UNIVERSITI PUTRA MALAYSIA

CHARACTERIZATION OF VIRGIN COCONUT OIL AND MULTIPLE INSTRUMENT APPROACH FOR THE DETECTION OF LARD ADULTERATION IN MODEL VIRGIN COCONUT OIL

TENGKU SALWANI BINTI TENGKU MANSOR

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By

TENGKU SALWANI BINTI TENGKU MANSOR

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

November 2011

DEDICATION

I dedicate this thesis to the 4 pillars of my life:

1) Mighty God Allah, who is always there to listen to my prayers
2) My beloved husband, Dr Ahmad Syukri Jamaludin for all your patience and love through sunshine and rain
3) My beautiful son, Ahmad Suhayl for the joy you bring
4) My parents and parents in laws for your unrelenting support

Thank you very much for everything

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

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Chair: Professor Dato' Yaakob Bin Che Man, PhD

Institute: Halal Products Research Institute

The driving force for adulteration is to cut cost and to increase profit. However, in the case of adulteration using animal oils, this would also affect in terms of consumers beliefs and practice such as for Hindus, vegans and vegetarians, Jews and Muslims. For Muslims, adulteration using lard (LD) or improperly slaughtered animal oils is of significant issue. Detecting adulteration in fats and oils especially the high-value oils such as virgin coconut oil (VCO) is indeed needed. The attempt to find the most effective, simple, chemical-free and straightforward analysis without compromising the sensitivity and specificity is essential. Therefore, the overall objective of this study is to apply these three instruments, namely differential scanning calorimeter (DSC), electronic nose/ fast gas-chromatography (fast GC) and Fourier transform infrared (FTIR) spectroscopy to detect LD adulterations in VCO. VCO is prepared through the 'wet' and 'dry' methods, while LD was rendered from adipose tissue of pig using microwave oven. In the first phase, the VCO samples were characterized and analyzed physicochemically. The results showed that in general all VCO samples conformed to the Asian and Pacific Coconut Community

(APCC, 2003) and does not differ strikingly from each other. Subsequently, samples of VCO and LD were mixed in different concentration (*v/v*). Each sample admixtures were subjected to analysis of fast GC, FTIR and DSC. Some chemical analyses were performed such as iodine value (IV) and peroxide value (PV). In addition, fatty acid (FA) and triacylglycerol (TAG) analyses were also conducted using gas chromatography-flame ionization detector (GC-FID) and high performance liquid chromatography (HPLC), respectively, as the control experiments. Simple linear regression on fast GC data demonstrated that three peaks on the fast GC chromatogram were found to fit the second order polynomial curve with R^2 of 0.8121, 0.8349 and 0.9344, respectively. Partial least square (PLS) from FTIR spectroscopy was able to predict LD adulteration in VCO with the equation y = 0.999x + 0.006. Meanwhile, DSC showed that T_e *A* (endset peak *A*) in the endothermic curve and T_r *D* (temperature range for peak *D*) in the exothermic curve were found to have good predictor ability in determining percentage LD adulteration in VCO with the equation from step 2 of stepwise multiple linear regression (SMLR); % LD adulteration = 293.1 – 11.36 (T_e *A*) – 2.17 (T_r *D*) and R^2 adjusted of 95.82. To conclude, all three techniques were able to detect LD in VCO with ease and without the use of chemicals.

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

PENCIRIAN MINYAK KELAPA DARA DAN PENGGUNAAN PELBAGAI INSTRUMEN UNTUK MENGESAN PERCAMPURAN LEMAK KHINZIR DALAM MODEL MINYAK KELAPA DARA

Oleh

TENGKU SALWANI BINTI TENGKU MANSOR

November 2011

Pengerusi: Profesor Dato' Yaakob Bin Che Man, PhD

Institut: Institut Penyelidikan Produk Halal

Pendorong utama terhadap pencemaran dalam makanan adalah untuk mengurangkan kos dan meningkatkan keuntungan. Namun begitu, pencemaran lemak haiwan akan menjejaskan amalan kepercayaan sesetengah penganut beragama Hindu, vegan dan 'vegetarian', penganut agama Yahudi dan juga Muslim. Bagi penganut Islam, penggunaan lemak khinzir (LK) ataupun penggunaan lemak haiwan yang tidak disembelih secara sah merupakan isu yang penting. Pengesanan pencemaran di dalam lemak dan minyak terutamanya minyak yang bernilai tinggi seperti Minyak Kelapa Dara (MKD) memang diperlukan. Percubaan untuk menemui teknik yang paling efektif, mudah dan tidak menggunakan bahan kimia tanpa mengurangkan sensitiviti dan spesifisiti adalah sangat-sangat diperlukan. Oleh itu, objektif keseluruhan kajian ini adalah untuk menggunakan Pembezaan Pengimbasan Kalorimeter (PPK), hidung elektronik/ Kromatografi-gas pantas (KG pantas) dan Pengubah Fourier Inframerah (PFIM) spektroskopi untuk mengesan kehadiran LK di dalam MKD. MKD telah disediakan melalui proses 'kering' dan 'basah', manakala

LK dihasilkan daripada ketuhar gelombang mikro. Pada fasa pertama, sampel-sampel MKD ini dianalisa sifat fizikal dan kimianya dan didapati bahawa secara keseluruhannya semua MKD yang dihasilkan adalah mengikut kriteria yang diberikan oleh Persatuan Kelapa Asian dan Pasifik (APCC, 2003) dan tidak berbeza antara satu sama lain secara keterlaluan. Sampel-sampel MKD dan LK kemudiannya dicampur dalam pelbagai kepekatan (*v/v*). Setiap sampel dianalisa oleh GK pantas, PFIM dan PPK. Analisis kimia juga telah dijalankan ke atas sampel-sampel ini seperti nilai iodin dan nilai peroksida. Analisis asid lemak (AL) dan triasilgliserol (TAG) juga dilakukan menggunakan kromatografi gas-pengesan pengionan nyala (KG-PPN) dan juga Kromatografi Cecair Berprestasi Tinggi (KCBT) sebagai eksperimen kawalan. Analisa Regresi Linear Mudah pada data KG pantas menunjukkan bahawa tiga puncak di kromatogram KG pantas serasi dengan lengkungan polinomial aturan kedua dengan R^2 0.8121, 0.8349 dan 0.9344. Statistik Persegi Separa Terkecil (PST) daripada PFIM juga dapat meramalkan LK di dalam MKD dengan persamaan matematik y = 0.999x + 0.006. Disamping itu, PPK menunjukkan bahawa T_e *A* (suhu akhiran puncak *A*) dan T_r *D* (perbezaan suhu puncak *D*) pada keluk eksoterma dapat mengesan peratus LK di dalam MKD dengan persamaan matematik daripada langkah kedua statistik Regresi Linear Berbilang Langkah (RLBL); yakni % percampuran LK = 293.1 – 11.36 (T_e *A*) – 2.17 (T_r *D*) dan penyesuaian R^2 = 95.82. Sebagai kesimpulan, ketiga-tiga teknik ini berjaya untuk mengsan kehadiran LK di dalam MKD dengan mudah dan tanpa menggunakan bahan kimia.

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Lastly, I greatly appreciate Universiti Putra Malaysia for providing the funds for the study and to give me the chance to study here.

Thank you all.

I certify that a Thesis Examination Committee has met on 29th November 2011 to conduct the final examination of Tengku Salwani Binti Tengku Mansor on her thesis entitled "Characterization of Virgin Coconut Oil and Multiple Instrument Approach for the Detection of Lard Adulteration in Model Virgin Coconut Oil" 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 student be awarded the Masters of Science degree.

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This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfillment of the requirement for the degree of **Masters 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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TENGKU SALWANI BINTI TENGKU MANSOR
Date: 29 November 2011

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