UNIVERSITI PUTRA MALAYSIA

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MASTER OF SCIENCE

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By

TAN PHUI YEE

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

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

DEVELOPMENT OF AN ACRYLAMIDE-FREE PALM SUGAR-LIKE FLAVOURING USING MAILLARD REACTION

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TAN PHUI YEE

November 2013

Chairman: Professor Tan Chin Ping, PhD

Faculty: Food Science and Technology

Palm sugar-like flavouring (PSLF) can be produced by heating a mixture of amino acids, sugar and sodium phosphate buffer ($NaHPO_4$) via the Maillard reaction. The main problem of the resulting PSLF was the saltiness and presence of a significant amount of acrylamide. Thus, the main objective of this research was to minimise the saltiness and acrylamide without adversely affecting the PSLF aroma quality. This study consisted of the following three main stages: the first stage involved preliminary and response surface methodology (RSM) experiments; the second stage involved the replacement of $NaHPO_4$ with potassium phosphate ($KHPO_4$) buffer; and finally, a sensory evaluation of the optimised PSLF in food was carried out. The modified PSLF buffer system significantly ($p<0.05$) reduced the sodium content from 728.19 ± 26.68 to 45.90 ± 0.55 mg/g fresh weight (FW) in comparison with the original PSLF. PSLF without $CaCl_2$ was found to contain higher acrylamide and lower flavour contents compared to the other concentration levels. Based on

preliminary results, a two-factor, three-level face-centred central composite design was employed to optimise the $CaCl_2$ (20-80 mg/L) and asparagine concentrations (0-25.50 mM). Both $CaCl_2$ and asparagine exhibited a positive linear interaction ($p<0.05$) effect on acrylamide. Acrylamide was lowest in the presence of 20 mg/L $CaCl_2$ and 0 mM asparagine. Both factors imparted a quadratic effect on all of the flavour compounds, namely 2-ethyl-3, 5-dimethylpyrazine (EDMP), 2, 3-diethyl-5-methylpyrazine (DEMP), 5H-5-methyl-6, 7-dihydroxycyclopentapyrazine and 4H-2,5-dimethyl-3(2H)-furanone (furaneol). Without the use of asparagine did not negatively affect the overall PSLF flavour quality. Thus, the optimised concentrations were 20 mg/L $CaCl_2$ and 0 mM asparagine.

By using the optimised formula, the Na_2HPO_4 in PSLF was replaced with various concentrations of K_2HPO_4 to further reduce the sodium content. A 0.200 M concentration of K_2HPO_4 most effectively reduced the sodium content while providing a good flavour profile in the PSLF. This final optimised formula was subjected to hedonic preference testing in comparison to the commercial palm sugars in sago-based palm sugar. PSLF was less preferred and received lower acceptability in contrast to the commercial products, which might be explained by consumer familiarity with the commercial products, causing the testers to not accept the novel taste. Additionally, based on a few comments on the perception of sourness in PSLF, the taste of the product could be improved by further amending the PSLF formula in the future.

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

PEMBANGUNAN PERISA TERPROSES SERUPA GULA KABUNG BEBAS AKRILAMIDA MELALUI TINDAK BALAS MAILLARD

Oleh

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November 2013

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Perisa terproses serupa gula kabung (PSLF) boleh dihasilkan dengan memanaskan campuran asid amino, gula dan penimbal natrium fosfat ($NaHPO_4$) melalui tindak balas Maillard. PSLF yang dihasilkan terasa masin dan mengandungi kuantiti akrilamida yang tinggi. Dengan itu, objektif utama penyelidikan ini adalah untuk mengurangkan kemasinan dan kuantiti akrilamida tanpa menjejaskan kualiti aroma PSLF. Kajian ini merangkumi tiga peringkat utama berikut: peringkat pertama melibatkan kajian awalan dan eksperimen kaedah permukaan gerak balas (RSM); peringkat kedua melibatkan penggantian $NaHPO_4$ dengan penimbal kalium fosfat ($KHPO_4$); dan akhirnya penilaian sensori PSLF optimum telah dijalankan. Sistem penimbal PSLF yang diubahsuai mengurangkan kuantiti natrium secara signifikan ($p<0.05$), dari 728.19 ± 26.68 ke 45.90 ± 0.55 mg/g berat segar (FW) berbanding dengan PSLF asal. PSLF tanpa $CaCl_2$ didapati mengandungi lebih tinggi akrilamida dan lebih rendah kuantiti perisa berbanding dengan tahap kepekatan yang lain.

Berdasarkan keputusan awalan, satu dua-faktor, tiga-tahap reka muka bentuk komposit berpusat telah digunakan untuk mengoptimum kepekatan $CaCl_2$ (20-80 mg/L) dan asparagin (0-25.50 mM). Kedua-dua faktor menunjukkan kesan interaksi linear yang positif ($p<0.05$) terhadap akrilamida. Akrilamida adalah paling rendah dengan gabungan 20 mg/L $CaCl_2$ dan 0 mM asparagin. Kedua-dua faktor memberi kesan kuadratik terhadap semua sebatian perisa, iaitu 2-etil-3,5-dimetilpirizina (EDMP), 2,3-dietil-5-metilpirizina (DEMP), 5H-5-metil-6,7-dihidrosiklopentapirazina dan 4H-2,5-dimetil-3(2H)-furanon (furaneol). Tanpa penggunaan asparagin tidak mempengaruhi kualiti perisa PSLF secara negatif. Justeru itu, kepekatan yang optimum ialah 20 mg/L $CaCl_2$ dan 0 mM asparagin.

Dengan menggunakan formulasi yang optimum, Na_2HPO_4 di dalam PSLF digantikan dengan pelbagai kepekatan K_2HPO_4 untuk mengurangkan kuantiti natrium ke paras yang lebih rendah. Kepekatan K_2HPO_4 0.200 M didapati paling berkesan menurunkan paras natrium di samping menghasilkan profil perisa PSLF yang baik. Formulasi yang optimum ini seterusnya dikaji dengan ujian hedonik berbanding dengan gula kabung komersial di dalam gula kabung sago. Berbeza daripada gula-gula kabung komersial, PSLF kurang disukai dan menerima tahap penerimaan yang lebih rendah. Keadaan ini mungkin boleh diterangkan oleh kebiasaan pengguna terhadap produk komersial, menyebabkan penguji tidak menerima rasa yang novel. Selain itu, berasaskan beberapa komen mengenai kemasaman PSLF, rasa produk ini boleh dipertingkatkan dengan mengubahkan formulasi PSLF lagi pada masa depan.

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I certify that a Thesis Examination Committee has met on 2013 to conduct the final examination of Tan Phui Yee on her thesis entitle "Development of an acrylamide-free palm sugar-like flavouring using the Maillard reaction" is accordance with 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 student be awarded the Master of Science.

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This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfillment of the requirements 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 institution.

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TAN PHUI YEE

Date: 11 November 2013

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