UNIVERSITI PUTRA MALAYSIA

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MASTER OF SCIENCE
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By

MOHAMED NAZIM BIN ANVARALI

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

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

PRODUCTION, OPTIMIZATION, CHARACTERIZATION AND STORAGE STABILITY OF ROSELLE CONCENTRATE

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MOHAMED NAZIM BIN ANVARALI

February 2013

Chairman: Professor Tan Chin Ping, PhD

Faculty: Food Science and Technology

Three different extraction techniques were used to determine the suitability and efficiency of the roselle extraction techniques for the development of roselle concentrate. These extraction techniques were 1) hot water extraction (HWE), 2) puree extraction (PE) and 3) osmotic extraction (OE). Data from preliminary comparative studies suggested that the osmotic solution (OS) from the OE technique can be used for the development of roselle concentrate as it has a significantly (p<0.05) higher anthocyanin content, D-malic and L-malic acid with the value of 100.00 ± 0.43 mg/L as expressed in delphinidin-3-glucoside, 4043.60 ± 11.17 and 2946.90 ± 16.69 (ppm/L); respectively, compared to HWE and PE. Further studies were conducted

using response surface methodology (RSM) in order to determine the optimal processing parameters of the OE technique. The parameters affecting the roselle extraction process were optimized for the color of the roselle concentrate (red purplish), a taste with minimum sharpness and a high anthocyanin content. A central composite design (CCD) with a quadratic model consisted of three independent variables: extraction time, osmotic solution concentration and extraction temperature. The response variables were used to determine the Hunter lab color index – L*, a*, b*, acidity percentage, total anthocyanin content, color density, color degradation index and sensory attributes, which included the color, grassy (odor), fruity (taste), sharpness (taste) and overall acceptability of all of the roselle concentrates and juices. A total of 20 different combinations (including six replicates of the center point each with coded value 0) were chosen at random according to a Central Composite Design (CCD) configuration for three factors. The results suggested that for the production of red to purple color of roselle concentrate, the extraction should be carried under the following conditions: 70 °C (extraction temperature), 205 minutes (extraction time) and 62.5 °Brix of sucrose solution (as a medium of extraction). Meanwhile, the storage temperature yielded significant (p<0.05) negative effects on the total quality of the roselle concentrate when compared to the duration of storage. High temperatures during storage may cause dramatic changes in anthocyanin

content and the color of the osmotic solution due to the degradation of anthocyanins. Roselle concentrate stored for 8 weeks at 5 °C retains up to 74.8% of its total anthocyanin content (compared to the initial value; 4334.15 mg/L); these values are significantly (p<0.05) higher than those of roselle concentrate that were stored at 25 °C and 45 °C (31.1% and 6.5% of its initial anthocyanin content at the end of storage, respectively). This research shows that the osmotic solution, which is normally not reused and is considered as industrial waste in the fruit osmotic dehydration (OD) process, exhibits the highest amount of total anthocyanin (p<0.05). The osmotic solution may be used as an ingredient as a healthy roselle concentrate. Proper storage at low temperature can ensure its appearance and taste qualities, and the functional properties of the concentrate will be stabilized, which will allow roselle juice to be accepted as a functional drink.

Abstrak tesis yang dikemukakan kepada senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Master Sains

PENGELUARAN, PENGOPTIMUMAN, PENCIRIAN DAN KESTABILAN PENYIMPANAN PEKATAN ROSELLE

Oleh

MOHAMED NAZIM BIN ANVARALI

Februari 2013

Pengerusi: Profesor Tan Chin Ping, PhD

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Tiga teknik pengekstrakan yang berbeza telah digunakan untuk menentukan kesesuaian dan kecekapan teknik pengekstrakan roselle untuk pembangunan roselle pekat. Teknik-teknik pengekstrakan tersebut adalah 1) pengekstrakan air panas (HWE), 2) pengekstrakan puri (PE) dan 3) pengekstrakan osmotik (OE). Data daripada kajian perbandingan awal mencadangkan bahawa larutan osmotik (OS) daripada teknik OE boleh digunakan untuk pembangunan pekat roselle kerana ia mempunyai secara nyata ($p < 0.05$) lebih tinggi kandungan antosianin, asid D-malik dan L-malik dengan nilai 100.00 ± 0.43 mg / L yang dinyatakan sebagai delphinidin-3 glukosida, 4043.60 ± 11.17 dan 2946.90 ± 16.69 (ppm / L), masing-masing, berbanding HWE dan PE. Kajian lanjutan dijalankan dengan menggunakan kaedah

gerak balas permukaan (RSM) untuk menentukan parameter pemprosesan optimum bagi teknik EO. Parameter yang mempengaruhi proses pengekstrakan roselle yang perlu dioptimumkan menjurus kepada hasilan pekatan roselle dengan warna merah keunguan, rasa ketajaman yang terhad dan kandungan antosianin yang tinggi. Satu reka bentuk pusat komposit (CCD) dengan model kuadratik terdiri daripada tiga pembolehubah bebas: masa pengekstrakan, kepekatan larutan osmotik dan suhu pengekstrakan. Pembolehubah sambutan telah digunakan untuk menentukan indeks warna makmal Hunter - L *, a*, b *, peratusan keasidan, jumlah kandungan antosianin, kepadatan warna, indeks kemerosotan warna dan sifat-sifat deria, termasuk warna, bau rumput, rasa kebuah-buahan , rasa ketajaman dan penerimaan keseluruhan bagi semua pekatan roselle dan jus. Sejumlah 20 kombinasi berbeza (termasuk enam replikasi titik pusat berkod 0) telah dipilih secara rawak mengikut Rekabentuk Pusat Komposit (CCD) konfigurasi dengan tiga faktor. Keputusan mencadangkan bahawa bagi penghasilan pekatan roselle berwarna merah ungu, pengekstrakan roselle perlu diproses dengan menggunakan parameter optimum seperti berikut berikut: 70 °C (suhu pengekstrakan), 205 minit (masa pengekstrakan) dan 62.5 °Briks larutan sukrosa (sebagai medium pengekstrakan). Sementara itu, suhu penyimpanan memberikan kesan negatif yang signifikan ($p < 0.05$) kepada kualiti pekatan roselle jika dibandingkan dengan tempoh

penyimpanan. Suhu tinggi semasa penyimpanan boleh menyebabkan perubahan dramatik dalam kandungan antosianin dan warna larutan osmotik yang disebabkan oleh kemusnahan antosianin. Roselle yang disimpan selama 8 minggu pada suhu 5 °C mengekalkan sehingga 74.8% daripada jumlah asal kandungan antosianin (berbanding dengan nilai awal; 4334.15 mg / L), nilai kandungan yang signifikan ($p < 0.05$) lebih tinggi berbanding kordial roselle yang disimpan pada suhu 25 °C dan 45 °C (31.1% dan 6.5% daripada jumlah asal kandungan antosianin yang diukur pada akhir tempoh penyimpanan, masing-masing). Kajian ini menunjukkan bahawa larutan osmosis, yang biasanya tidak diguna semula dan dianggap sebagai sisa dari perindustrian dehidrasi buah osmotik (OD), mengandungi jumlah kandungan antosianin yang tinggi ($p < 0.05$). Ia boleh digunakan sebagai ramuan dalam penghasilan pekatan roselle yang sihat dan berwarna merah. Penyimpanan yang betul pada suhu rendah boleh memastikan penampilan dan kualiti rasa, serta ciri-ciri fungsi kekal stabil, di mana ini membolehkan jus roselle boleh diterima sebagai minuman berfungsi.

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21st March 2013

I certify that an Examination Committee has met on 22nd February 2013 to conduct the final examination of Mohamed Nazim Bin Anvarali on his Master of Science thesis entitled " Production Optimization, Characterization And Storage Stability Of Roselle Concentrate" in accordance with the Universities and University College 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.

Members of the Thesis Examination Committee were as follows:

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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 Master of Science. 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 at any other institutions.

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MOHAMED NAZIM BIN ANVARALI

Date: 22 February 2013

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