# EFFECT OF PALM-BASED DESICCATED COCONUT FILLING ON FAT MIGRATION IN FILLED CHOCOLATES

**By**

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

**March 2006**

**This thesis is special dedicated to my beloved parents and sisters**

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

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**Chairperson : Professor Jinap Selamat, PhD**

**Faculty : Food Science and Technology**

**Local ingredients such as desiccated coconut, palm mid-fraction (PMF), and refined, bleached, deodorised palm kernel stearin (RBD PKS) has the potential to be used as filling in chocolates. However, softening and bloom formation on chocolate coating have been major problems. The objectives of this study were to develop desiccated coconut filled chocolate using PMF and RBD PKS as the filling fats, to study the mechanism of fat migration and to determine the effectiveness of chitosan in controlling fat migration. Three formulations of filling containing RBD PKS with different ratio of icing sugar and desiccated coconut (5:1, 2:1, and 1:1) were developed and sensory qualities were evaluated by 80 panelists on hardness, taste (sweetness, coconut flavour) and overall acceptability. The most preferred formulation, 5:1 ratio of icing sugar and desiccated coconut, was used in developing the product. It was latter compared against PMF-desiccated coconut filled chocolate in terms of organoleptic properties (hardness, flavour, melt away and overall acceptability), physical (texture analysis) and shelf life (visual inspection of fat bloom formation) prior**

**to sensory quality assessment on hardness, sweetness, coconut flavour and overall acceptability by 30 panelists against imported similar products. Results showed that PMF-desiccated coconut filled chocolate with maximum penetration force (MPF) of 1516.1±66.8 g was more accepted in terms of hardness and overall acceptability compared to RBD PKS (MPF: 1860.3±50.4 g). Shelf life of dark chocolate filled with PMF-desiccated coconut filling was higher (7 weeks) than that with RBD PKS (5 weeks). These products were comparable in terms of sweetness, coconut flavour and overall acceptability with the imported similar products. In determining the mechanism and effect of chitosan on fat migration, untreated and treated sample with different concentrations of chitosan (0.0, 1.0, 3.0 and 5.0%) were stored at 30$^{o}$C for 3 months. Physical properties (texture analysis, bloom test, solid fat content), chemical analysis (total fat content, fatty acid and triacylglycerol composition) and sensory evaluation (hardness, glossiness) were conducted at week 0, 1, 3, 5, 7, 9, and 11. Fat migration of all the PMF-filled samples showed a rapid increase from filling to coating from 0 to 7 weeks of storage and dropped after week-7. Similar profile was observed for all the RBD PKS-filled chocolates, which reached equilibrium stage after week-5. Both chitosan treated samples for PMF and RBD PKS showed no significant difference ($p>0.05$) with the control in terms of physicochemical and sensory properties.**

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

**KESAN BAGI INTI KELAPA PARUT KERING BERASASKAN SAWIT KE ATAS MIGRASI LEMAK DALAM COKLAT-COKLAT BERINTI**

**Oleh**

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**Ramuan tempatan seperti kelapa parut kering, pecahan tengah minyak sawit (PMF) dan minyak isirong stearin yang telah disuling, dinyahwarna serta dinyahbau (RBD PKS) berpotensi untuk digunakan sebagai inti dalam coklat. Namum begitu, kelembikan serta pembentukan bebunga lemak pada salutan coklat telah menjadi masalah utama. Objektif kajian ini adalah untuk menghasilkan coklat berinti kelapa parut kering yang menggunakan PMF dan RBD PKS sebagai minyak isian; mengkaji mekanisasi bagi migrasi lemak; dan menilai keberkesanan kitosan dalam pengawalan migrasi lemak. Tiga formulasi inti yang mengandungi RBD PKS dan nisbah gula aising kepada kelapa parut kering yang berbeza (5:1, 2:1, dan 1:1) telah dihasilkan dan ciri-ciri sensori dinilai oleh 80 orang panel ke atas kekerasan, rasa (kemanisan, rasa kelapa) dan penerimaan keseluruhan. Formulasi yang paling digemari pada kadar 5:1 bagi gula icing dan kelapa parut kering kemudian digunakan untuk menghasilkan coklat berinti PMF-kelapa parut kering. Produk ini kemudian dibandingkan di antara satu sama lain dari segi ciri-ciri organoleptik (kekerasan, bau, kepantasan melebur dan penerimaan keseluruhan), fizikal (analisis tekstur) dan hayat penyimpanan (pemerhatian bagi pembentukan**

**bebunga lemak) sebelum penilaian kualiti sensori ke atas kekerasan, kemanisan, rasa kelapa dan penerimaan keseluruhan) oleh 30 orang panel terhadap produk coklat berinti kelapa parut kering yang diimport. Coklat kosong berinti PMF-kelapa parut kering yang mempunyai kuasa penebusan maksima (MPF) sebanyak 1516.1±66.8 g adalah lebih digemari dari segi kekerasan dan penerimaan keseluruhan berbanding dengan inti yang berasaskan RBD PKS (MPF: 1860.3±50.4 g). Hayat penyimpanan coklat kosong berinti PMF-kelapa parut kering adalah lebih lama (7 minggu) berbanding dengan RBD PKS (5 minggu). Produk-produk tersebut adalah setanding dengan produk coklat berinti kelapa parut kering yang diimport dari segi kemanisan, rasa kelapa serta penerimaan keseluruhan. Untuk mengkaji mekanisasi serta keberkesanan kitosan ke atas migrasi lemak, sample tanpa rawatan dan dirawat dengan kitosan pada kepekatan yang berbeza (0.0, 1.0, 3.0 dan 5.0%) telah disimpan pada suhu 30$^{o}$C selama 3 bulan. Ciri-ciri fizikal (analisis tekstur, ujian pembentukan bebunga lemak, kandungan lemak pejal), analisis kimia (kandugan lemak, komposisi asid lemak dan trigliserol) serta penilaian sensori (kekerasan, kekilauan) telah dikendalikan pada minggu ke-0, 1, 3, 5, 7, 9 dan 11. Semua sampel berasakan PMF telah menunjukkan migrasi lemak yang cepat dari inti ke salutan dari minggu-0 hingga minggu ke-7 dan menurun selepas minggu ke-7. Profil yang sama juga dapat dilihat pada semua coklat berinti RBD PKS dengan kadar migrasi mencapai tahap keseimbangan selepas minggu ke-5. Kedua-dua sampel yang telah dicampurkan dengan kitosan tidak menunjukkan perbezaan yang signifikan ($p>0.05$) dengan sampel kawalan dari segi ciri-ciri fizikal, kimia dan sensori.**

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**and sacrifices, which had helped me in undertakings and completing this research study.**

**I certify that an Examination Committee has met on 1st March 2006 to conduct the final examination of Chin Hui Han on her Master of Science thesis entitled "Effect of Palm-Based Desiccated Coconut Filling on Fat Migration in Filled Chocolates" in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulations 1981. The Committee recommends that the candidate be awarded the relevant degree. Members of the Examination Committee are as follows:**

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## DECLARATION

**I hereby declare that the thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at UPM or other institutions.**

_____

**CHIN HUI HAN**

**Date:**

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## LIST OF ABBREVIATIONS

| | |
|---|---|
| **Approx.** | **Approximate** |
| **ASEAN** | **Association of South East Asian Nations** |
| **b.p.** | **Boiling Point** |
| **CAOBISCO** | **Association of Candy and Biscuit makers (in the European Economic Community)** |
| **CB** | **Cocoa Butter** |
| **CBE** | **Cocoa Butter Equivalent** |
| **CBS** | **Cocoa Butter Substitute** |
| **cm** | **Centimetre** |
| **CN** | **Carbon Number** |
| **CNP** | **Carbon Number Profile** |
| **Conc.** | **Concentration** |
| **DCN** | **Desiccated Coconut** |
| **d.f.** | **Film thickness / Diameter of Film** |
| **g** | **Gram** |
| **HDL** | **High Density Lipoprotein** |
| **HPLC** | **High Performance Liquid Chromatography** |
| **$H_3PO_4$** | **Phosphoric Acid** |
| **i.d.** | **Internal Diameter** |
| **kg** | **Kilogram** |
| **LDL** | **Low Density Lipoprotein** |
| **LLL** | **Trilaurin** |
| **LLM** | **1,2-Dilauro-myristin** |
| **m** | **Meter** |
| **mg** | **Milligram** |

| | |
|---|---|
| **mg KOH/g** | **Milligram Kalium Hydroxide per Gram** |
| **mm** | **Millimetre** |
| **mm/s** | **Millimetre per Second** |
| **ml** | **Millilitre** |
| **ml/min** | **Millilitre per Minute** |
| **MPF** | **Maximum Penetration Force** |
| **MW** | **Molecular Weight** |
| **N** | **Normality** |
| **N.Y.** | **New York** |
| **OOO** | **Triolein** |
| **PKO** | **Palm Kernel Olein** |
| **PKS** | **Palm Kernel Stearin** |
| **PLiO** | **1-Palmito-2-Linolo-3-Olein** |
| **PLiP** | **1,3-Dipalmito-2-Linolien** |
| **PMF** | **Palm Mid-Fraction** |
| **POO** | **1-Palmito-2, 3-Diolein** |
| **POP** | **1, 3-Dipalmito-2-Olein** |
| **POS** | **1-Palmito-2-Oleo-3-Stearin** |
| **PPO** | **1, 2-Dipalmito-3-Olein** |
| **PPP** | **Tripalmitin** |
| **QDA** | **Quantitative Descriptive Analysis** |
| **RBD PKS** | **Refine, Bleached and Deodorised Palm Kernel Stearin** |
| **SFC** | **Solid Fat Content** |
| **SLO** | **1-Stearo-2-Linolo-3-Olein** |
| **SOO** | **1-Stearo-2,3-Diolein** |

| | |
|---|---|
| **SOS** | **1, 3-Distearo-2-Olein** |
| **SUS** | **Saturated-Unsaturated-Saturated** |
| **TG** | **Triacylglycerol** |
| **U.K.** | **United Kingdom** |
| **U.S.A** | **United State of America** |
| **USFA** | **Unsaturated Fatty Acids** |
| **v/v** | **Volume per Volume** |
| **w/v** | **Weight per Volume** |
| **μl** | **Micro litre** |
| **μm** | **Micrometer** |
| **%** | **Percentage** |
| **% wt.** | **Percentage of Weight** |
| α | **Alpha** |
| β | **Beta** |
| $\beta_1$ | **Beta-1** |
| $\beta_2$ | **Beta-2** |
| β’ | **Second Beta** |
| $\beta'_1$ | **Second Beta-1** |
| $\beta'_2$ | **Second Beta-2** |
| γ | **Gamma** |