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APPENDICES

Appendix A

OIL-PRODUCING CROPS [57]

Plant	Latin Name	Kg Oil/ Hectare	Plant	Latin Name	Kg Oil/ Hectare
corn	*Zea mays*	145	tung oil tree	*Aleurites fordii*	790
cashew nut	*Anacardium occidentale*	148	sunflower	*Helianthus annuus*	800
oat	*Avena sativa*	183	cocoa	*Theobroma cacao*	863
palm	*Erythea salvadorensis*	189	peanut	*Arachis hypogaea*	890
lupine	*Lupinus albus*	195	opium poppy	*Papaver somniferum*	978
rubber seed	*Hevea brasiliensis*	217	rapeseed	*Brassica napus*	1000
kenaf	*Hibiscus cannabinus L.*	230	olive tree	*Olea europaea*	1019
calendula	*Calendula officinalis*	256	piassava	*Attalea funifera*	1112
cotton	*Gossypium hirsutum*	273	gopher plant	*Euphorbia lathyris*	1119
hemp	*Cannabis sativa*	305	castor bean	*Ricinus communis*	1188
soybean	*Glycine max*	375	bacuri	*Platonia insignis*	1197
coffee	*Coffea arabica*	386	pecan	*Carya illinoensis*	1505
linseed	*Linum usitatissimum*	402	jojoba	*Simmondsia chinensis*	1528
hazelnut	*Corylus avellana*	405	babassu palm	*Orbignya martiana*	1541
euphorbia	*Euphorbia lagascae*	440	jatropha	*Jatropha curcas*	1590
pumpkin seed	*Cucurbita pepo*	449	macadamia nut	*Macadamia terniflora*	1887
coriander	*Coriandrum sativum*	450	brazil nut	*Bertholletia excelsa*	2010
mustard	*Brassica alba*	481	avocado	*Persea americana*	2217
camelina	*Camelina sativa*	490	coconut	*Cocos nucifera*	2260
sesame	*Sesamum indicum*	585	oiticia	*Licania rigida*	2520
crambe	*Crambe abyssinica*	589	buriti palm	*Mauritia flexuosa*	2743
safflower	*Carthamus tinctorius*	655	pequi	*Caryocar brasiliense*	3142
buffalo gourd	*Cucurbita foetidissima*	665	macauba palm	*Acrocomia aculeata*	3775
rice	*Oriza sativa L.*	696	oil palm	*Elaeis guineensis*	5000

Appendix B

CALCULATIONS

Calculated % yield of methyl ester

The synthesized methyl ester was calculated in following:

Sample :

Crude palm oil (initial) 400.08 grams comparable 476.80 mmol

Palm methyl ester (finality) 387.62 grams comparable 433.51 mmol

(Due to molecular weight of crude palm oil and palm oil methyl ester = 839.10, 843.12 g/mol, respectively.)

So, Palm methyl ester 476.80 mmol comparable 100% yield

Palm methyl ester 433.51 mmol comparable $\frac{433.51 \times 100}{476.80} = 96.45\ \%$

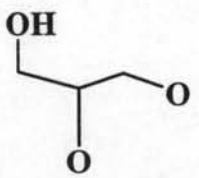
For molecular weight of crude palm oil can be calculated in following:

Molecular weight (approx.) of palm oil = $M_G + 3M_{Ac}$

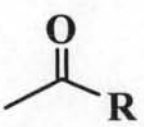
where M_G : Molecular weight of glycerol moiety = $C_3H_5O_3$ = 89.07 g/mol

M_{Ac} : Molecular weight of acyl moiety of fatty acid of palm oil

M_{FFA} : Molecular weight of fatty acid



Glycerol moiety



Acyl moiety

where

$M_{FFA} = \frac{\Sigma\ [(\text{MW of fatty acids} \times \%\ \text{fatty acids})}{\text{total of fatty acids (only fatty acid)}}$

% fatty acid composition in crude palm oil was showed in Appendix C.

So, $M_{FFA} = \frac{[(144.2\times0.3) + (172.3\times0.3) + (200.3\times4.9) + ...]}{99.7}$

$= 267.02$ g/mol

and M_{Ac} = molecular weight (approx.) of fatty acid – molecular weight of (-OH)

$= 267.02 - 17.01$

$= 250.01$ g/mol

$\therefore$ Molecular weight (approx.) of palm oil $= 89.07 + (3\times250.01)$

$= 839.10$ g/mol

The molecular weight of palm oil methyl ester has been calculated from the molecular weight (approx.) of acyl moiety of fatty acid, that is

Molecular weight of methyl ester = M_{Ac} + molecular weight of (-OH)

$= 250.01 + 31.03$

$= 281.04$ g/mol

So, Molecular weight of methyl ester of palm oil $= 281.04 \times 3 = 843.12$ g/mol

Calculated % methyl ester of transesterification from ^{1}H-NMR spectrum [58]

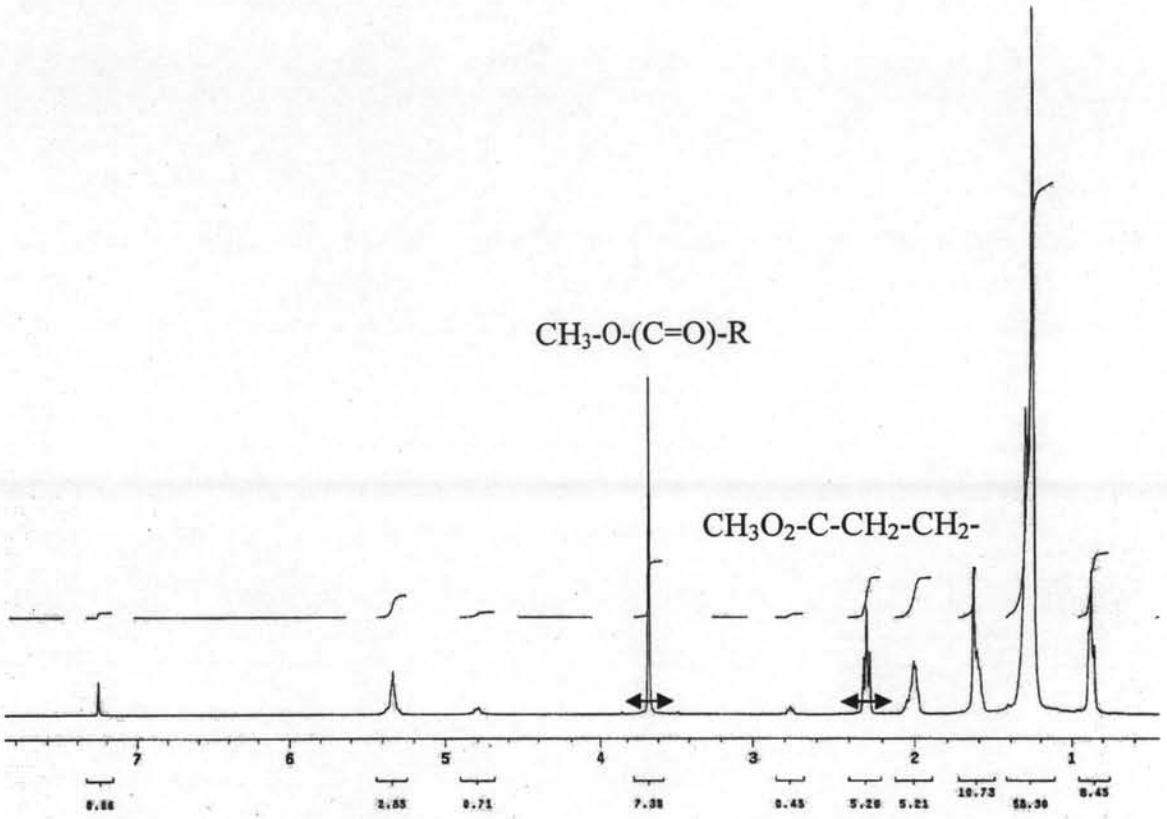
The % methyl ester of transesterification was calculated in following:

$$\% \text{ Methyl ester} = [(2I_{Me}) / (3I_{CH2})] \times 100$$

where I_{Me} = Integration value of the protons of the methyl esters (the strong singlet), appear at δ 3.7 ppm

I_{CH2} = Integration value of the methylene protons, appear at δ 2.3 ppm

Sample :



$$\% \text{ Methyl ester} = [(2\times7.39) / (3\times5.26)] \times 100$$

$$= 93.66$$

Appendix C

COMPOSITION OF FATTY ACID IN CRUDE PALM OIL

TEST REPORT

Sample's name	Mark / Brand	Laboratory No.
Crude Palm Oil	-	YU.992

Test Results

Fatty acid composition, % of total fatty acids	
Caprylic acid	0.3
Capric acid	0.3
Lauric acid	4.9
Myristic acid	2.1
Palmitic acid	36.6
Palmitoleic acid	0.1
Stearic acid	3.9
Oleic acid	41.5
Linoleic acid	9.3
Linolenic acid	0.2
Arachidic acid	0.3
Eicosenoic acid	0.1
Behenic acid	0.1
Others	0.3

Customer's name	Faculty of Science, Chulalongkorn University
Customer's address	SCI 25 Floor 15 Phayathai Road, Bangkok 10330
Sample's description	reddish brown liquid
Test date	4 September 2006
Test method	In-house method based on AOAC (2005)

Approved by
Bangon Boonsh
(Mrs. Bangorn Boonshu)
Scientist 8

Reported by
Wipawan Srimuk
(Mrs. Wipawan Srimuk)
Scientist 6

Department of Science Service, Ministry of Science and Technology
Rama VI Road, Ratchathewi, Bangkok 10400, Thailand

Appendix E

SPECTRA

Mass spectra of synthesized palm methyl ester

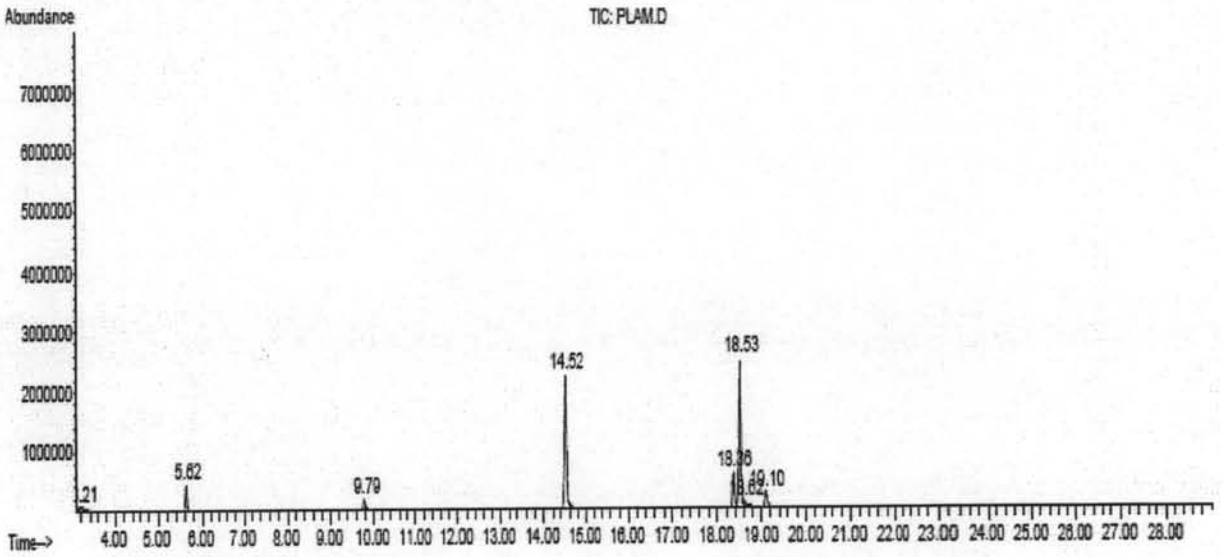


Figure 1E Gas chromatogram of analyzed palm methyl ester

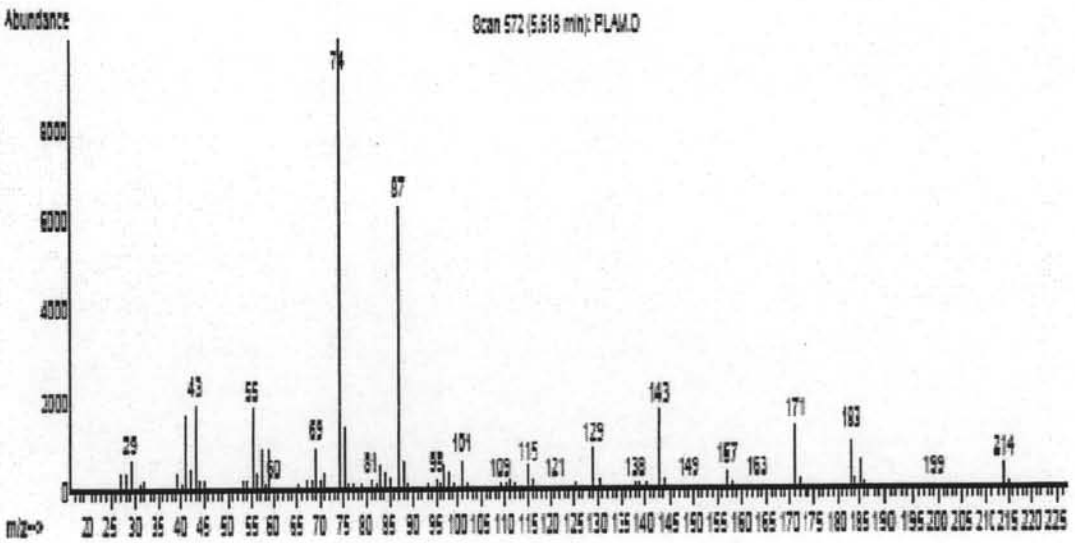


Figure 2E Mass spectrum of palm methyl ester at retention time of 5.618 min

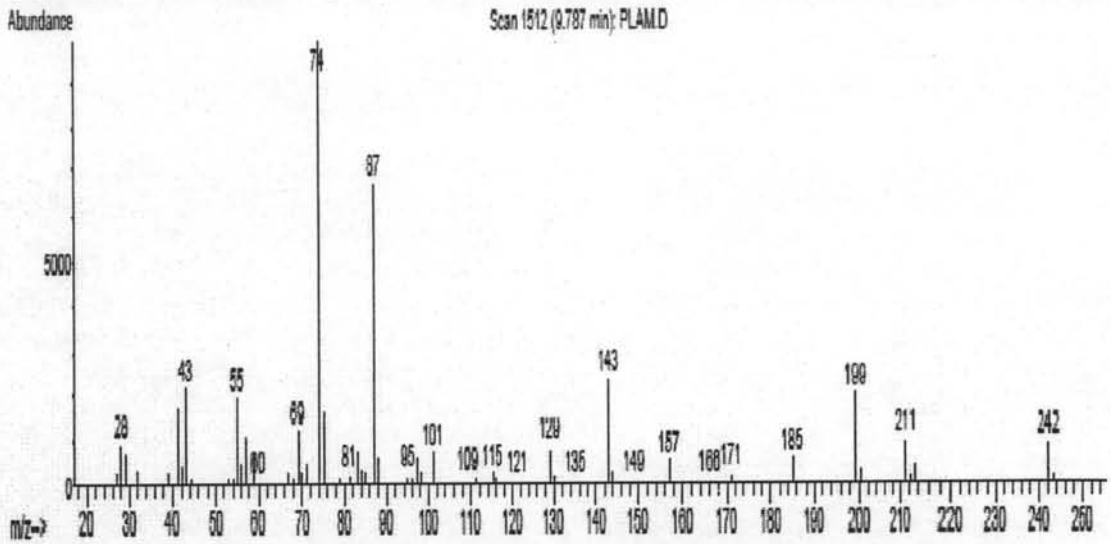


Figure 3.1E Mass spectrum of methyl myristate (methyl tetradecanoate; 14:0) at retention time of 9.787 min

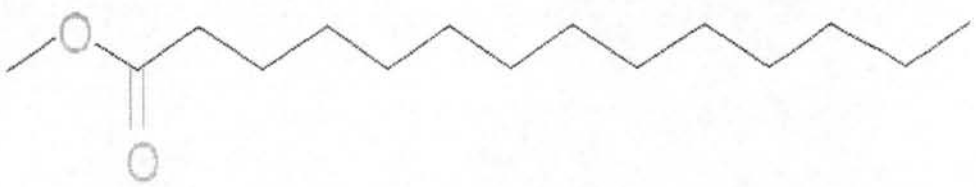


Figure 3.2E Structure of methyl myristate (methyl tetradecanoate)

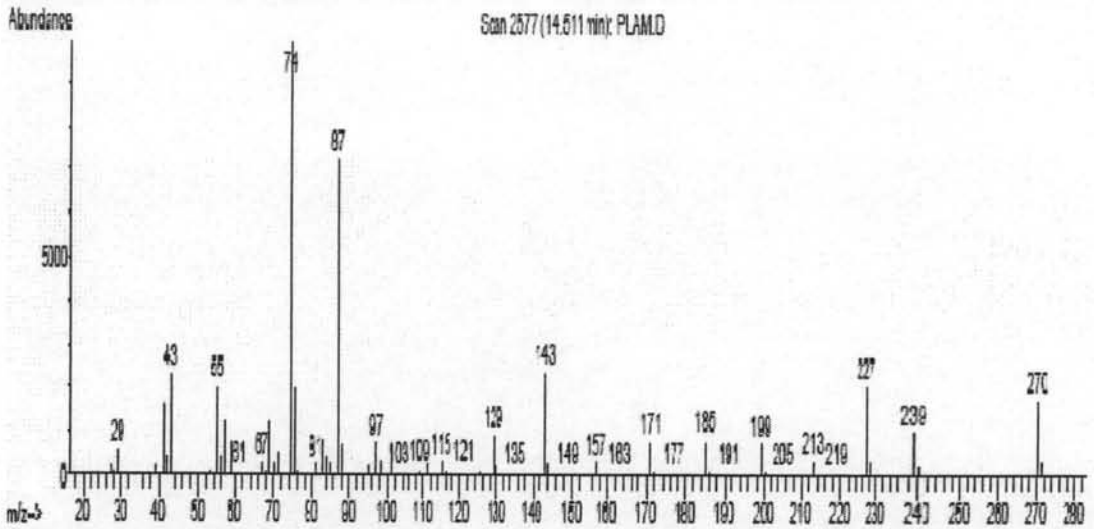


Figure 4.1E Mass spectrum of methyl palmitate (methyl hexadecanoate; 16:0) at retention time of 14.511 min

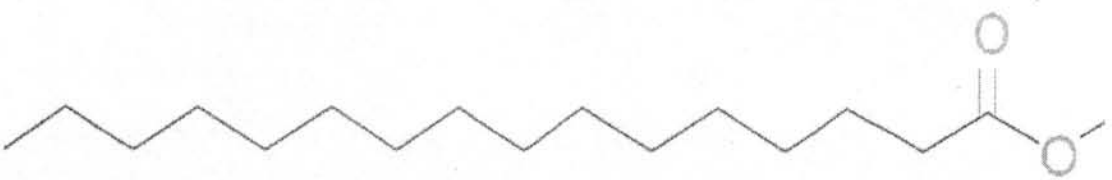


Figure 4.2E Structure of methyl palmitate (methyl hexadecanoate)

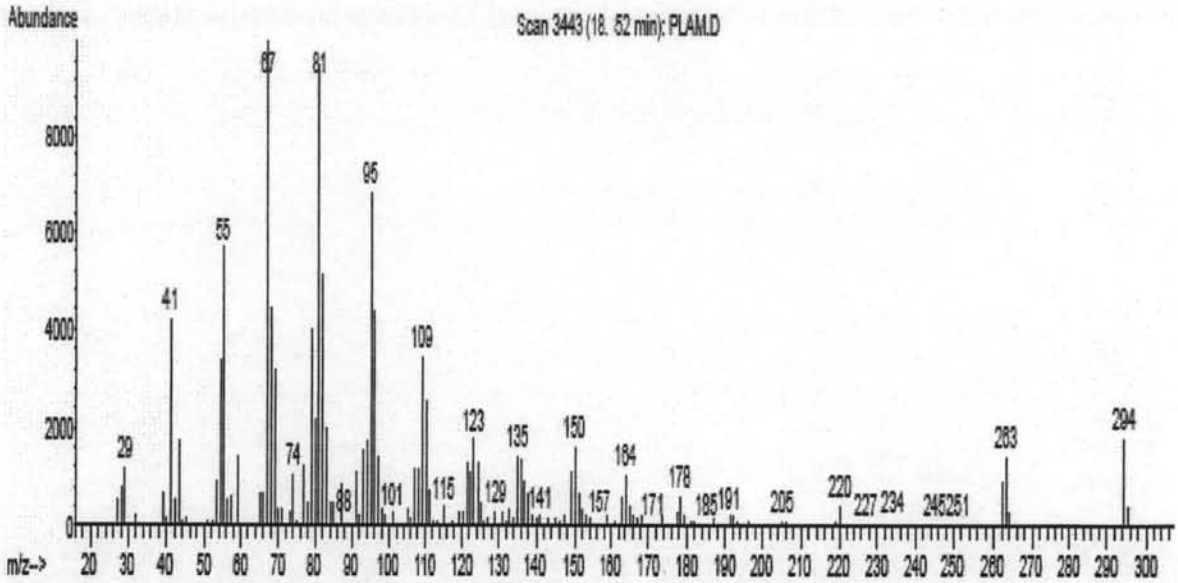


Figure 5.1E Mass spectrum of methyl linoleate (methyl octadecadienoate; 18:2) at retention time of 18.52 min

Figure 5.2E Structure of methyl linoleate (methyl octadecadienoate)

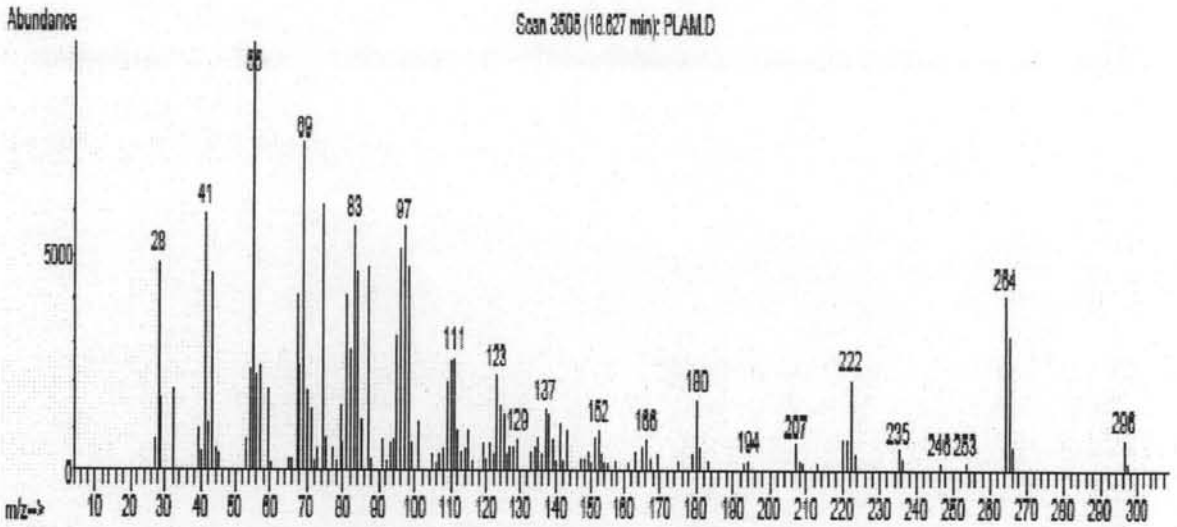


Figure 6.1E Mass spectrum of methyl oleate (methyl octadecenoate; 18:1) at retention time of 18.627 min

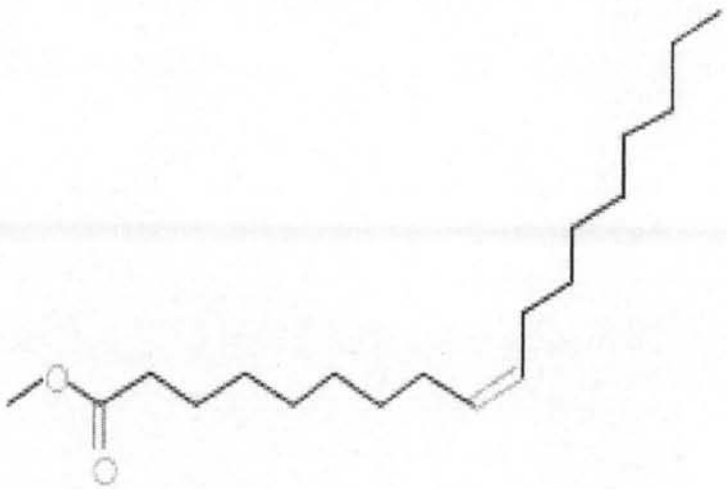


Figure 6.2E Structure of methyl oleate (methyl octadecenoate)

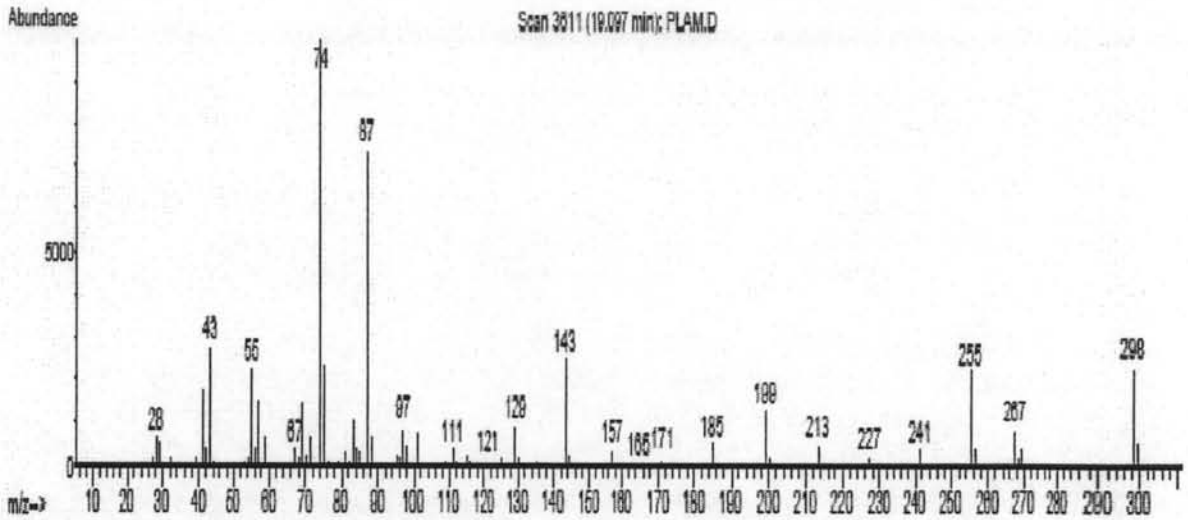


Figure 7.1E Mass spectrum of methyl stearate (methyl octadecanoate; 18:0) at retention time of 19.097 min

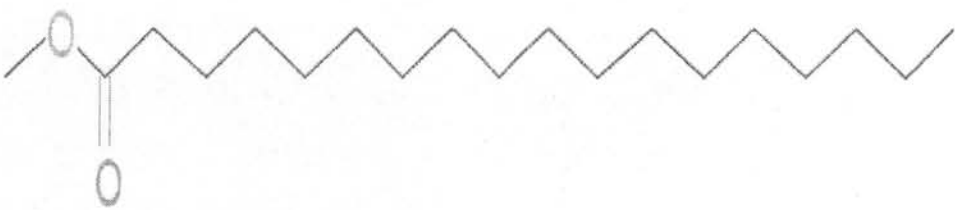


Figure 7.2E Structure of methyl stearate (methyl octadecanoate)

^{1}H-NMR spectra of palm oil and palm methyl ester adsorbed with adsorbents

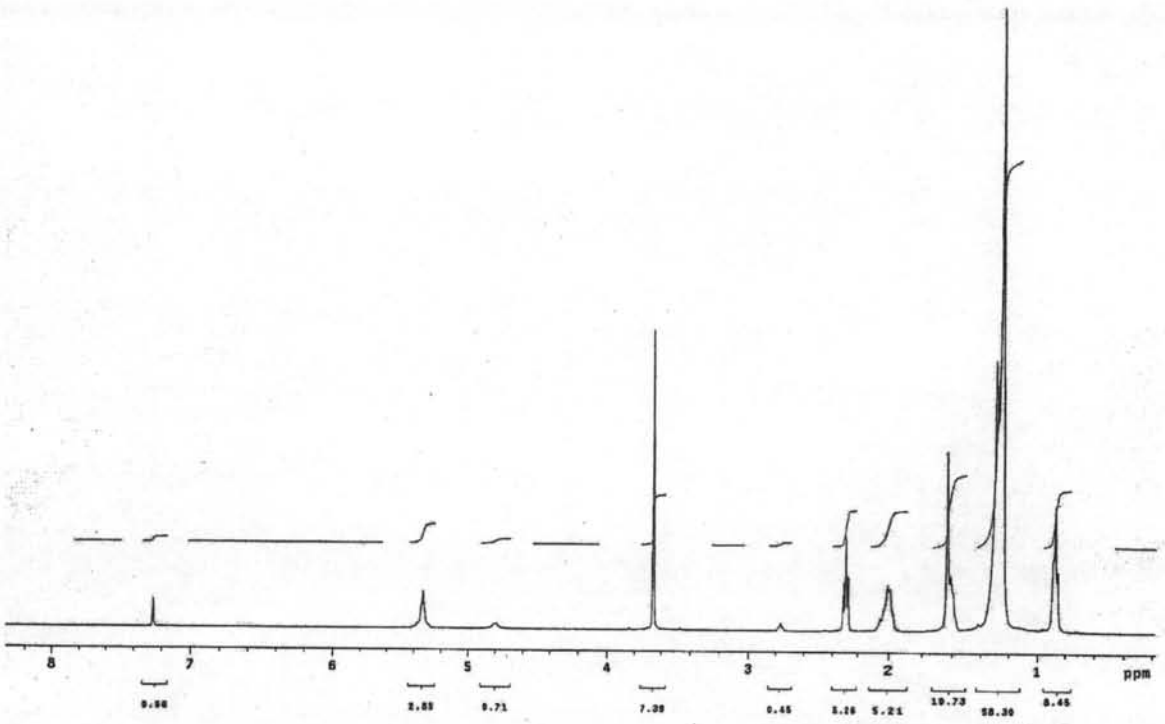


Figure 8E ^{1}H-NMR spectrum of methyl ester (base-catalyzed process)

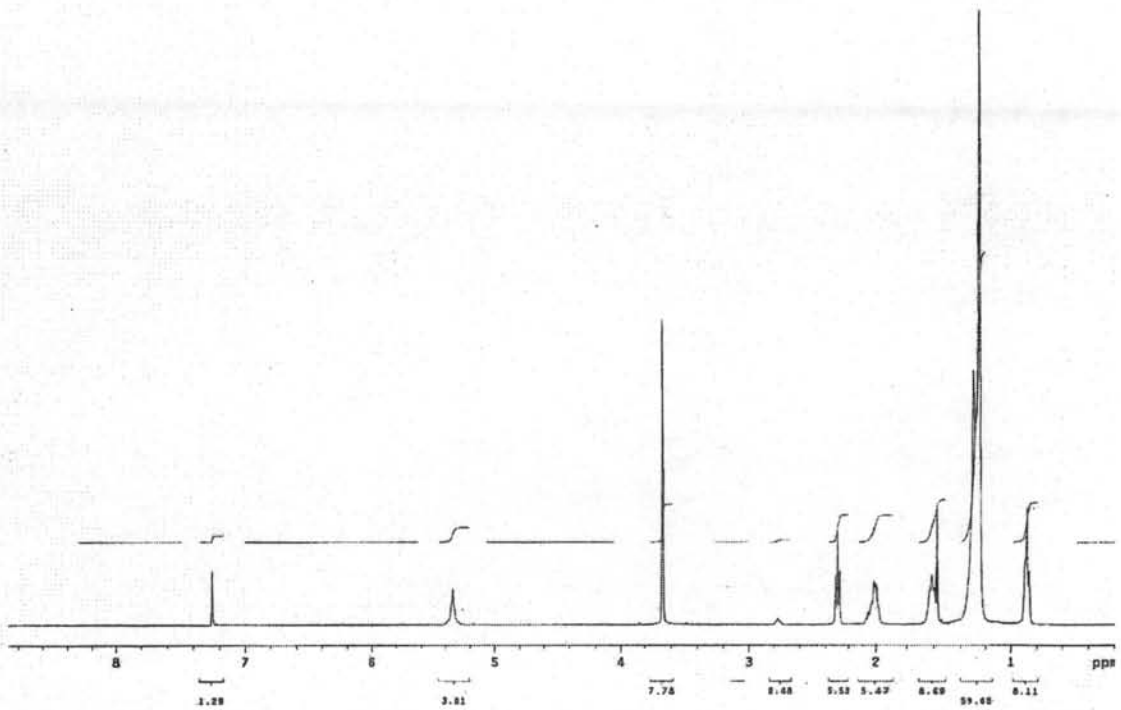


Figure 9E ^{1}H-NMR spectrum of methyl ester adsorbed with magnesol.

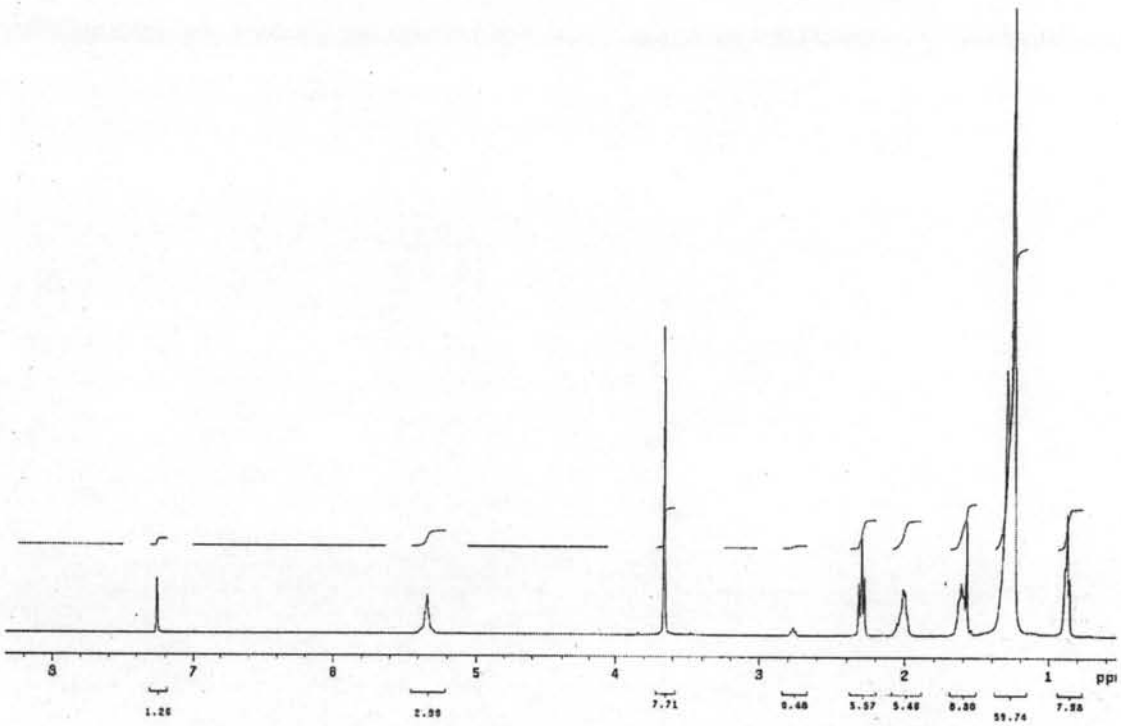


Figure 10E ^{1}H-NMR spectrum of methyl ester adsorbed with alumina

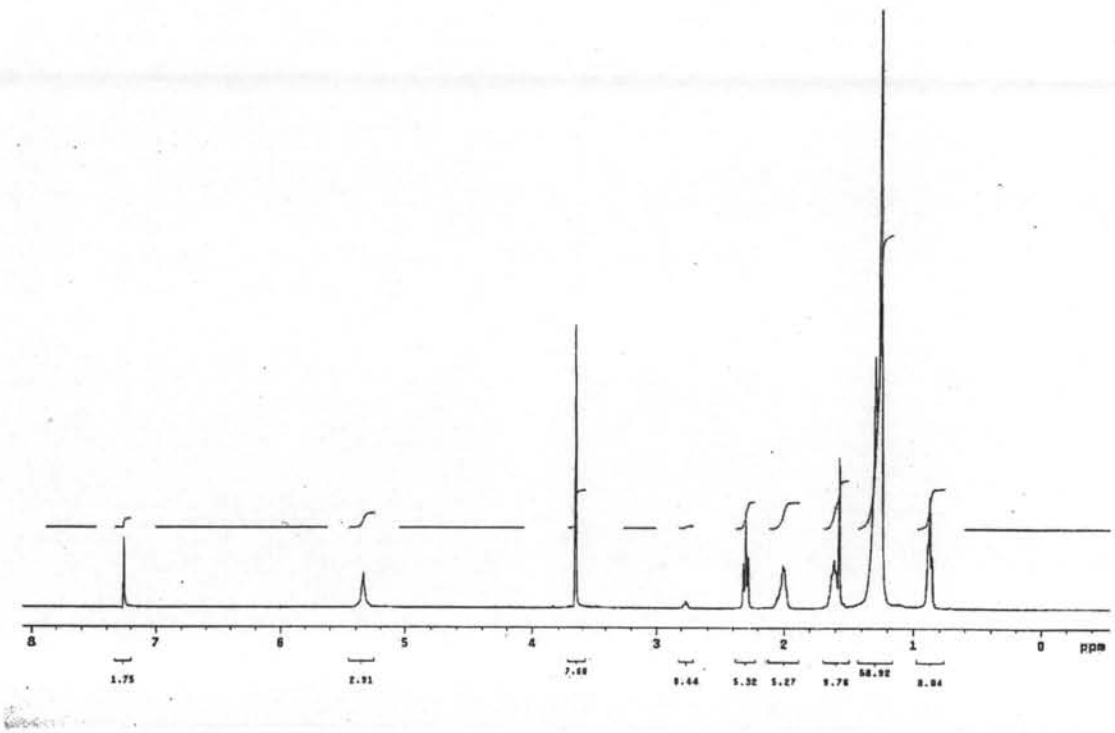


Figure 11E ^{1}H-NMR spectrum of methyl ester adsorbed with activated charcoal (powder)

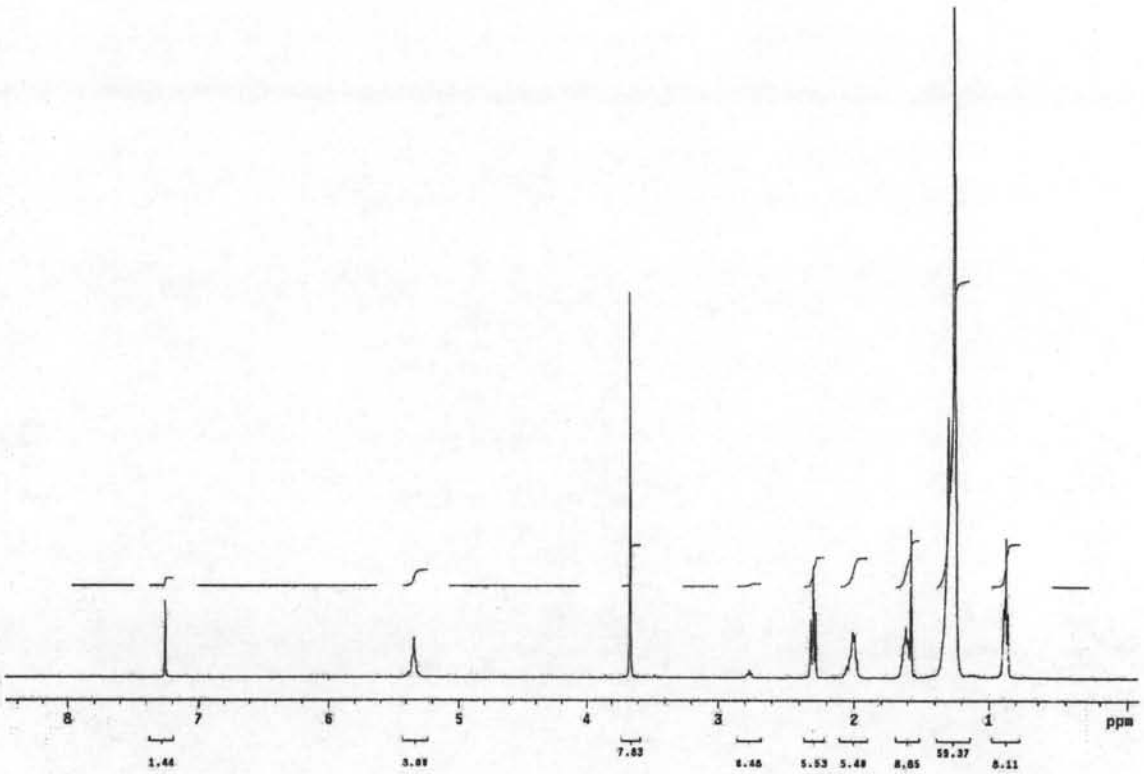


Figure 12E ^{1}H-NMR spectrum of methyl ester adsorbed with activated charcoal (granule)

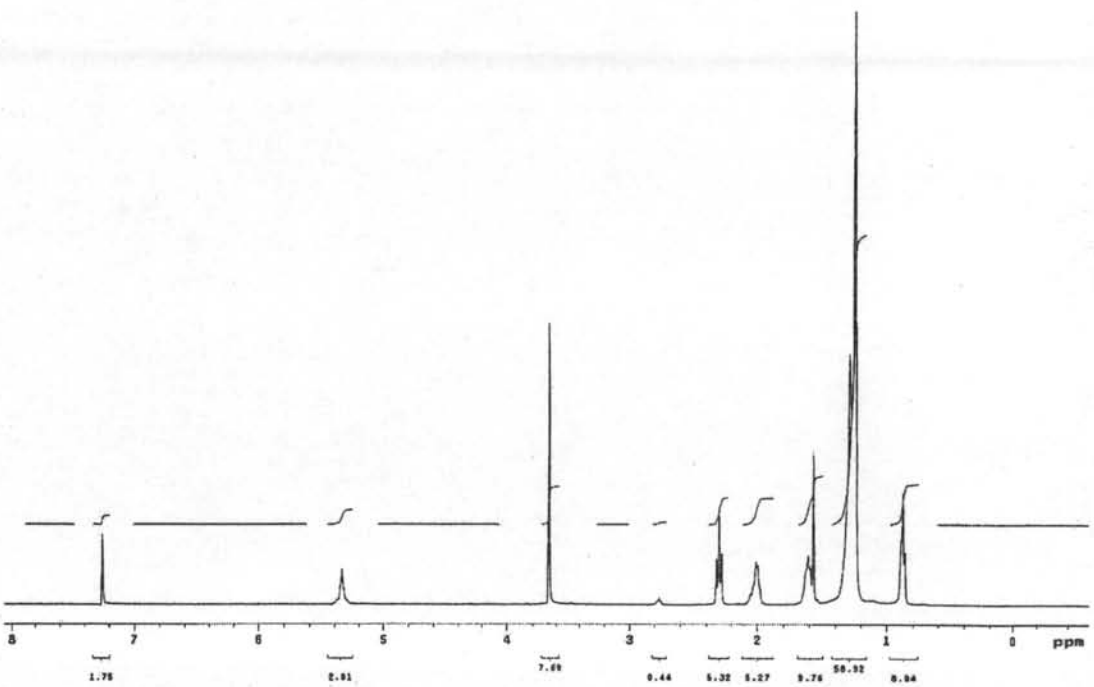


Figure 13E ^{1}H-NMR spectrum of methyl ester adsorbed with molecular sieve (4Å)

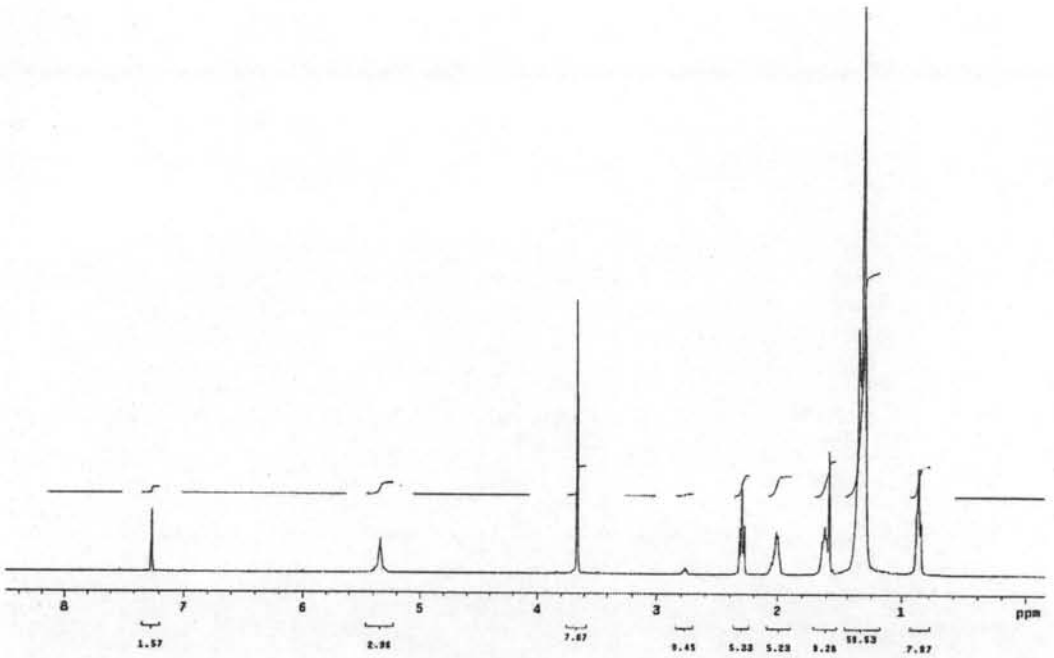


Figure 14E ^{1}H-NMR spectrum of methyl ester adsorbed with bentonite clay (standard)

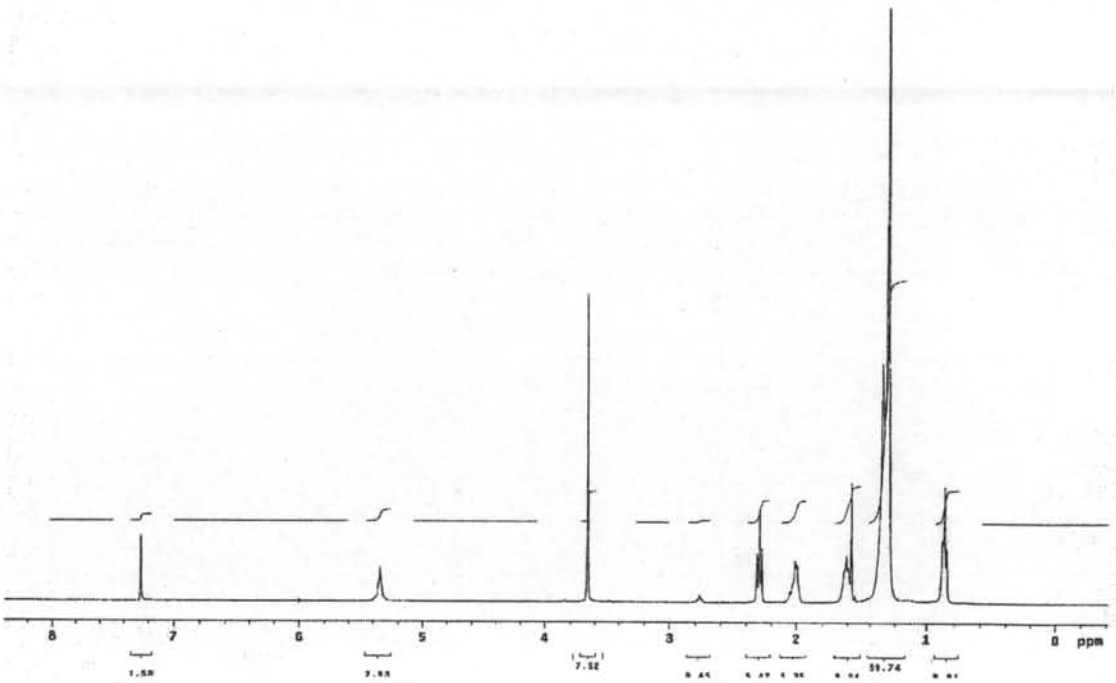


Figure 15E ^{1}H-NMR spectrum of methyl ester adsorbed with bentonite clay (treated NaOH)

Appendix E

OTHER INFORMATIONS

Specification of Magnesol

DALLAS

The Dallas Group of America, Inc.
374 Route 22
P.O. Box 489
Whitehouse, NJ 08888

MAGNESOL®

SYNTHETIC MAGNESIUM SILICATE

R SERIES

MAGNESOL® is a registered trademark of The Dallas Group of America, Inc. for a synthetic, amorphous, hydrous form of magnesium silicate. With a porous internal structure and enormous activated surface, Magnesol® products are ideal for use as adsorbents, anti-static flow agents, anti-caking agents, catalyst supports, carriers, and reinforcing fillers.

Parameter	Specification
Assay (ignited basis)	
% MgO	15.0 min.
% SiO_2	67.0 min.
% Loss on ignition @ 900°C (dry basis)	15.0 max.
% SO_4 by weight (dry basis)	4.0 max.
% Loss on drying @ 105°C (as packaged)	20.0 max.
Surface area (m^2/g, B.E.T.)	300 min.

Particle size	Typical Mean Value (microns)
R30	27 - 32
R60	65 - 72
R130	130 - 145

% Methyl ester in biodiesel by EN 14103

ภาควิชาเคมีเทคนิค คณะวิทยาศาสตร์ จุฬาลงกรณ์มหาวิทยาลัย
ถนนพญาไท แขวงวังใหม่ เขตปทุมวัน กรุงเทพฯ 10330

Department of Chemical Technology, Faculty of Science, Chulalongkorn University
Phya Thai Rd., Patumwan, Bangkok 10330, THAILAND
Tel: (662) 2185324, 2185328-30 Fax: (662) 2555831 E-mail: chemtech@sc.chula.ac.th

27 เมษายน 2550

รายงานผลการวิเคราะห์และทดสอบ

เรื่อง รายงานผลการทดสอบหา % Methyl ester ในน้ำมัน

ด้วยเครื่อง Gas Chromatrograph

ชนิดตัวอย่าง : น้ำมัน Biodiesel

หน่วยงาน : คุณจิรพรรณ เจริญสินวรกุล

ผู้ส่งตัวอย่าง : คุณจิรพรรณ เจริญสินวรกุล

อ้างอิงตามมาตรฐานการทดสอบ : EN 14103

ชนิดตัวอย่าง	ผลการวิเคราะห์ % Methyl ester
Biodiesel	92.6

(อารยา การุณรัตน์)
ผู้วิเคราะห์

ขอรับรองผลการวิเคราะห์ถูกต้อง

(อาจารย์ ดร. ชวลิต งามจรัสศรีวิชัย)
หัวหน้าห้องเครื่องมือวิเคราะห์
27 เมษายน 2550

BIOGRAPHY

Miss Jiraphan Charoensinvorakul was born on March 16, 1982 in Songkhla, Thailand. She received the Bachelor Degree of Science in Chemistry, Prince of Songkhla University in 2003. She continued her Master study in Program of Petrochemistry and Polymer Science, Faculty of Science, Chulalongkorn University in 2004 and completed the program in 2006.