FORMATION AND CHARACTERISTICS OF ENGKABANG-BASED NANO-COSMECEUTICALS

SITI SALWA ABD GANI
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FORMATION AND CHARACTERISTICS OF ENGKABANG-BASED NANO-COSMECEUTICALS

By

SITI SALWA ABD GANI

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

July 2010
DEDICATED TO:

My family: Abah & Emak, my siblings,
my nephews and nieces

For your unwavering support, love and what you mean to me.
FORMATION AND CHARACTERISTICS OF ENGKABANG-BASED NANO-COSMECEUTICALS

By

SITI SALWA ABD GANI

July 2010

Chairman: Professor Dr. Mahiran Basri, PhD
Faculty: Science

Engkabang fat esters were synthesized from engkabang fat using Lipozyme® RM IM as a catalyst. The main composition of the fat esters were oleyl palmitate, oleyl stearate and oleyl oleate. The percentage yield was 93.67%.
Phase behaviors of engkabang fat and engkabang fat esters were determined through the construction of ternary phase diagrams using nonionic surfactants.
The increase of hydrophilic lipophilic balance (HLB) value of the surfactant gave larger homogenous and isotropic region in both ternary phase diagrams of Engkabang fat/Nonionic surfactant/Deionized water and Engkabang fat esters/Nonionic surfactant/Deionized water. Homogenous and isotropic regions were larger in the phase diagrams of engkabang wax esters compared to the phase diagrams of engkabang fat. Compositions of homogenous region from the ternary phase diagrams were selected as a pre-formulated cosmeceuticals
emulsions. Then, they were modified with the additions of solubilisant gamma, glycerin, xanthan gum and beeswax in an attempt to get stable formulations at high temperature.

Formulations F10 and E15 were chosen for further studies due to the stability at 45°C. They were prepared using high shear homogenizer, followed by using high pressure homogenizer. Both formulations were stable at room temperature, at 45°C and after undergoing thaw cycles test. The particle sizes of F10 and E15 after using high pressure were 115.75 nm and 148.41 nm, respectively. The zeta potential of F10 and E15 at 25°C were -36.4 mV and -48.8 mV and the pH values were 5.59 and 5.81, respectively. The rheology of F10 and E15 showed pseudoplastic material with shear thinning properties. There were no bacteria and fungus growth in the samples. Short-term moisturizing effect on 20 subjects analyzed by means of Analysis of Variance (ANOVA), gave P-values of $7.35 \times 10^{-12}$ and $2.77 \times 10^{-15}$ for F10 and E15, respectively. The hydration of the skins increased after application of F10 and E15 with P-value below 0.05.

The formulations of encapsulated and non-encapsulated titanium dioxide using engkabang fat and esters were produced by emulsification method using high shear homogenizer. All the formulations were stable after undergoing thaw cycles test, at room temperature and 45°C for three months except for Formulations F10-4A and F10-6A. The particle sizes of formulations were in...
range 80 nm to approximately 400 nm. Surface charge measurements of formulations having values from -30 mV to -59 mV denoted the presence of stable dispersions.

The morphological characterization confirmed the encapsulations of titanium dioxide in the formulations. The rheology analysis of the formulations showed shear thinning property as when the shear rate increased, the viscosity decreased. Formulations containing Engkabang fat could be classified as the thixotropic materials, whereby formulations containing Engkabang fat esters could be classified as pseudo plastic materials under a non-Newtonian fluid. Increasing amount of TiO$_2$ gave higher pH values of the formulations and higher conductivity. The TGA thermograms showed three major weight losses due to the evaporation of water content, evaporation of water content in lattice structure and decomposition of oil phase. The stable formulations containing encapsulated of TiO$_2$ gave higher absorbance compared to the formulations containing non-encapsulated of TiO$_2$. 
Abstrak tesis dikemukakan kepada Senat Universiti Putra Malaysia bagi memenuhi syarat untuk mendapatkan ijazah Doktor Falsafah

PENGHASILAN DAN SIFAT-SIFAT EMULSI BERASASKAN ENGKABANG DALAM BIDANG NANO-KOSMESUTIKAL

Oleh

SITI SALWA ABD GANI

Julai 2010

Pengerusi: Profesor Dr. Mahiran Basri, PhD

Fakulti: Sains

Ester lemak engkabang disintesis daripada lemak engkabang menggunakan Lipozyme® RM IM. Komposisi utama daripada ester lemak adalah oleyl palmitate, oleyl stearate dan oleyl oleate. Peratusan penghasilan adalah 93.67%. Fasa perilaku lemak engkabang dan ester lemak engkabang ditentukan dengan menggunakan rajah tiga fasa menggunakan surfaktan tidak berion. Peningkatan nilai keseimbangan sifat suka air dan minyak (HLB) surfaktan memberikan fasa homogen dan isotropik yang lebih besar di kedua-dua wilayah diagram tiga fasa lemak engkabang / surfaktan tak berion / air dinyah ion dan lemak ester engkabang / surfaktan tak berion / air dinyah ion. Fasa homogen dan isotropik lebih besar dalam rajah tiga fasa ester lemak engkabang dibandingkan dengan rajah tiga fasa lemak engkabang. Fasa homogen dari diagram tiga fasa dipilih sebagai emulsi awal kosmesutikal.
Kemudian, formulasi itu diubahsuai dengan penambahan solubilisant gamma, glycerin, xanathan gum dan beeswax untuk mendapatkan formulasi yang stabil pada suhu tinggi.


Formulasi mengandungi enkapsulasi dan tidak enkapsulasi titanium dioksida menggunakan lemak dan ester engkabang dihasilkan melalui kaedah pengemulsian menggunakan mesin pengemulsi bertekanan tinggi. Semua formulasi adalah stabil selepas menjalani ujian kitaran mencair, pada suhu bilik
dan 45⁰C selama tiga bulan, kecuali formulasi F10-4A dan F10-6A. Saiz zarah formulasi adalah antara 80 nm ke 400 nm. Pengukuran cas permukaan formulasi menunjukkan nilai daripada -30 mV ke-59 mV mengesahkan kestabilan formulasi-formulasi tersebut.

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In the name of Allah S.W.T the compassionate and merciful, I would like to express my deepest gratitude to Allah S.W.T. for allowing me to complete my study. I wish to express my sincere appreciation to my supervisor, Prof. Dr. Mahiran Basri for her valuable guidance, advice, supervision, patience, and suggestions during the period of this study. My appreciation also goes to my co-supervisors, committee members and EMTECH group’s principle researchers; Prof. Dr. Mohd Basyaruddin Abdul Rahman, Prof. Dr. Anuar Kassim, Prof. Dr. Raja Noor Zaliha Raja Abd Rahman, Prof. Dr. Abu Bakar Salleh, Dr. Zahariah Ismail for their valuable time, comments, encouragement and moral support.

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I certify that a Thesis Examination Committee has met on 1st July 2010 to conduct the final examination of Siti Salwa Abd Gani on her thesis entitled “Formation and Characteristics of Engkabang-based Nano-Cosmeceuticals” in accordance with Universities and Universities 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 Doctor of Philosophy Degree.

Members of the Thesis Examination Committee were as follows:

Zulkarnain Zainal, Ph.D
Professor
Faculty of Science
Universiti Putra Malaysia
(Chairman)

Faujan Hj. Ahmad, Ph.D
Professor
Faculty of Science
Universiti Putra Malaysia
(Internal Examiner)

Mohd Aspollah Hj. Md. Sukari, Ph.D
Professor
Faculty of Science
Universiti Putra Malaysia
(Internal Examiner)

Shahidan Radiman, Ph.D
Professor
Faculty of Science and Technology
Universiti Kebangsaan Malaysia
Malaysia
(External Examiner)

BUJANG BIN KIM HUAT, PhD
Professor and Deputy Dean
School of Graduate Studies
Universiti Putra Malaysia

Date:
This thesis is submitted to the Senate of University Putra Malaysia has been accepted as fulfillment of the requirements for the degree of Doctor of Philosophy. The members of Supervisory Committee are as follows:

**Mahiran Basri, PhD**  
Professor  
Faculty of Science  
Universiti Putra Malaysia  
(Chairperson)

**Anuar Kassim, PhD**  
Professor  
Faculty of Science  
Universiti Putra Malaysia  
(Member)

**Raja Noor Zaliha Raja Abd Rahman, PhD**  
Professor  
Faculty of Biotechnology and Biomolecular Science  
Universiti Putra Malaysia  
(Member)

**Zahariah Ismail, PhD**  
Chief Chemist 1  
Banting, Selangor, Malaysia  
(Member)

---

**HASANAH MOHD. GHAZALI, PhD**  
Professor and Dean  
School of Graduate Studies  
Universiti Putra Malaysia

Date: 12 August 2010
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 Universiti Putra Malaysia or other institutions.

_______________________
(SITI SALWA ABD GANI)
Date:
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4.30 TEM Micrograph of F10-2A (2% Encapsulated TiO$_2$) at 60 000x Magnification

4.31 TEM Micrograph of F10-2B (2% Non-encapsulated TiO$_2$) at 100 000x Magnification

4.32 TEM Micrograph of E15(1) (without TiO$_2$) at 60 000x Magnification

4.33 TEM Micrograph of E15(1)-2A (2% Encapsulated TiO$_2$) at 60 000x Magnification

4.34 TEM Micrograph of E15(1)-6A (6% Encapsulated TiO$_2$) at 70 000x Magnification

4.35 TEM Micrograph of E15(1)-2B (2% Non-encapsulated TiO$_2$) at 100 000x Magnification

4.36 Graph of Shear Stress ($\tau$) and Apparent Viscosity ($\eta$) Versus Shear Rate ($\gamma$) for (a) F10-2A, (b) F10-2B, (c) F10-4A, (d) F10-4B, (e) F10-6A and (f) F10-6B

4.37 Graph of Shear Stress ($\tau$) and Apparent Viscosity ($\eta$) Versus Shear Rate ($\gamma$) for (a) E15(1)-2A, (b) E15(1)-2B, (c) E15(1)-4A, (d) E15(1)-4B, (e) E15(1)-6A and (f) E15(1)-6B

4.38 PH Values of EF Formulations with Increasing Amount of TiO$_2$

4.39 PH Values of EFE Formulations with Increasing Amount of TiO$_2$

4.40 Conductivity Measurement of EF Formulations with Increasing Amount of TiO$_2$

4.41 Conductivity Measurement of EFE Formulations with Increasing Amount of TiO$_2$

4.42 TGA Thermogram of F10

4.43 TGA Thermogram of F10-2A