UNIVERSITI PUTRA MALAYSIA

EFFECTS OF EXTRACTION, PURIFICATION AND DRYING ON THE PHYSICOCHEMICAL PROPERTIES OF DURIAN (*Durio zibethinus*) SEED GUM

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By

BAHAREH TABATABAEE AMID

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

December 2011

Specially Dedicated to

My Parent

Father, Mother, Husband,

Brother and Sister

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Doctor of Philosophy

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Chairman : Seyed Hamed Mirhosseini, PhD

Faculty : Food Science and Technology

The long-term goal of the current study was to look into the possibility of applying the biorefinery process for utilizing the main biomass of durian fruit. The main objective was to investigate the effect of extraction, purification and drying on the chemical composition, physicochemical and functional properties of durian seed gum. The efficiency of two aqueous and chemical extraction techniques was compared under the optimum extraction conditions to determine the most suitable extraction condition resulted in the crude durian seed gum with desirable functional properties. For further improvement of functional properties of crude gum, the determination of most suitable purification and drying techniques resulting in the purified durian seed gum with desirable properties was carried out. The results indicated that durian seed gum exhibited a typical

‘pseudoplastic or shear-thinning rheological behavior’. In fact, the viscosity of durian seed gum decreased when the shear rate was increased. The durian seed gum showed more viscous (liquid like) behavior rather than the elastic (solid like) behavior. This is typical rheological behaviour of diluted gum solution, when the molecules cannot entangle and produce a network structure during oscillatory stress. This could be due to the random-coil polysaccharide structure which behaved like a liquid when exposed to low frequencies of oscillation. The carbohydrate analysis showed that the major monosaccharide composition of crude durian seed gum include D-galactose (57.2 ± 3.2), glucose (41.8 ± 3.9), and small contents of arabinose (0.6 ± 0.03) and xylose (0.4 ± 0.06). The current study revealed that the durian seed gum may be classified as a galactan or arabinogalactans rather than a galactomannan.

The results indicated that the chemical extraction variables exhibited the highest significant ($p < 0.05$) effect on the oil-holding capacity (OHC) and extraction yield, respectively. Among all chemical extraction variables, the soaking temperature and decolouring time showed the most significant ($p < 0.05$) effect on the physicochemical and functional properties of the crude durian seed gum. The optimum chemical extraction (i.e. the decolouring time ~119 min, soaking time ~1.5 h and soaking temperature 16.5 °C) resulted in the most desirable physicochemical properties. The results indicated that the purification process significantly ($p < 0.05$) improved the solubility of crude durian seed gum. This could be explained by the fact that the purification process resulted in the significant ($p < 0.05$) decrease in the protein content and some impurities in the chemical structure of crude durian seed gum. The current study revealed that the purification method C (using saturated barium hydroxide) resulted in the highest protein content, maximum solubility and OHC as well as the most desirable viscous modulus (G″) among all purification methods. In addition, the purified seed gum using saturated barium hydroxide also provided high WHC, large specific surface area and relatively high purification yield and viscosity. Therefore, the present study suggests that the purification process using saturated barium hydroxide is recommended as the most suitable purification technique for durian seed gum.

Finally, the effect of four different drying methods (namely oven drying (105 °C), vacuum oven drying, freeze drying and spray drying) on the chemical composition and physicochemical properties of purified durian seed gum was investigated. In this study, the drying process led to improve the solubility of purified durian seed gum. This observation could be explained by the significant ($p < 0.05$) effect of drying process on the carbohydrate composition and protein content of purified durian seed gum. In fact, the drying process resulted in (i) decrease the protein, xylose and arabinose contents and (ii) increase the glucose and galactose contents. The present study revealed that the freeze drying resulted in the durian seed gum with smallest average droplet size. In addition, the freeze-dried seed gum also provided the highest protein content and maximum solubility, specific surface area, viscosity and OHC among other samples. Therefore, the present study recommends the freeze drying as the most suitable drying technique for the durian seed gum.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi sebahagian keperluan untuk ijazah Doktor Falsafah

KESAN PENGEKSTRAKAN, BERSUCI DAN PENGERINGAN TERHADAP CIRI FIZIKOKIMIA DURIAN (*Durio zibethinus*) SEED GUM

Oleh

BAHAREH TABATABAEE AMID

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Matlamat jangka panjang kajian semasa adalah untuk mengkaji kemungkinan menggunakan proses biorefinery untuk menggunakan biomass utama buah durian. Objektif utama adalah untuk menyiasat kesan pengekstrakan, penulenan dan pengeringan pada komposisi kimia, sifat-sifat fizikokimia dan berfungsi gusi benih durian. Kecekapan dua teknik pengekstrakan akueus dan kimia berbanding di bawah syarat-syarat yang pengekstrakan optimum untuk menentukan pengekstrakan keadaan yang paling sesuai yang menyebabkan gusi benih durian mentah dengan ciri-ciri yang diingini berfungsi. Untuk penambahbaikan sifat-sifat fungsi gula mentah, penentuan penyucian yang paling sesuai dan pengeringan teknik-teknik yang menyebabkan gusi disucikan benih durian dengan sifat-sifat yang diingini telah dijalankan. Keputusan menunjukkan bahawa gula-gula getah benih durian yang dipamerkan 'tingkah laku pseudoplastic atau penipisan ricih

reologi' tipikal. Malah, kelikatan gusi benih durian berkurangan apabila kadar ricih meningkat. Gusi benih durian menunjukkan tingkah laku yang lebih likat (cecair seperti) bukannya kelakuan anjal (pepejal seperti). Ini adalah tingkah laku yang biasa reologi larutan gula dicairkan, apabila molekul tidak boleh menjerat dan menghasilkan struktur rangkaian semasa tekanan ayunan. Analisis karbohidrat menunjukkan bahawa komposisi monosakarida utama gusi benih durian mentah termasuk D-galactose (57.2 ± 3.2), glucose (41.8 ± 3.9), dan kandungan kecil arabinose (0.6 ± 0.03) dan xylose (0.4 ± 0.06). Kajian semasa menunjukkan bahawa gula-gula getah benih durian boleh dikelaskan sebagai galactan atau arabinogalactans bukannya satu galactomannan.

Keputusan menunjukkan bahawa pemboleh ubah pengekstrakan kimia mempamerkan tertinggi yang signifikan ($p < 0.05$) kesan ke atas keupayaan minyak pegangan (OHC) dan hasil pengekstrakan, masing-masing. Antara semua pembolehubah pengekstrakan kimia, suhu jering dan masa decolouring menunjukkan kesan yang paling ketara ($p < 0.05$) pada sifat-sifat fizikokimia dan berfungsi gusi benih durian mentah. Pengekstrakan kimia yang optimum (iaitu masa decolouring ~ 119 min, jering masa ~ 1,5 h dan merendam suhu 16,5 ° C) menyebabkan sifat-sifat fizikokimia yang paling wajar. Keputusan menunjukkan bahawa proses penulenan yang signifikan ($p < 0.05$) meningkatkan kebolehlarutan gusi benih durian mentah. Ini dapat dijelaskan oleh fakta bahawa proses penulenan menyebabkan penurunan yang signifikan ($p < 0.05$) di dalam kandungan protein dan beberapa kekotoran dalam struktur kimia gusi benih durian mentah. Kajian semasa menunjukkan bahawa kaedah penulenan C (menggunakan saturated barium hydroxide) menyebabkan kandungan protein tertinggi, kelarutan maksimum dan OHC serta modulus likat yang paling dikehendaki (G″) di kalangan semua kaedah penulenan. Oleh itu, kajian ini mencadangkan bahawa proses penulenan menggunakan saturated barium hydroxide tepu disyorkan sebagai teknik penulenan yang paling sesuai untuk gusi benih durian.

Akhir sekali, kesan daripada empat kaedah pengeringan yang berlainan (iaitu pengeringan oven (105 °C), ketuhar vakum pengeringan pengeringan beku, dan semburan pengeringan) pada komposisi kimia dan sifat-sifat fizikokimia suci gusi benih durian disiasat. Dalam kajian ini, proses pengeringan membawa kepada meningkatkan kebolehlarutan gusi benih durian. Pemerhatian ini boleh dijelaskan oleh kesan yang signifikan ($p < 0.05$) proses pengeringan pada komposisi karbohidrat dan kandungan protein gusi benih durian. Malah, proses pengeringan yang mengakibatkan (i) mengurangkan protein, xylose dan kandungan arabinose dan (ii) meningkatkan kandungan glukosa dan galaktosa. Kajian ini menunjukkan bahawa pembekuan pengeringan menyebabkan gusi benih durian dengan kelantangan-wajaran minimum bermakna (atau terkecil purata saiz titisan). Di samping itu, pembekuan kering benih gusi juga menyediakan kandungan protein yang tertinggi dan kelarutan maksimum, kawasan permukaan yang tertentu, kelikatan dan OHC di kalangan sampel lain. Oleh itu, kajian ini mencadangkan pembekuan pengeringan sebagai teknik yang paling sesuai kering gusi benih durian.

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I certify that an Examination Committee has met on December 2011 to conduct the final examination of Bahareh Tabatabaee Amid on his Doctor of Philosophy thesis entitled " **EFFECTS OF EXTRACTION, PURIFICATION AND DRYING ON THE PHYSICOCHEMICAL CHARACTERISTICS OF DURIAN (*Durio zibethinus*) SEED GUM**" 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 degree of Doctor of Philosophy.

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This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfilment of the requirement for the degree of Doctor of Philosophy. The members of the Supervisory Committee were as follows:

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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 other degree at Universiti Putra Malaysia or other institutions.

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BAHAREH TABATABAEE AMID

Date: 9 December 2011

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