



**UNIVERSITI PUTRA MALAYSIA**

**PRODUCTION AND CHARACTERISATION OF DIACYLGLYCEROLS  
FROM VARIOUS EDIBLE OIL DEODORISER DISTILLATES BY LIPASE-  
CATALYSED ESTERIFICATION**

**LO SEONG KOON**

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CATALYSED ESTERIFICATION**

**By**

**LO SEONG KOON**

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**February 2003**

**Chairman : Associate Professor Badlishah Sham Baharin, M.Sc.**

**Faculty : Food Science and Biotechnology**

Diacylglycerols (DAG) are minor acylglycerols (< 10% w/w) found in edible oils and fats. Recently, 1,3-DAG has been found to prevent and manage obesity. Consequently, the novel industrial production process of 1,3-DAG was patented worldwide (US 2001/0004462) by Kao Corporation, Japan. In this work, an alternative process to produce 1,3-DAG was discovered. The process comprised of esterifying free fatty acids from edible oil deodoriser distillates with glycerol by using 1,3-position specific lipases. Deodoriser distillates from the processing of palm, soybean, canola and corn oils were used.

The effects of esterification reaction parameters such as the source of 1,3-position specific lipase, reaction time, lipase concentration, reaction temperature, total fatty acid to glycerol molar ratio, water and molecular sieves contents were conducted. *Rhizomucor miehei* lipase (Lipozyme<sup>®</sup> RM IM) was found to be the best performing lipase. The reaction time required for optimum production of DAG is at 6 h for palm oil deodoriser distillate, and 4 to 5 h for soybean, canola and corn oil deodoriser distillates. The following reaction parameters resulted in optimum yield of

DAG: 10% (w/w) of Lipozyme<sup>®</sup> RM IM, reaction temperature of 65 °C, total fatty acid to glycerol molar ratio of 2.5: 1, total absence of water in the substrates, and the presence of molecular sieves of 30% (w/w). DAG yield of 60 to 72% and DAG purity of 82 to 85% were obtained.

DAG produced from the deodoriser distillates and their various blends were characterised for their fatty acid and DAG compositions, iodine values (IV), thermal profiles, and slip melting points (SMP). The analytical results indicated that DAG produced from palm oil deodoriser distillate had lower degrees of unsaturation and, therefore, had higher melting points compared with that from soybean, canola and corn oil deodoriser distillates. DAG produced from soybean oil deodoriser distillate had the highest degree of unsaturation.

In the DAG produced from soybean, canola, and corn oil deodoriser distillates,  $\beta$ -sitosterol, campesterol and stigmasterol were the dominant phytonutrients, while tocotrienols were the major phytonutrient in the DAG produced from palm oil deodoriser distillate. The phytosterol and vitamin E compositions in the DAG produced from the various blends varied according to the proportion of the distillate used.

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

**PENGHASILAN DAN PENCIRIAN DIASILGLISERIDA DARIPADA  
SULINGAN PENYAHBAU DENGAN MENGGUNAKAN ESTERIFIKASI  
BERMANGKIN LIPASE**

Oleh

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**Februari 2003**

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Diasilgliserida (DAG) boleh didapati secara semulajadi dalam kuantiti yang kecil (< 10% b/b) di dalam kebanyakan minyak dan lemak yang boleh dimakan. Baru-baru ini, 1,3-DAG telah didapati boleh mencegah dan mengawal obesiti. Dengan itu, satu proses penghasilan 1,3-DAG secara industri telah dipatenkan di seluruh dunia (US 2001/0004462) oleh syarikat Kao Corporation, Jepun. Dalam kajian ini, satu proses alternatif untuk menghasilkan 1,3-DAG telah ditemui. Proses ini melibatkan esterifikasi asid lemak yang terdapat pada sulingan penyahbau dan gliserol dengan menggunakan lipase khusus posisi 1,3. Sulingan penyahbau daripada pemprosesan minyak-minyak kelapa sawit, kacang soya, kanola dan jagung telah digunakan.

Kajian tentang kesan parameter tindakbalas esterifikasi seperti sumber lipase khusus berposisi 1,3, masa tindakbalas, kepekatan lipase, suhu tindakbalas, nisbah molar jumlah asid lemak kepada gliserol, kandungan air dan penapis molekul telah dilakukan. Lipase *Rhizomucor miehei* (Lipozyme<sup>®</sup> RM IM) merupakan lipase yang terbaik. Masa tindakbalas yang diperlukan untuk penghasilan DAG yang optima

adalah 6 jam untuk sulingan penyahbau minyak kelapa sawit, dan 4 hingga 5 jam untuk sulingan penyahbau minyak-minyak kacang soya, kanola dan jagung. Kajian ini juga mendapati bahawa parameter tindakbalas berikut menyebabkan penghasilan DAG yang optima: Lipozyme<sup>®</sup> RM IM 10% (b/b), suhu tindakbalas 65 °C, nisbah molar jumlah asid lemak kepada gliserol pada 2.5: 1, ketidakhadiran air pada substrat, dan kehadiran 30% (b/b) penapis molekul. Hasil DAG antara 60 hingga 72% dan tahap ketulenan DAG di antara 82 hingga 85% telah didapati.

Komposisi asid lemak dan DAG, nilai iodin, profil terma, dan takat lebur telah digunakan untuk mencirikan DAG yang dihasilkan daripada sulingan penyahbau dan campuran sulingan. Hasil kajian menunjukkan bahawa DAG yang dihasilkan daripada sulingan penyahbau minyak kelapa sawit mengandungi tahap ketidaktepuan yang rendah dan, oleh itu, mempunyai takat lebur yang lebih tinggi berbanding dengan DAG yang dihasilkan daripada sulingan penyahbau minyak-minyak kacang soya, kanola dan jagung. DAG yang dihasilkan daripada sulingan penyahbau minyak kacang soya mempunyai tahap ketidaktepuan yang tertinggi.

Dalam DAG yang dihasilkan daripada sulingan penyahbau minyak-minyak kacang soya, kanola dan jagung,  $\beta$ -sitosterol, kampesterol dan stigmasterol adalah fitonutrien yang utama, manakala tokotrienol adalah fitonutrien yang utama di dalam DAG yang dihasilkan daripada sulingan penyahbau minyak kelapa sawit. Komposisi fitosterol dan vitamin E dalam DAG yang dihasilkan daripada campuran sulingan didapati berubah mengikut nisbah sulingan yang digunakan.

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I certify that an Examination Committee met on the 20<sup>th</sup> of February 2003 to conduct the final examination of Lo Seong Koon on his Master of Science thesis entitled "Production and Characterisation of Diacylglycerols from Various Edible Oil Deodoriser Distillates by Lipase-catalysed Esterification" 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. The 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 currently submitted for any other degree at UPM or other institutions.



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**LO SEONG KOON**

Date: 20 February 2003

## TABLE OF CONTENTS

	<b>Page</b>
ABSTRACT	2
ABSTRAK	4
ACKNOWLEDGEMENTS	6
APPROVAL	7
DECLARATION	9
LIST OF TABLES	14
LIST OF FIGURES	20
LIST OF ABBREVIATIONS	29
<b>CHAPTER</b>	
I INTRODUCTION	38
II LITERATURE REVIEW	41
Obesity	41
Functional Foods and Ingredients	44
Introduction	44
Functional Lipids – structured lipids	45
Diacylglycerols	51
Introduction	51
1,3-Diacylglycerols (1,3-DAG)	54
Metabolic Process of Triacylglycerols (TAG)	55
Metabolic Process of 1,3-Diacylglycerols (1,3-DAG)	57
Advantages of 1,3-DAG Over TAG as Dietary Lipid	59
Enzymatic Production of DAG	61
Industrial Production of 1,3-DAG	64
Esterification	65
Chemical Esterification	65
Enzymatic Esterification	66
Lipases	70
Introduction	70
Lipase Specificities	72
Interfacial Activation of Lipase	76
Lipase-catalysed Esterification	78
Mechanism of Lipase-catalysed Esterification	86
Role of Water in Lipase-catalysed Esterification	87
Edible Oil Deodoriser Distillates	89
Phytosterols	90
Vitamin E	94

III	PRODUCTION OF DIACYLGLYCEROLS FROM VARIOUS EDIBLE OIL DEODORISER DISTILLATES BY LIPASE-CATALYSED ESTERIFICATION	97
	Introduction	97
	Materials and Methods	99
	Materials	99
	Methods	100
	Immobilisation of Lipase	100
	Lipase Activity Assay	101
	Determination of Free Fatty Acids	102
	Production of Diacylglycerols from Edible Oil Deodoriser Distillates by Lipase-catalysed Esterification	102
	Effect of Various 1,3-Position Specific Lipase on the Production of Diacylglycerols	103
	Effect of Reaction Time on the Production of Diacylglycerols	104
	Effect of Lipase Concentration on the Production of Diacylglycerols	104
	Effect of Reaction Temperature on the Production of Diacylglycerols	105
	Effect of Total Fatty Acid to Glycerol Molar Ratio on the Production of Diacylglycerols	106
	Effect of Water Content on the Production of Diacylglycerols	106
	Effect of Molecular Sieves on the Production of Diacylglycerols	107
	Effect of Combined Optimum Reaction Parameters on the Production of Diacylglycerols	107
	Determination of Total Free Fatty Acid and Acylglycerols Content	108
	Statistical Analysis	108
	Results and Discussion	109
	Synthetic Activity of Immobilised Lipases	109
	Total Free Fatty Acid and Acylglycerol Contents of Edible Oil Deodoriser Distillates	111
	Effect of Various 1,3-Position Specific Lipase on the Production of Diacylglycerols	113
	Effect of Reaction Time on the Production of Diacylglycerols	118
	Effect of Lipase Concentration on the Production of Diacylglycerols	125
	Effect of Reaction Temperature on the Production of Diacylglycerols	131
	Effect of Total Fatty Acid to Glycerol Molar Ratio on the Production of Diacylglycerols	137
	Effect of Water Content on the Production of Diacylglycerols	142
	Effect of Molecular Sieves on the Production of Diacylglycerols	148

	Effect of Combined Optimum Reaction Parameters on the Production of Diacylglycerols	154
	Summary	156
IV	PHYSICAL AND CHEMICAL CHARACTERISATION OF DIACYLGLYCEROLS	158
	Introduction	158
	Materials and Methods	159
	Materials	159
	Methods	159
	Esterification Reaction of Free Fatty acids from Individual and Blends of Edible Oil Deodoriser Distillates	159
	Removal of Residual Free Fatty Acids	160
	Partial Purification of Diacylglycerols	160
	Analysis of Fatty Acid Composition	161
	Analysis of Diacylglycerol Molecular Species	162
	Determination of Iodine Value	162
	Thermal Analysis of Diacylglycerols	163
	Determination of Slip Melting Point	163
	Statistical Analysis	164
	Results and Discussion	164
	Fatty Acid Composition	164
	Identification of Diacylglycerol Molecular Species	173
	Diacylglycerol Composition	181
	Iodine Value (IV)	190
	Thermal Profiles and Slip Melting Points (SMP) of Diacylglycerols	195
	Summary	219
V	CHARACTERISATION OF PHYTONUTRIENTS	221
	Introduction	221
	Materials and Methods	222
	Materials	222
	Methods	223
	Extraction of Phytosterols and Vitamin E	223
	Analysis of Phytosterol and Vitamin E Compositions	223
	Statistical Analysis	224
	Results and Discussion	224
	Composition of Phytosterols and Vitamin E	224
	Summary	249
VI	GENERAL DISCUSSION AND CONCLUSIONS	250
	BIBLIOGRAPHY	253

APPENDICES	275
Appendix A: Preliminary Trials on Time Course of Esterification Reactions Catalysed by Various 1,3-Position Specific Immobilised Lipases	276
Appendix B: Identification of Total Sum of Free Fatty Acids and Monoacylglycerols, Total Diacylglycerols and Total Triacylglycerols by Reversed-phase High-performance Liquid Chromatography	279
Appendix C: Identification of Diacylglycerol Molecular Species by Reversed-phase High-performance Liquid Chromatography	287
BIODATA OF THE AUTHOR	323

## LIST OF TABLES

Table		Page
1	Mathematical definition of Body Mass Index (BMI) and its classification.	42
2	Lipase-catalysed batch production of specific structured lipids.	46
3	Lipase-catalysed continuous production of specific structured lipids.	49
4	Comparison of the theoretical and experimental energy values of diacylglycerol and triacylglycerol oils.	56
5	Lipase-catalysed production of diacylglycerols.	62
6	Production of polyunsaturated fatty acid-enriched acylglycerols using lipase-catalysed esterification.	68
7	Lipase-catalysed esterification reaction.	79
8	Comparison of synthetic activity of non-immobilised and immobilised lipases using IONAC <sup>®</sup> A 328 anion exchange resin with commercially immobilised lipases.	110
9	Total free fatty acid and acylglycerol contents of edible oil deodoriser distillates from four different sources.	112
10	Composition of esterification reaction products from four types of edible oil deodoriser distillates catalysed by lipases from various sources.	114
11	Time course of Lipozyme <sup>®</sup> RM IM-catalysed esterification reaction of four types of edible oil deodoriser distillates.	119
12	Composition of esterification reaction products from four types of edible oil deodoriser distillates catalysed by various concentrations of Lipozyme <sup>®</sup> RM IM.	126
13	Composition of esterification reaction products from four types of edible oil deodoriser distillates catalysed by Lipozyme <sup>®</sup> RM IM at various reaction temperatures.	132
14	Composition of esterification reaction products from four types of edible oil deodoriser distillates catalysed by Lipozyme <sup>®</sup> RM IM at various fatty acid to glycerol ratios.	138

15	Composition of esterification reaction products from four types of edible oil deodoriser distillates catalysed by Lipozyme <sup>®</sup> RM IM at various amounts of added water.	143
16	Composition of esterification reaction products from four types of edible oil deodoriser distillates catalysed by Lipozyme <sup>®</sup> RM IM at various amounts of added molecular sieves.	149
17	Composition of esterification reaction products from four types of deodoriser distillates catalysed by Lipozyme <sup>®</sup> RM IM using the combined optimum reaction parameters.	155
18	Fatty acid composition of deodoriser distillates from palm, soybean, canola and corn oils.	165
19	Fatty acid composition of commercial diacylglycerol oil and diacylglycerol oils produced from individual and blends of deodoriser distillates from palm, soybean, canola and corn oils.	167
20	Equivalent carbon number (ECN) of fatty acids	176
21	Partition numbers (PN), calculated equivalent carbon numbers (ECN) and retention times of 1,2- and 1,3-diacylglycerol molecular species.	177
22	Retention times of diacylglycerol reference standards.	178
23	Comparison of the predicted elution order of 1,3-diacylglycerols with that of triacylglycerols based on the polar differences of 1-and 3-position fatty acids.	180
24	Diacylglycerol composition of commercial diacylglycerol oil and diacylglycerol oils produced from individual and blends of deodoriser distillates from palm, soybean, canola and corn oils.	182
25	Distribution of positional isomers of diacylglycerols from the commercial diacylglycerol oil and diacylglycerols produced from individual and blends of deodoriser distillates from palm, soybean, canola and corn oils.	185
26	Iodine values (IV) of palm, soybean, canola, and corn oil deodoriser distillates.	191
27	Iodine values (IV) of commercial diacylglycerol oil and diacylglycerol oils produced from individual and blends of deodoriser distillates from palm, soybean, canola, and corn oils.	192



28	Crystallisation and melting temperatures and slip melting points of diacylglycerol from the commercial source and diacylglycerols produced from deodoriser distillates of palm, soybean, canola and corn oils.	198
29	Crystallisation and melting temperatures and slip melting points of diacylglycerols produced from edible oil deodoriser distillates of palm oil, soybean oil, and their palm-soybean blends at various ratios.	201
30	Crystallisation and melting temperatures and slip melting points of diacylglycerols produced from deodoriser distillates of palm oil, canola oil, and their palm-canola blends at various ratios.	204
31	Crystallisation and melting temperatures and slip melting points of diacylglycerols produced from deodoriser distillates of palm oil, corn oil, and their palm-corn blends at various ratios.	207
32	Crystallisation and melting temperatures and slip melting points of diacylglycerols produced from deodoriser distillates of soybean oil, canola oil, and their soybean-canola blends at various ratios.	210
33	Crystallisation and melting temperatures and slip melting points of diacylglycerols produced from deodoriser distillates of soybean oil, corn oil, and their soybean-corn blends at various ratios.	213
34	Crystallisation and melting temperatures and slip melting points of diacylglycerols produced from deodoriser distillates of canola oil, corn oil, and their canola-corn blends at various ratios.	216
35	Phytosterol and vitamin E compositions of deodoriser distillates from palm, soybean, canola and corn oils.	239
36	Retention times of phytosterol and vitamin E reference standards.	240
37	Compositions of phytosterols and vitamin E of commercial diacylglycerol oil and diacylglycerol oils produced from individual and blends of deodoriser distillates from palm, soybean, canola and corn oils.	241
38	Comparison of phytosterol ratios of commercial diacylglycerol oil and diacylglycerol oils produced from individual and blends of deodoriser distillates from palm, soybean, canola and corn oils.	248

39	Retention times of selected fatty acid and acylglycerol reference standards	281
40	Identification of diacylglycerols from the commercial diacylglycerol oil.	288
41	Identification of diacylglycerols produced from palm oil deodoriser distillate.	289
42	Identification of diacylglycerols produced from soybean oil deodoriser distillate.	290
43	Identification of diacylglycerols produced from canola oil deodoriser distillate.	291
44	Identification of diacylglycerols produced from corn oil deodoriser distillate.	292
45	Identification of diacylglycerols produced from blend of palm and soybean oil deodoriser distillates at ratio of 1: 9.	293
46	Identification of diacylglycerols produced from blend of palm and soybean oil deodoriser distillates at ratio of 3: 7.	294
47	Identification of diacylglycerols produced from blend of palm and soybean oil deodoriser distillates at ratio of 5: 5.	295
48	Identification of diacylglycerols produced from blend of palm and soybean oil deodoriser distillates at ratio of 7: 3.	296
49	Identification of diacylglycerols produced from blend of palm and soybean oil deodoriser distillates at ratio of 9: 1.	297
50	Identification of diacylglycerols produced from blend of palm and canola oil deodoriser distillates at ratio of 1: 9.	298
51	Identification of diacylglycerols produced from blend of palm and canola oil deodoriser distillates at ratio of 3: 7.	299
52	Identification of diacylglycerols produced from blend of palm and canola oil deodoriser distillates at ratio of 5: 5.	300
53	Identification of diacylglycerols produced from blend of palm and canola oil deodoriser distillates at ratio of 7: 3.	301
54	Identification of diacylglycerols produced from blend of palm and canola oil deodoriser distillates at ratio of 9: 1.	302
55	Identification of diacylglycerols produced from blend of palm and corn oil deodoriser distillates at ratio of 1: 9.	303

56	Identification of diacylglycerols produced from blend of palm and corn oil deodoriser distillates at ratio of 3: 7.	304
57	Identification of diacylglycerols produced from blend of palm and corn oil deodoriser distillates at ratio of 5: 5.	305
58	Identification of diacylglycerols produced from blend of palm and corn oil deodoriser distillates at ratio of 7: 3.	306
59	Identification of diacylglycerols produced from blend of palm and corn deodoriser oil distillates at ratio of 9: 1.	307
60	Identification of diacylglycerols produced from blend of soybean and canola oil deodoriser distillates at ratio of 1: 9.	308
61	Identification of diacylglycerols produced from blend of soybean and canola oil deodoriser distillates at ratio of 3: 7.	309
62	Identification of diacylglycerols produced from blend of soybean and canola oil deodoriser distillates at ratio of 5: 5.	310
63	Identification of diacylglycerols produced from blend of soybean and canola oil deodoriser distillates at ratio of 7: 3.	311
64	Identification of diacylglycerols produced from blend of soybean and canola oil deodoriser distillates at ratio of 9: 1.	312
65	Identification of diacylglycerols produced from blend of soybean and corn oil deodoriser distillates at ratio of 1: 9.	313
66	Identification of diacylglycerols produced from blend of soybean and corn oil deodoriser distillates at ratio of 3: 7.	314
67	Identification of diacylglycerols produced from blend of soybean and corn oil deodoriser distillates at ratio of 5: 5.	315
68	Identification of diacylglycerols produced from blend of soybean and corn oil deodoriser distillates at ratio of 7: 3.	316
69	Identification of diacylglycerols produced from blend of soybean and corn oil deodoriser distillates at ratio of 9: 1.	317
70	Identification of diacylglycerols produced from blend of canola and corn oil deodoriser distillates at ratio of 1: 9.	318
71	Identification of diacylglycerols produced from blend of canola and corn oil deodoriser distillates at ratio of 3: 7.	319

72	Identification of diacylglycerols produced from blend of canola and corn oil deodoriser distillates at ratio of 5: 5.	320
73	Identification of diacylglycerols produced from blend of canola and corn oil deodoriser distillates at ratio of 7: 3.	321
74	Identification of diacylglycerols produced from blend of canola and corn oil deodoriser distillates at ratio of 9: 1.	322

## LIST OF FIGURES

Figure		Page
1	Structures of various isoforms of diacylglycerol.	53
2	Reactions occurring during the lipase-catalysed process.	73
3	Chemical structures of cholesterol, unsaturated and saturated phytosterols.	91
4	Structures of various homologues of tocopherol and tocotrienol.	95
5	Percentage increases of total diacylglycerols from four types of edible oil deodoriser distillates catalysed by various lipases.	116
6	Percentage changes of total free fatty acids and monoacylglycerols, diacylglycerols, and triacylglycerols from Lipozyme <sup>®</sup> RM IM-catalysed esterification of palm and soybean oil deodoriser distillates against reaction time.	122
7	Percentage changes of total free fatty acids and monoacylglycerols, diacylglycerols, and triacylglycerols from Lipozyme <sup>®</sup> RM IM-catalysed esterification of canola and corn oil deodoriser distillates against reaction time.	123
8	Percentage changes of total free fatty acids and monoacylglycerols, diacylglycerols, and triacylglycerols from Lipozyme <sup>®</sup> RM IM-catalysed esterification of palm and soybean oil deodoriser distillates against lipase concentration.	129
9	Percentage changes of total free fatty acids and monoacylglycerols, diacylglycerols, and triacylglycerols from Lipozyme <sup>®</sup> RM IM-catalysed esterification of canola and corn oil deodoriser distillates against lipase concentration.	130
10	Percentage changes of total free fatty acids and monoacylglycerols, diacylglycerols, and triacylglycerols from Lipozyme <sup>®</sup> RM IM-catalysed esterification of palm and soybean oil deodoriser distillates against reaction temperature.	133

11	Percentage changes of total free fatty acids and monoacylglycerols, diacylglycerols, and triacylglycerols from Lipozyme <sup>®</sup> RM IM-catalysed esterification of canola and corn oil deodoriser distillates against reaction temperature.	135
12	Percentage changes of total free fatty acids and monoacylglycerols, diacylglycerols, and triacylglycerols from Lipozyme <sup>®</sup> RM IM-catalysed esterification of palm and soybean oil deodoriser distillates against free fatty acids to glycerol molar ratio.	139
13	Percentage changes of total free fatty acids and monoacylglycerols, diacylglycerols, and triacylglycerols from Lipozyme <sup>®</sup> RM IM-catalysed esterification of canola and corn oil deodoriser distillates against free fatty acids to glycerol molar ratio.	140
14	Percentage changes of total free fatty acids and monoacylglycerols, diacylglycerols, and triacylglycerols from Lipozyme <sup>®</sup> RM IM-catalysed esterification of palm and soybean oil deodoriser distillates against water content.	144
15	Percentage changes of total free fatty acids and monoacylglycerols, diacylglycerols, and triacylglycerols from Lipozyme <sup>®</sup> RM IM-catalysed esterification of canola and corn oil deodoriser distillates against water content.	146
16	Percentage changes of total free fatty acids and monoacylglycerols, diacylglycerols, and triacylglycerols from Lipozyme <sup>®</sup> RM IM-catalysed esterification of palm and soybean oil deodoriser distillates against molecular sieves content.	150
17	Percentage changes of total free fatty acids and monoacylglycerols, diacylglycerols, and triacylglycerols from Lipozyme <sup>®</sup> RM IM-catalysed esterification of canola and corn oil deodoriser distillates against molecular sieves content.	151
18	Differential scanning calorimetry (DSC) melting curves of diacylglycerols produced from deodoriser distillates of palm (A), soybean (B), canola (C), and corn (D) oils and from the commercial source (E).	196
19	Differential scanning calorimetry (DSC) crystallisation curves of diacylglycerols produced from the commercial source (A) and from deodoriser distillates of palm (B), soybean (C), canola (D) and corn (E) oils.	197

20	Differential scanning calorimetry (DSC) melting curves of diacylglycerols produced from deodoriser distillates of palm oil (A), soybean oil (G) and their palm-soybean blends at ratios of 9: 1 (B), 7: 3 (C), 5: 5 (D), 3: 7 (E) and 1: 9 (F).	199
21	Differential scanning calorimetry (DSC) crystallisation curves of diacylglycerols produced from deodoriser distillates of palm oil (G), soybean oil (A) and their palm-soybean blends at ratios of 1: 9 (B), 3: 7 (C), 5: 5 (D), 7:3 (E) and 9: 1 (F).	200
22	Differential scanning calorimetry (DSC) melting curves of diacylglycerols produced from deodoriser distillates of palm oil (A), canola oil (G) and their palm-canola blends at ratios of 9: 1 (B), 7: 3 (C), 5: 5 (D), 3: 7 (E) and 1: 9 (F).	202
23	Differential scanning calorimetry (DSC) crystallisation curves of diacylglycerols produced from deodoriser distillates of palm oil (G), canola oil (A) and their palm-canola blends at ratios of 1: 9 (B), 3: 7 (C), 5: 5 (D), 7: 3 (E) and 9: 1 (F).	203
24	Differential scanning calorimetry (DSC) melting curves of diacylglycerols produced from deodoriser distillates of palm oil (A), corn oil (G) and their palm-corn blends at ratios of 9: 1 (B), 7: 3 (C), 5: 5 (D), 3: 7 (E) and 1: 9 (F).	205
25	Differential scanning calorimetry (DSC) crystallisation curves of diacylglycerols produced from deodoriser distillates of palm oil (G), corn oil (A) and their palm-corn blends at ratios of 1: 9 (B), 3: 7 (C), 5: 5 (D), 7: 3 (E) and 9: 1 (F).	206
26	Differential scanning calorimetry (DSC) melting curves of diacylglycerols produced from deodoriser distillates of soybean oil (A), canola oil (G) and their soybean-canola blends at ratios of 9: 1 (B), 7: 3 (C), 5: 5 (D), 3: 7 (E) and 1: 9 (F).	208
27	Differential scanning calorimetry (DSC) crystallisation curves of diacylglycerols produced from deodoriser distillates of soybean oil (G), canola oil (A) and their soybean-canola blends at ratios of 1: 9 (B), 3: 7 (C), 5: 5 (D), 7: 3 (E) and 9: 1 (F).	209
28	Differential scanning calorimetry (DSC) melting curves of diacylglycerols produced from deodoriser distillates of soybean oil (A), corn oil (G) and their soybean-corn blends at ratios of 9: 1 (B), 7: 3 (C), 5: 5 (D), 3: 7 (E) and 1: 9 (F).	211



29	Differential scanning calorimetry (DSC) crystallisation curves of diacylglycerols produced from deodoriser distillates of soybean oil (G), corn oil (A) and their soybean-corn blends at ratios of 1: 9 (B), 3: 7 (C), 5: 5 (D), 7: 3 (E) and 9: 1 (F).	212
30	Differential scanning calorimetry (DSC) melting curves of diacylglycerols produced from deodoriser distillates of canola oil (A), corn oil (G) and their canola-corn blends at ratios of 9: 1 (B), 7: 3 (C), 5: 5 (D), 3: 7 (E) and 1: 9 (F).	214
31	Differential scanning calorimetry (DSC) crystallisation curves of diacylglycerols produced from deodoriser distillates of canola oil (G), corn oil (A) and their canola-corn blends at ratios of 1: 9 (B), 3: 7 (C), 5: 5 (D), 7: 3 (E) and 9: 1 (F).	215
32	Gas-liquid chromatographs of phytosterols and vitamin E compositions of the commercial diacylglycerol oil (A) and diacylglycerol oils produced from deodoriser distillate of palm (B).	225
33	Gas-liquid chromatographs of phytosterols and vitamin E compositions of diacylglycerol oils produced from deodoriser distillates of soybean (A), canola (B) and corn (C) oils.	226
34	Gas-liquid chromatographs of phytosterols and vitamin E compositions of diacylglycerol oils produced from blends of palm and soybean oil deodoriser distillates at ratios of 1: 9 (A) and 3: 7 (B).	227
35	Gas-liquid chromatographs of phytosterols and vitamin E compositions of diacylglycerol oils produced from blends of palm and soybean oil deodoriser distillates at ratios of 5: 5 (A), 7: 3 (B) and 9: 1 (C).	228
36	Gas-liquid chromatographs of phytosterols and vitamin E compositions of diacylglycerol oils produced from blends of palm and canola oil deodoriser distillates at ratios of 1: 9 (A) and 3: 7 (B).	229
37	Gas-liquid chromatographs of phytosterols and vitamin E compositions of diacylglycerol oils produced from blends of palm and canola oil deodoriser distillates at ratios of 5: 5 (A), 7: 3 (B) and 9: 1 (C).	230



38	Gas-liquid chromatographs of phytosterols and vitamin E compositions of diacylglycerol oils produced from blends of palm and corn oil deodoriser distillates at ratios of 1: 9 (A) and 3: 7 (B).	231
39	Gas-liquid chromatographs of phytosterols and vitamin E compositions of diacylglycerol oils produced from blends of palm and corn oil deodoriser distillates at ratios of 5: 5 (A), 7: 3 (B) and 9: 1 (C).	232
40	Gas-liquid chromatographs of phytosterols and vitamin E compositions of diacylglycerol oils produced from blends of soybean and canola oil deodoriser distillates at ratios of 1: 9 (A) and 3: 7 (B).	233
41	Gas-liquid chromatographs of phytosterols and vitamin E compositions of diacylglycerol oils produced from blends of soybean and canola oil deodoriser distillates at ratios of 5: 5 (A), 7: 3 (B) and 9: 1 (C).	234
42	Gas-liquid chromatographs of phytosterols and vitamin E compositions of diacylglycerol oils produced from blends of soybean and corn oil deodoriser distillates at ratios of 1: 9 (A) and 3: 7 (B).	235
43	Gas-liquid chromatographs of phytosterols and vitamin E compositions of diacylglycerol oils produced from blends of soybean and corn oil deodoriser distillates at ratios of 5: 5 (A), 7: 3 (B) and 9: 1 (C).	236
44	Gas-liquid chromatographs of phytosterols and vitamin E compositions of diacylglycerol oils produced from blends of canola and corn oil deodoriser distillates at ratios of 1: 9 (A) and 3: 7 (B).	237
45	Gas-liquid chromatographs of phytosterols and vitamin E compositions of diacylglycerol oils produced from blends of canola and corn oil deodoriser distillates at ratios of 5: 5 (A), 7: 3 (B) and 9: 1 (C).	238
46	Changes of percentage DAG against reaction time of various lipase-catalysed esterification of palm (A) and soybean (B) oil deodoriser distillates. Dotted line indicates suitable time for termination of reaction.	277
47	Changes of percentage DAG against reaction time of various lipase-catalysed esterification of canola (A) and corn (B) oil deodoriser distillates. Dotted line indicates suitable time for termination of reaction.	278