila suhu udara masuk dan kepekatan MD meningkat. RMD hampir tidak memberi kesan kepada higroskopisiti dan ketumpatan pukal serbuk naga putih yang terhasil. Keadaan optimum untuk hasilkan serbuk naga putih yang tidak melekit telah dikenal pasti pada keadaan ketika suhu udara masuk 153 °C, suhu udara keluar 82 °C dan kepekatan RMD 20%. Manakala untuk penghasilan serbuk WMD pula pada keadaan ketika suhu udara masuk 150 °C, suhu udara keluar 75 °C dan kepekatan MD 18%.

Serbuk yang dihasilkan menggunakan kedua-dua agen pengering, RMD dan MD pada keadaan optimum kemudian dianalisis untuk ciri-ciri fizikal, morfologi dan perubahan suhu kaca, T_g . Keputusan menunjukkan bahawa RMD mengurangkan aktiviti air dan kandungan air serbuk lebih baik daripada MD, sementara ketumpatan pukal serbuk WRMD lebih tinggi daripada serbuk MD. Selain itu, saiz zarah serbuk WRMD lebih kecil daripada WMD dan morfologi serbuk WRMD menunjukkan bahawa ia mempunyai satu permukaan yang licin berbanding serbuk WMD yang dilihat mempunyai permukaan yang kecut dan kemik. T_g bagi serbuk WMD mencatat nilai yang lebih tinggi tetapi kedua-dua serbuk secara signifikan ($p > 0.05$) tidak mempunyai perbezaan. Potensi untuk kedua-dua serbuk naga putih sebagai sumber prebiotik baru kemudian dikaji dengan mengkaji samaada kedua-dua serbuk naga putih yang dihasilkan pada keadaan optimum dapat menyokong pertumbuhan *Bifidobacterium longum* BB536, *Lactobacillus casei* Shirota. Pertumbuhan dua jenis bakteria tersebut telah dijalankan setiap 6 jam selama 24 jam secara inkubasi anaerobic pada suhu 37 °C dalam 6 jenis MRS media yang mengandungi glukos, RMD, MD, serbuk WRMD, serbuk WMD serta fruktooligosakarida (FOS) bertindak sebagai substrat. Keputusan kajian menunjukkan bahawa semua substrat secara signifikan ($p < 0.05$) meningkatkan pertumbuhan probiotik bakteria; *L.casei* Shirota dan *B.longum* BB536 dan serbuk WRMD menunjukkan bilangan bakteria paling banyak. Oleh itu, ini menunjukkan bahawa serbuk WRMD mempunyai potensi sebagai sumber prebiotik yang baru dalam industri makanan berfungsi.

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I certify that a Thesis Examination Committee has met on 21 May 2013 to conduct the final examination of **NORZAIDA YUSOF** on her Master thesis entitled “**POWDER PROPERTIES AND PREBIOTIC ACTIVITY OF WHITE DRAGON FRUIT (HYLOCEREUS UNDATUS) JUICE SPRAY-DRIED USING RESISTANT MALTODEXTRIN**” 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 candidate be awarded the Master degree.

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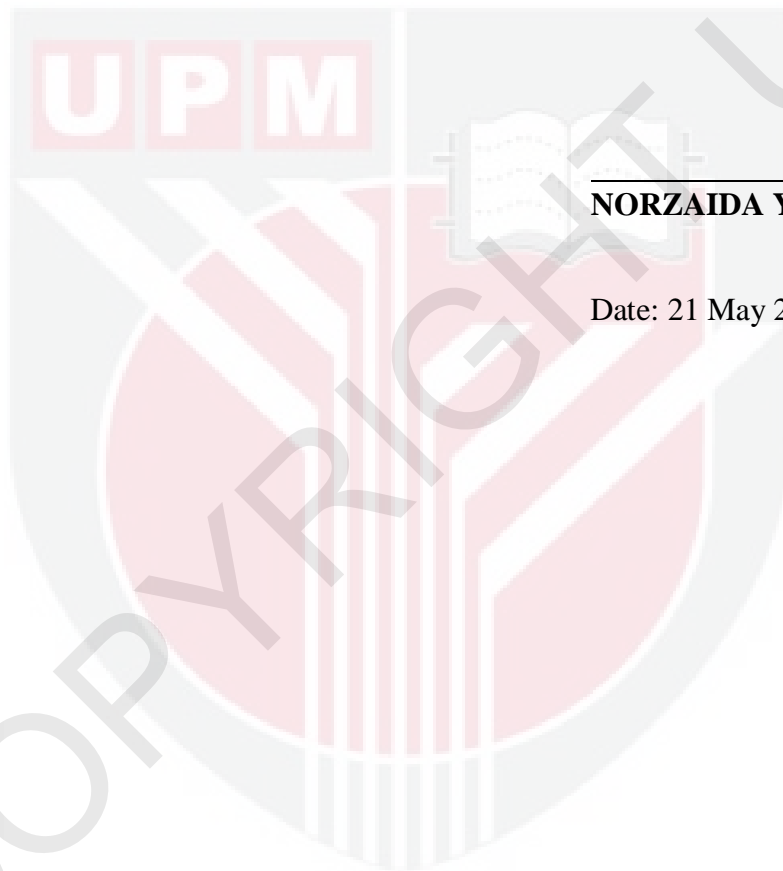
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DECLARATION

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 degree at Universiti Putra Malaysia or at any other institution.



NORZAIDA YUSOF

Date: 21 May 2013



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