



**UNIVERSITI PUTRA MALAYSIA**

**Polymorphic Structures of Ternary Blends of Dihydroxystearic Acid-  
Octy Dihydroxystearate with RBD Palm Kernel Olein and Medium  
Chain Triglycerides**

**RATHIDEVI NADARAJAN**

**FS 2008 6**



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**By**

**RATHIDEVI NADARAJAN**

**Thesis Submitted in Fulfilment of the Requirements for the  
Degree of Master of Science  
Universiti Putra Malaysia**

**June 2008**



## DEDICATIONS

*Specially goes to:*

*My Husband, Richard Nesan*

*Both my parents*

*My dad, Nadarajan*

*My mom, Sarasuazi*

*'For the energy, enthalpy and the equilibrium'*



Abstract of thesis presented to the Senate of Universiti Putra Malaysia in  
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**RATHIDEVI NADARAJAN**

**June 2008**

**Chairman : Professor Anuar Kassim, PhD**

**Faculty : Science**

The objective is to study the phase behaviors in ternary system of DHSA/DHSA-octyl ester/RBD Palm Kernel Olein (RBDPKOo) & Medium Chain Triglycerides (MCT) and DHSA&DHSA-octyl ester/Glycerine/RBD Palm Kernel Olein(RBDPKOo) & Medium Chain Triglycerides (MCT) at 85°C. The phase changes were observed through polarizing light while the formation of texture was confirmed using polarizing microscope combination with heating. From the ternary phase diagrams, results showed that all ratios of DHSA/DHSA-octyl ester and DHSA&DHSA-octyl ester/Glycerine were completely in two-phase region with various concentrations of RBDPKOo and MCT. Needles and spherulite textures were found in these systems.



The rheological analysis showed the deformation and flow behaviour of DHSA/DHSA-Octyl ester/RBDPKOo&MCT and DHSA&DHSA-Octyl ester/Glycerine/RBDPKOo&MCT respectively. For the ternary phase of DHSA/DHSA-octyl ester/RBDPKOo&MCT, the viscosity value is increasing due to the decreasing of DHSA-octyl ester and increasing of DHSA in the mixture. For the phase of DHSA&DHSA-octyl ester/Glycerine/RBDPKOo&MCT, the viscosity value increases at first and then decreases which shows the viscosity value have no trend. In term of thixotropy value, most of the ratio showing a lowest strength breakdown in both ternary system of DHSA/DHSA-Octyl ester/RBDPKOo & MCT and DHSA & DHSA-Octyl ester / Glycerine / RBDPKOo&MCT.

DSC analysis showed that, three endothermic peaks were observed for the phase of DHSA/DHSA-Octyl ester at 50% RBDPKOo&MCT and DHSA&DHSA-Octyl ester/Glycerine at 50% RBDPKOo/MCT. The melting point of DHSA-Octyl ester showed from the range 47 to 66<sup>o</sup>C and the melting point of DHSA showed from the range 77 to 88<sup>o</sup>C. Besides that, the melting point of mixture DHSA/DHSA-Octyl ester/RBDPKOo&MCT was from the range 59 to 68<sup>o</sup>C and the melting point of mixture of DHSA&DHSA-Octyl ester/Glycerine/RBDPKOo&MCT was from the range 69 to 71<sup>o</sup>C.



Hence, DHSA, DHSA-Octyl ester, RBDPKOo and MCT were developed into the cosmetic formulation by preparing them into emulsion system. Stable formulations at 20:80, 30:70 and 50:50 of DHSA: DHSA-Octyl ester was chosen as a best formulation due to the stability test, size of particle and rheological test in the emulsion systems.



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

**STRUKTUR POLIMORPIK DALAM  
ASID DIHIDROKSISTEARIK/OKTIL DIHIDROKSISTEARAT/ RBD OLEIN  
KERNEL KELAPA SAWIT & TRIGLISERIDA RANTAI SEDERHANA.**

**Oleh**

**RATHIDEVI NADARAJAN**

**Jun 2008**

**Pengerusi : Profesor Anuar Kassim, PhD**

**Fakulti : Sains**

Tujuan kajian ini dijalankan untuk mengkaji ciri-ciri fasa dalam sistem tiga fasa bagi Acid Dihidroksistearik / Oktil Dihidroksistearat / RBD Olein Kernel kelapa sawit & Trigliserida rantai sederhana dan Acid Dihidroksistearik & Oktil Dihidroksistearat /Gliserin/ RBD Olein Kernel kelapa sawit & Trigliserida rantai sederhana pada 85°C. Penukaran fasa diperhatikan melalui cahaya berkutub dan pembentukan hablur ditentukan melalui mikroskop berkutub semasa pemanasan. Dari sistem tiga fasa, Acid Dihidroksistearik / Oktil Dihidroksistearat dan Acid Dihidroksistearik & Oktil Dihidroksistearat /Gliserin



menunjukkan dua fasa larutan dengan kepekatan RBD Olein Kernel kelapa sawit dan trigliserida rantai sederhana yang berlainan. Hablur jejaram dan sperulit terbentuk dalam sistem ini .

Analisis reologi menunjukkan sifat aliran dan nyah bentuk bagi Acid Dihidroksistearik / Oktil Dihidroksistearat /RBD Olein Kernel kelapa sawit & Trigliserida rantai sederhana dan Acid Dihidroksistearik & Oktil Dihidroksistearat /Gliserin/RBD Olein Kernel kelapa sawit & Trigliserida rantai sederhana masing-masing. Dalam sistem tiga fasa , Acid Dihidroksistearik / Oktil Dihidroksistearat / RBD Olein Kernel kelapa sawit & Trigliserida rantai sederhana, kelikatan sampel semakin bertambah dengan pengurangan oktil dihidroksistearat dan penambahan acid dihidroksistearik. Bagi fasa yang melibatkan Acid Dihidroksistearik & Oktil Dihidroksistearat /Gliserin dan RBD Olein Kernel kelapa sawit & Trigliserida rantai sederhana, pada mulanya kelikatan sampel semakin bertambah dan kemudian berkurang menunjukkan kelikatan sample yang tidak serata. Dari nilai tiksotropi, kebanyakan sampel menunjukkan tenaga pemecahan yang rendah dalam fasa Acid Dihidroksistearik / Oktil Dihidroksistearat /RBD Olein Kernel kelapa sawit & Trigliserida rantai sederhana dan Acid Dihidroksistearik & Oktil Dihidroksistearat /Gliserin/ RBD Olein Kernel kelapa sawit & Trigliserida rantai sederhana.



Analisis DSC menunjukkan tiga puncak endotermik bagi sistem tiga fasa yang melibatkan Acid Dihidroksistearik & Oktil Dihidroksistearat /RBD Olein Kernel kelapa sawit & Trigliserida rantai sederhana. dan Acid Dihidroksistearik & Oktil Dihidroksistearat /Gliserin/ RBD Olein Kernel kelapa sawit & Trigliserida rantai sederhana . Takat lebur oktil dihidroksistearat ditunjukkan dari suhu 47 hingga 66°C dan takat lebur acid dihidroksistearik ditunjukkan dari suhu 77 hingga 88°C. Manakala, takat lebur bagi campuran Acid Dihidroksistearik / Oktil Dihidroksistearat /RBD Olein Kernel kelapa sawit & Trigliserida rantai sederhana ditunjukkan dari suhu 59 hingga 68°C dan takat lebur bagi campuran Acid Dihidroksistearik & Oktil Dihidroksistearat /Gliserin/ RBD Olein Kernel kelapa sawit & Trigliserida rantai sederhana pula ditunjukkan dari suhu 69 hingga 71°C.

Maka, acid dihidroksistearik, oktil dihidroksistearat, RBD Olein Kernel kelapa sawit dan Trigliserida rantai sederhana telah diperkembangkan dalam formulasi kosmetik. Formulasi 20:80, 30:70 dan 50:50, Acid Dihidroksistearik : Oktil Dihidroksistearate adalah nisbah yang terbaik dalam formulasi kosmetik dari segi kestabilan sampel, saiz partikel dan reologi analisis dalam emulsi sistem.

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Finally, I wish to express gratefulness to my beloved husband, my family, my friends especially Puan Marisol, Mr. Zaihanif, Miss Ayu and all those who have contributed in every aspect and whom I had in advertently omitted mentioning.



I certify that an Examination Committee has met 30<sup>th</sup> June 2008 to conduct the final examination of Rathidevi Nadarajan on her Master Of Science thesis entitled "Polymorphic Structure in Dihydroxystearic Acid/Octyl dihydroxystearate /RBD Palm Kernel Olein & Medium Chain Tryglicerides" 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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Professor and Dean of  
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Date: 11 September 2008



## 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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**RATHIDEVI      NADARAJAN**

Date : 24<sup>th</sup> July 2008



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## LIST OF ABBREVIATIONS

DHSA	Dihydroxystearic Acid
DHSA-Octyl ester	Octyl dihydroxystearate
MCT	Medium Chain Triglycerides
RBDPKOo	RBD Palm Kernel Olein
DSC	Differential Scanning Calorimeter
°C	Celsius
LC	Liquid crystal
HLB	Hydrophile-Lipophile Balance
W/O	Water- in -oil
O/W	Oil -in -water
W/O/W	Water-in-oil-in water
$\sigma_Y$	Yield stress



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