

Novel Acyl Derivatives from Karanja Oil: Alternative Renewable Lubricant Basestocks

Geethanjali, Gorla Sony M. Kour, Korlipara V. Padmaja, Mallampalli S. L Karuna,
Rachapudi B. N. Prasad*

Centre for Lipid Research, Indian Institute of Chemical Technology, Hyderabad, 500-007, India

Keywords

Karanja oil, formic acid, epoxidation, hydroxylation, acylation, lubricant base stocks.

ABSTRACT: Lubricant base stocks of acylated oil and its derivatives namely propionylated, butanoylated, hexanoylated karanja oil and fatty acid methyl esters were synthesized from renewable non edible source karanja oil (*Pongamia glabra*). The reaction was carried out by Prilezhaev dihydroxylation using *in situ* generated peroxyformic acid from hydrogen peroxide and formic acid. The hydroxylated derivatives were acylated using different anhydrides (C₃, C₄ and C₆). All the synthesized Products were characterized by GC, GC-MS, IR, ¹H NMR spectral studies. The synthesized acylated derivatives were evaluated for physico-chemical and lubricant properties. Propionylated and butanoylated esters of KFAME were found suitable for IS: 3098 hydraulic fluids in ISO VG 46 and ISO VG 68 category respectively. Propionylated ester of KFAME was found suitable for IS: 8406 gear oils (R & O type). Other lubrication properties like viscosity, viscosity index of all the products belong to group III, category of base fluids as per API classification, Cu corrosion value, air release value were found to be good. These base stocks may find applications in hydraulic fluids and metal working fluids.

Table 1. Fatty Acid Composition of Acylated Karanja Fatty Acid Methyl Esters.

Fatty Acid	BuEHKFAME	PrEHKFAME	HxEHKFAME
C _{16:0}	1.5	1.2	1.8
C _{18:0}	2.4	1.8	2.6
C _{18:1}	NIL	NIL	NIL
C _{18:2}	NIL	NIL	NIL
C _{20:0}	1.3	1.2	1.2
C _{20:1}	Nil	6.5	Nil
C _{22:0}	6.3	6.5	5.8
C _{24:0}	2.8	1.1	2.3
C _{18:1} Acyloxy	38.4	39.8	43.4
C _{18:2} Acyloxy	25.1	15.5	23.3
C _{20:1} Acyloxy	1.9	nil	1.4
others	19.8	16.2	16.7

Table 2. Lubricating Properties of Acylated Products of Karanja oil

Property	PrEHKO	BuEHKO	HxEHKO
Density 30°C	ND	ND	ND
Viscosity, cSt 40 °C	ND	ND	ND
100 °C	63.7	55.6	36.5
Viscosity Index	ND	ND	ND
Pour Point (°C)	12	9	9
Copper strip corrosion	1a	1a	1a
Flash point (°C)	228	275	288
Noack evaporation loss (%)	4.2	3.2	3.1
RBOT(min)	10	10	12
Air release value (min)	43.7	42.8	26.9
Weld load (kg)	210	210	200
Hydrolytic Stability			
Cu strip weight loss	0.0012	0.0017	0.0009
Cu strip appearance	1a	3b	1b
Water acidity	5.16	6.25	12.6
Foam stability (mL)	Nil/Nil	Nil/Nil	10/Nil
Sequence1 24°C	Nil/Nil	20/Nil	20/Nil
Sequence2 93.5°C	Nil/Nil	Nil/Nil	Nil/Nil
Sequence3 24°C			

Table 3. Lubricating Properties of Acylated Products of Karanja Fatty Acid Methyl Esters.

Property		PrEHKFAME	BuEHKFAME	HxEHKFAME
Density 30°C		0.97306	0.97236	0.96424
Viscosity, cSt	40 °C	25.2	25.8	25.8
	100 °C	4.8	4.9	5.1
Viscosity Index		111	114	128
Pour Point (°C)		+15	+15	+15
Copper strip corrosion		1a	1a	1a
Flash point (°C)		234	244	222
Noack evaporation loss (%)		23.4	16.6	13.8
RBOT(min)		5	10	10
Air release value (min)		8.15	8.58	8.87
Weld load (kg)		180	170	170
Emulsion characteristics		40-40-0 (10 min)	43-37-0 (90 min)	43-37-0 (90 min)
Hydrolytic Stability				
Cu strip weight loss		0.0011	0.008	0.0008
Cu strip appearance		1b	1b	1b
Water acidity		11.5	8.9	8.4
Foam stability (mL)				
Sequence1 24°C		Nil /Nil	Nil /Nil	Nil /Nil
Sequence2 93.5°C		Nil /Nil	Nil /Nil	Nil /Nil
Sequence3 24°C		Nil/Nil	Nil/Nil	Nil/Nil

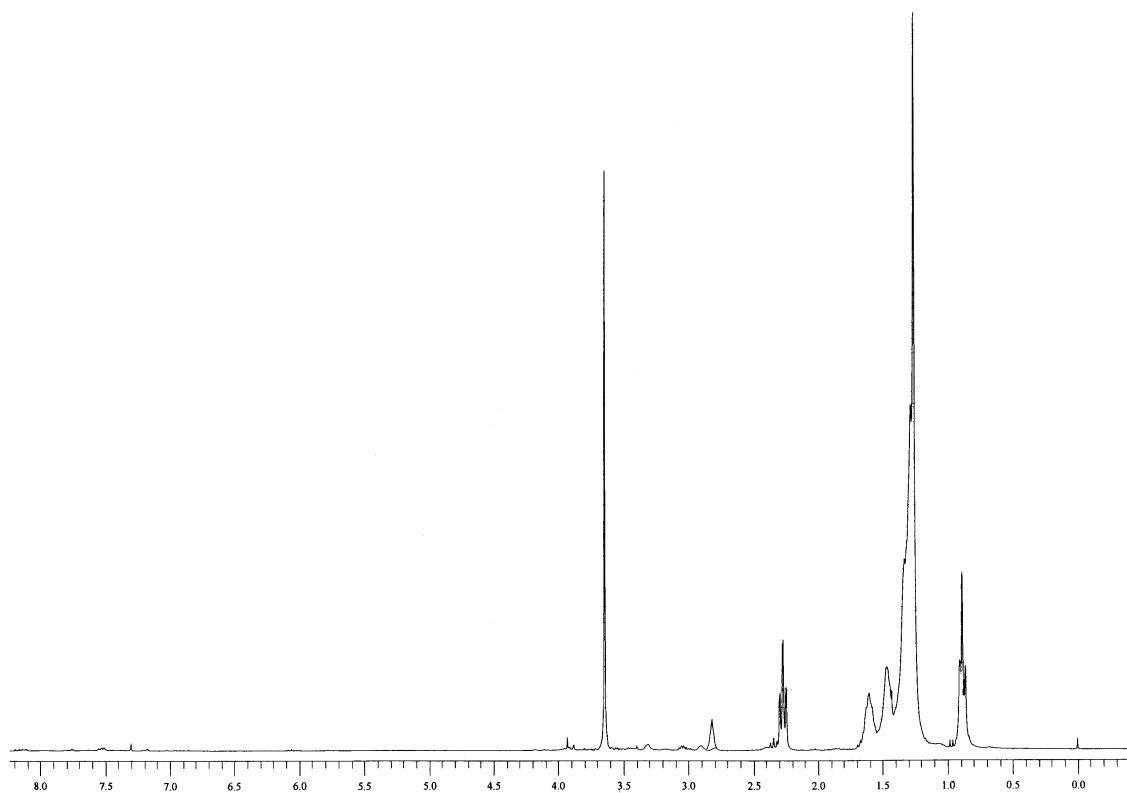


Fig S1: ¹H NMR Spectrum of Epoxy KFAME.

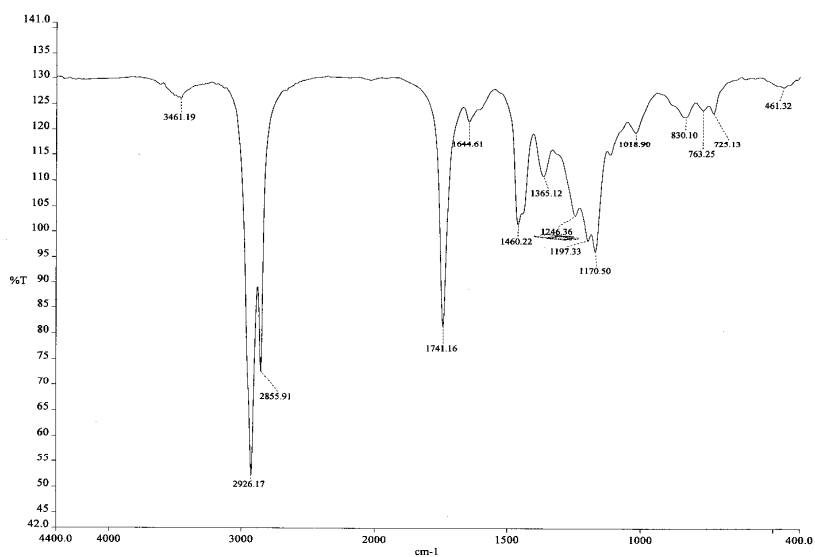


Fig S2: IR Spectrum of Epoxy KFAME

HYDROXYLATED KARANJA OIL

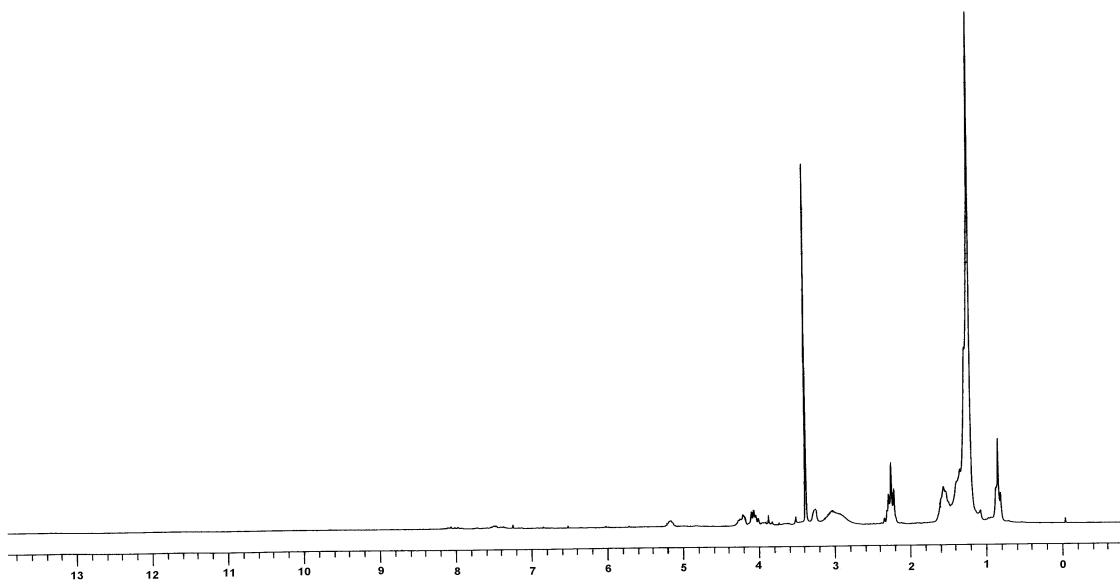


Fig.S3: ¹H NMR Spectrum of Hydroxylated Karanja Oil

IR (neat, cm⁻¹): 3445 (-OH), 2925 (C-H), 1743 (C=O), 1102 (C-C(=O)-

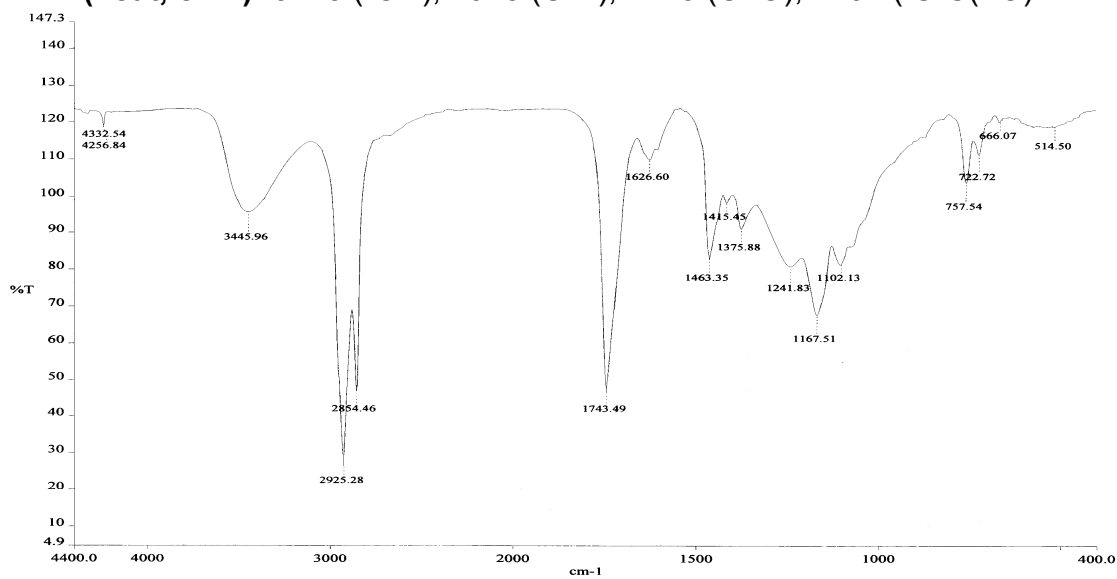


Fig.S4: IR Spectrum of Hydroxylated Karanja Oil

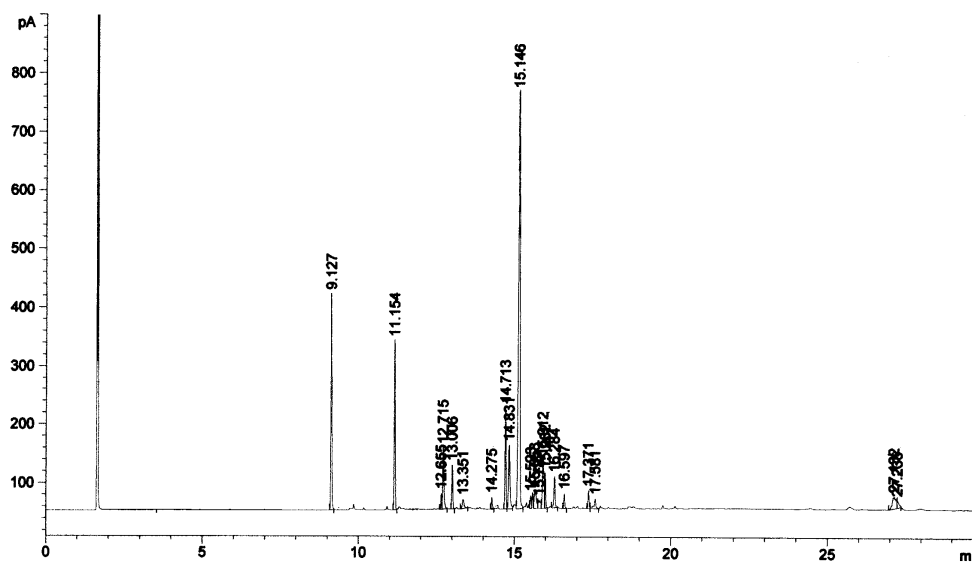


Fig.S5: GC Spectrum of Hydroxylated Karanja Oil

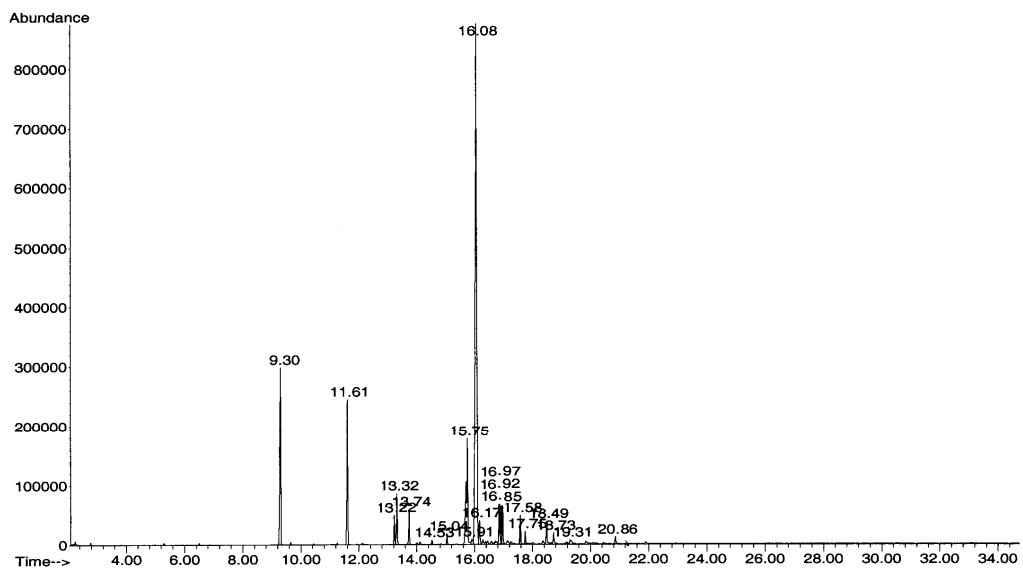


Fig.S6: GC-MS Spectrum of Hydroxylated Karanja Oil

PROPYLOXY ESTER OF HYDROXYLATED KARANJA OIL

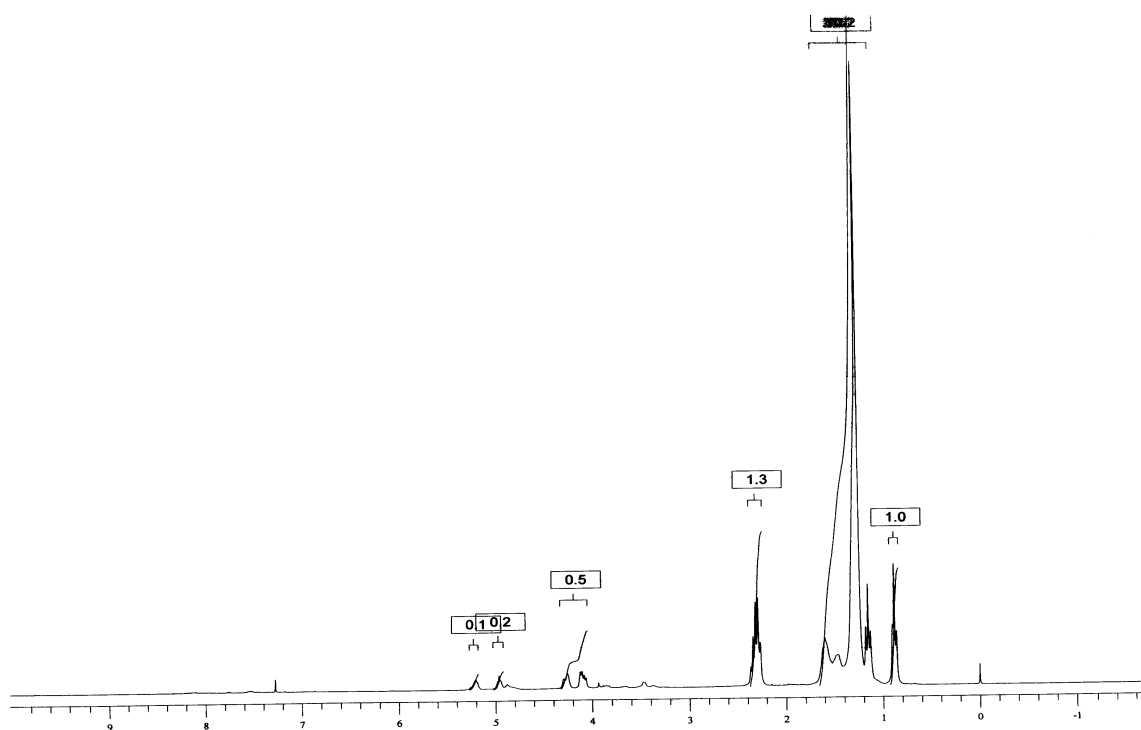


Fig.S7. ^1H NMR Spectrum of Propyloxy Ester of Hydroxylated Karanja Oil

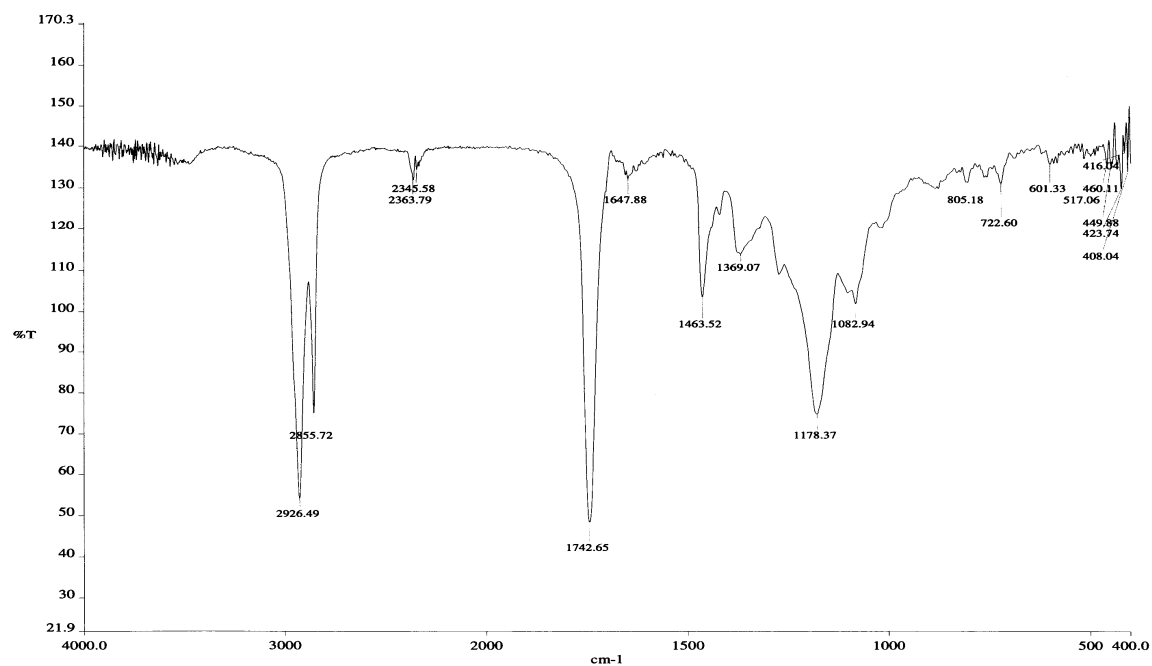


Fig.S8. IR Spectrum of Propyloxy Ester of Hydroxylated Karanja Oil

HYDROXYLATED KARANJA FATTY ACID METHYL ESTERS

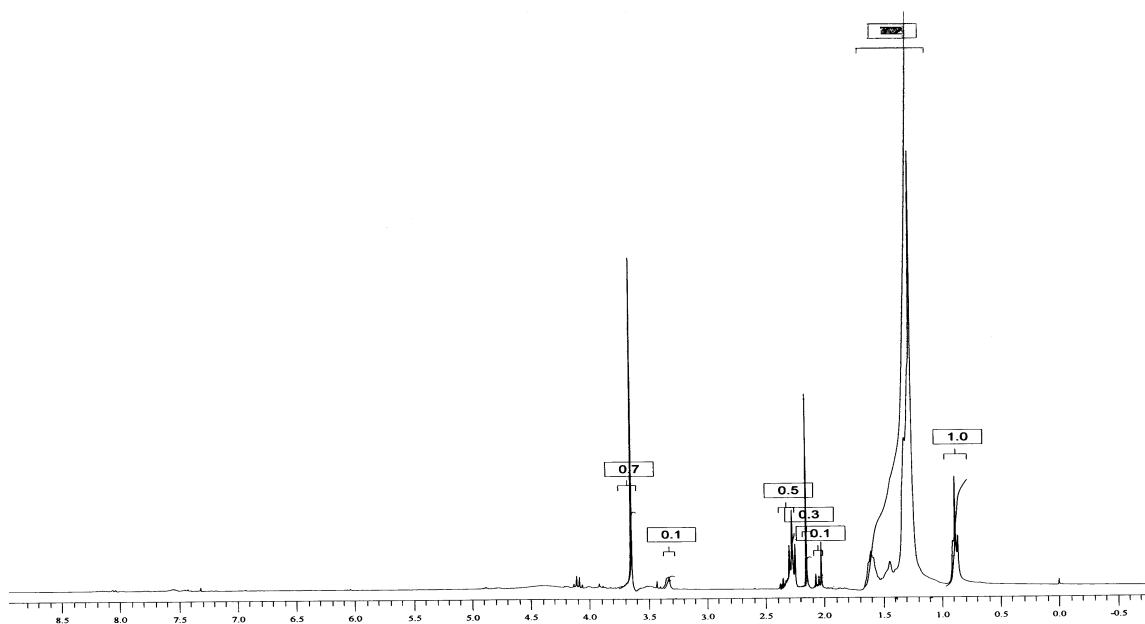


Fig.S9. ^1H NMR Spectrum of Hydroxylated Karanja Fatty Acid Methyl Esters

IR (neat, cm^{-1}): 3445 (-OH), 2925 (C-H), 1743 (C=O), 1102 (C-C(=O)-O).

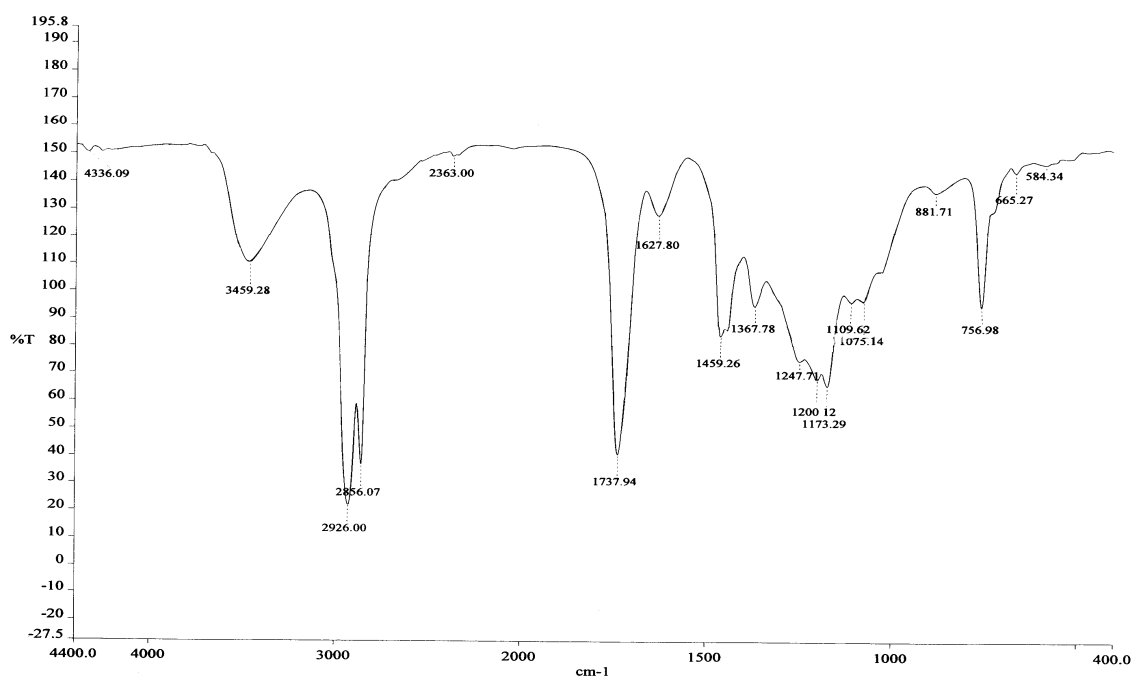


Fig.S10. IR Spectrum of Hydroxylated Karanja Fatty Acid Methyl Esters

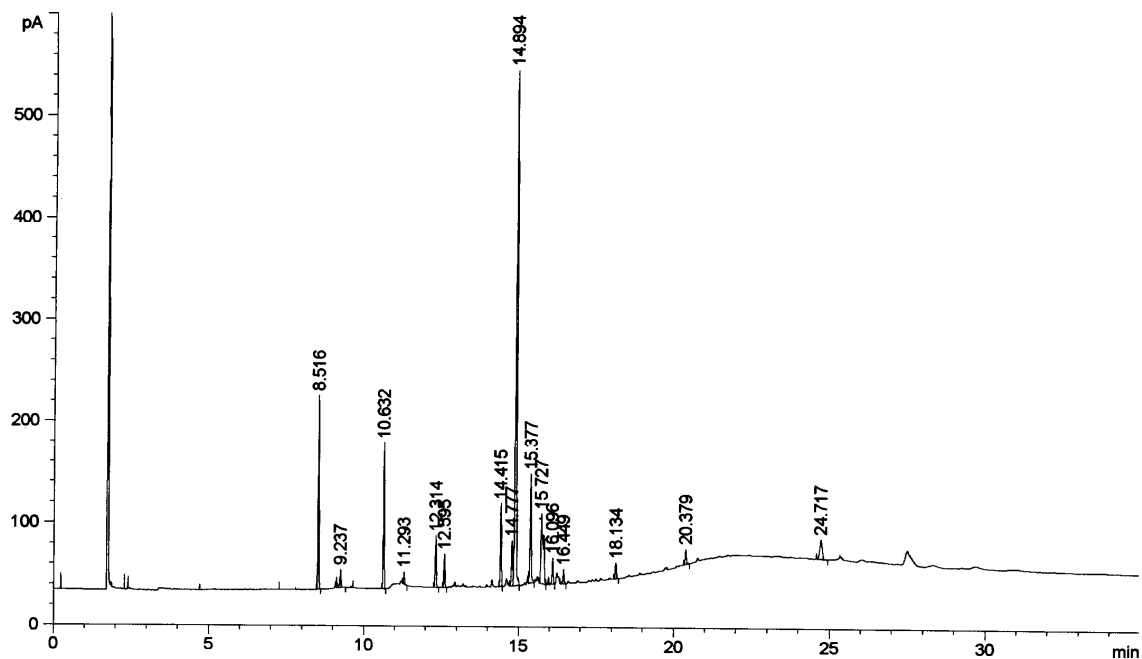


Fig.S11. GC Spectrum of Hydroxylated Karanja Fatty Acid Methyl Esters

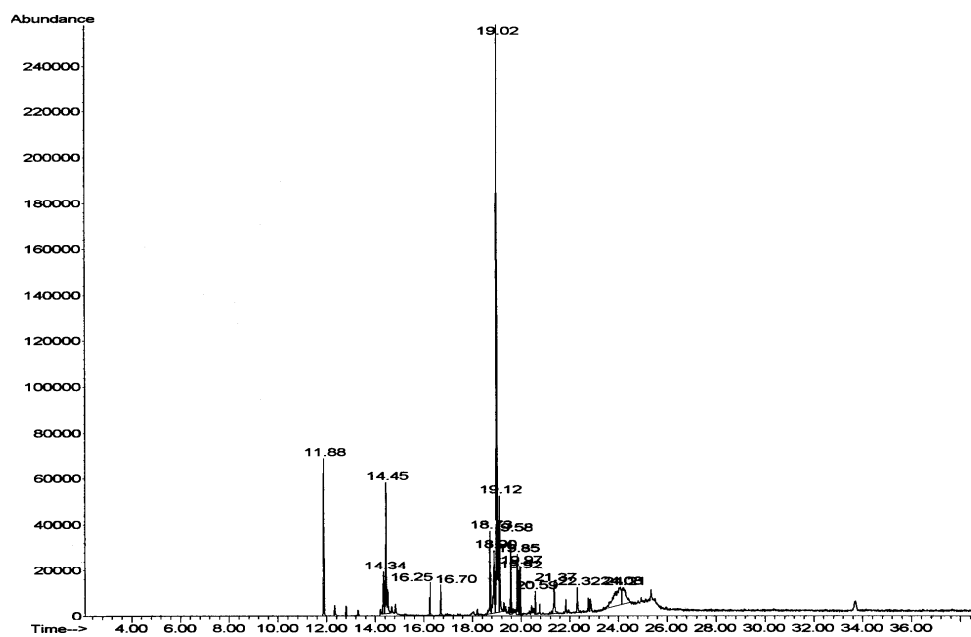


Fig.S12. GC-MS Spectrum of Hydroxylated Karanja Fatty Acid Methyl Esters

**PROPYLOXY ESTER OF HYDROXYLATED KARANJA FATTY ACID
METHYL ESTERS**

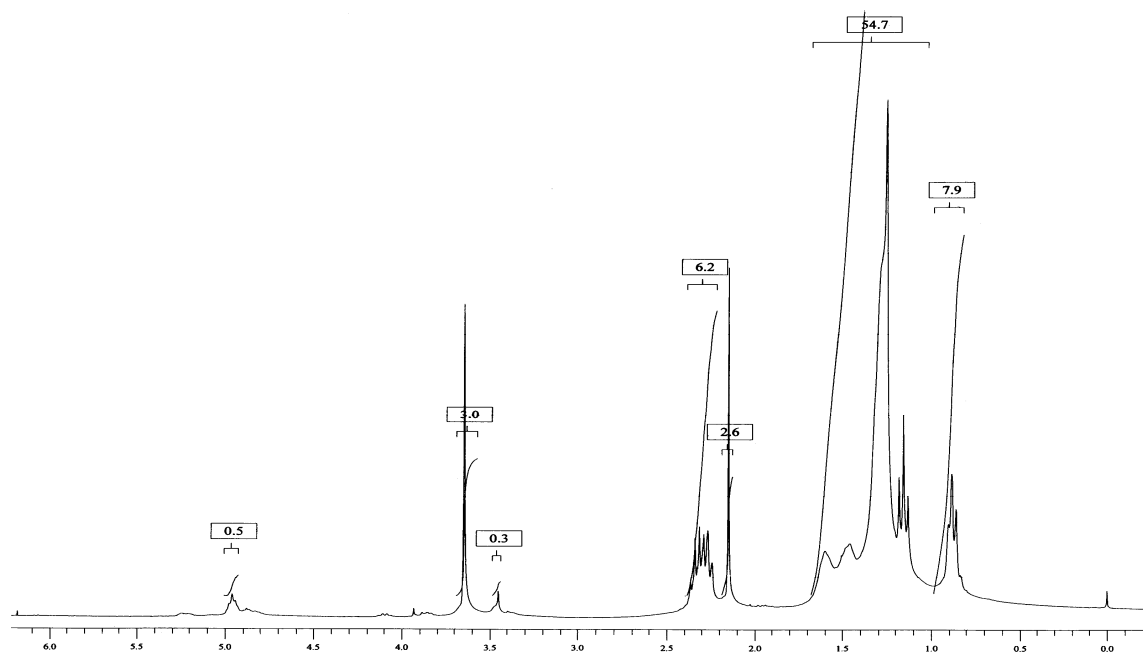


Fig.S13. ^1H NMR Spectrum of Propyloxy Ester of Hydroxylated Karanja Fatty Acid Methyl Esters

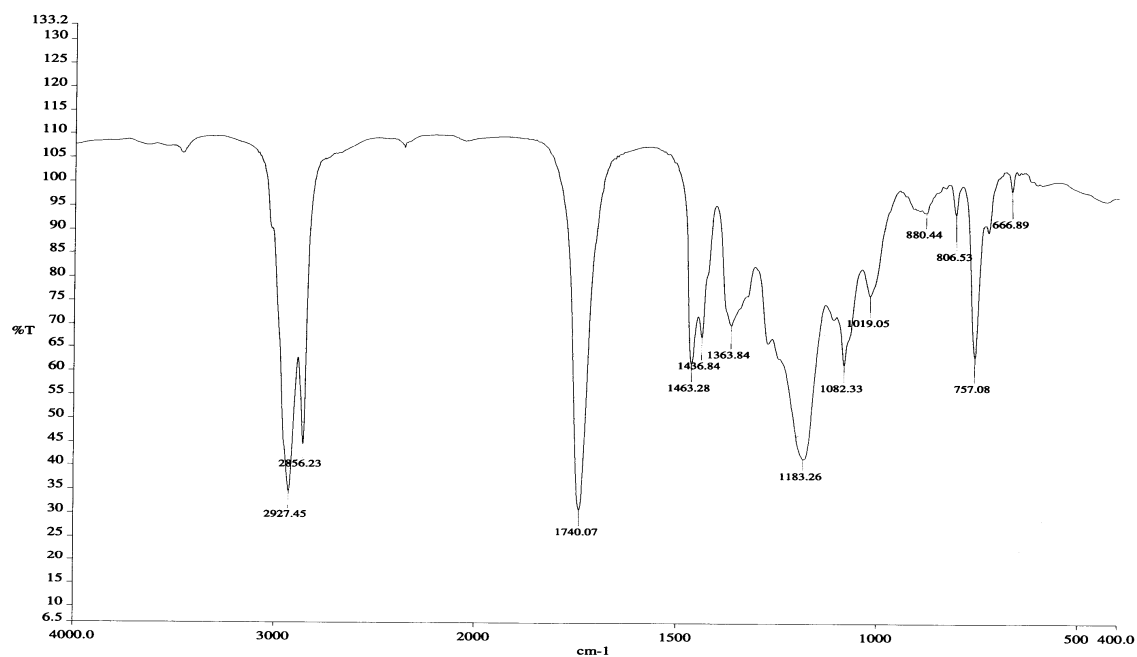


Fig.S14. IR Spectrum of Propyloxy Ester of Hydroxylated Karanja Fatty Acid Methyl Esters

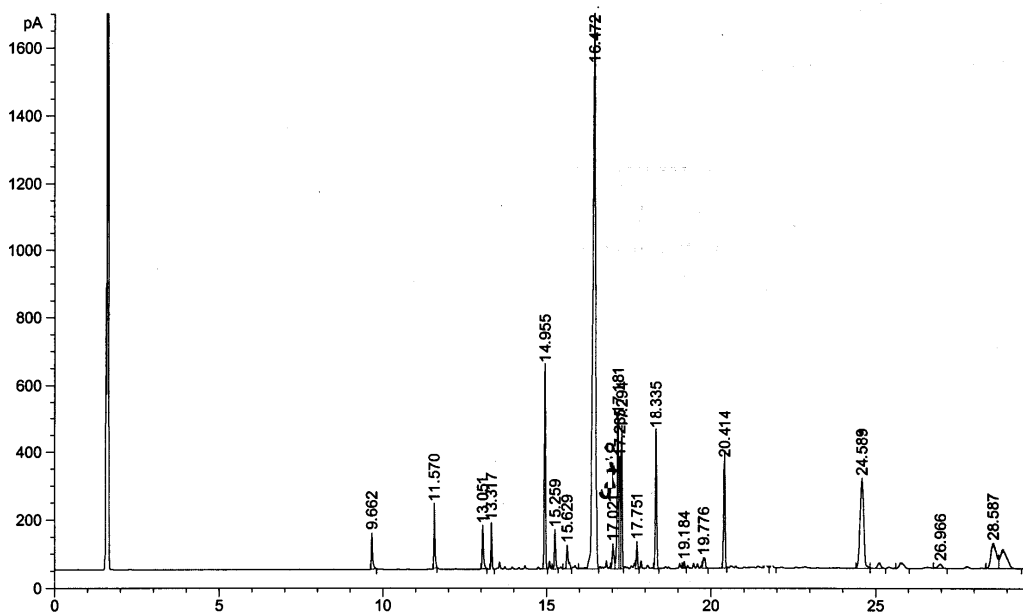


Fig.S15. GC Spectrum of Propyloxy Ester Of Hydroxylated Karanja Fatty Acid Methyl Esters

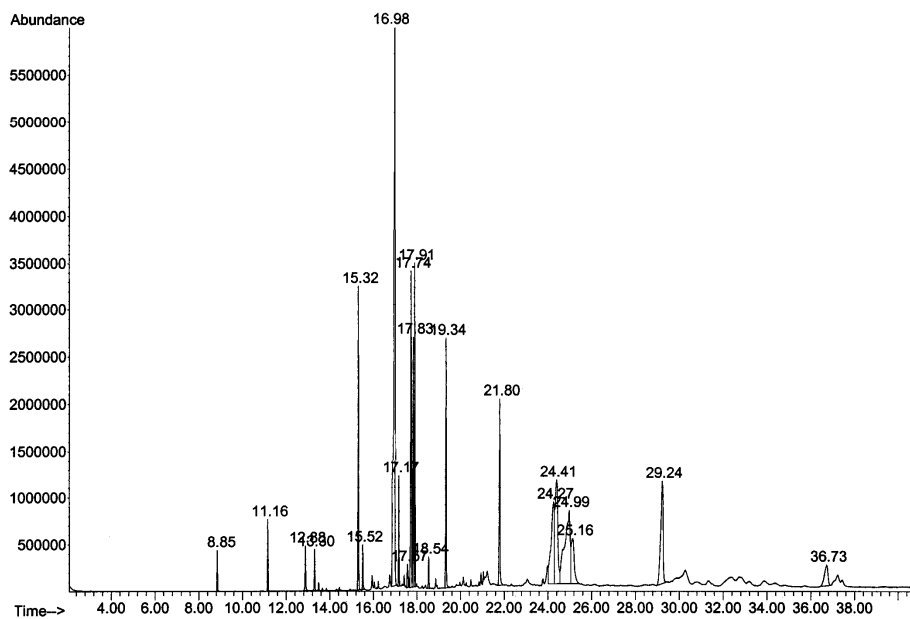


Fig.S16. GC-MS Spectrum of Propyloxy Ester of Hydroxylated Karanja Fatty Acid Methyl Esters

**HEXYLOXY ESTER OF HYDROXYLATED KARANJA FATTY ACID
METHYL ESTERS:**

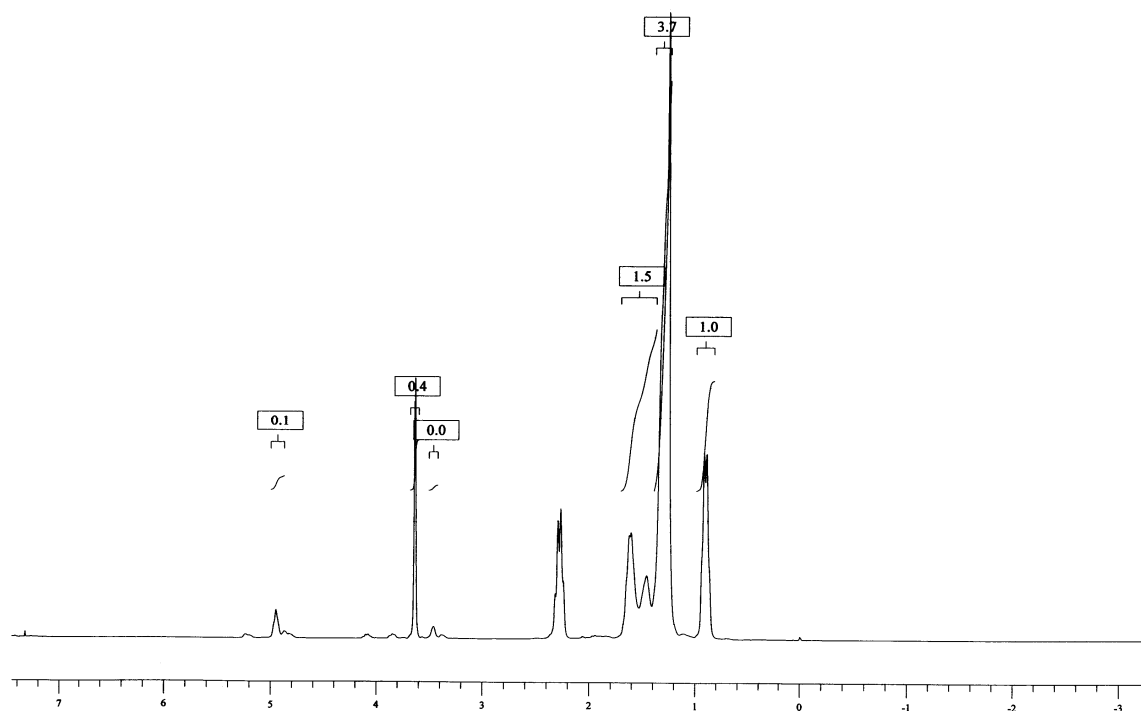


Fig.S17. ^1H NMR spectrum of Hexyloxy Ester of Hydroxylated Karanja Fatty Acid Methyl Esters

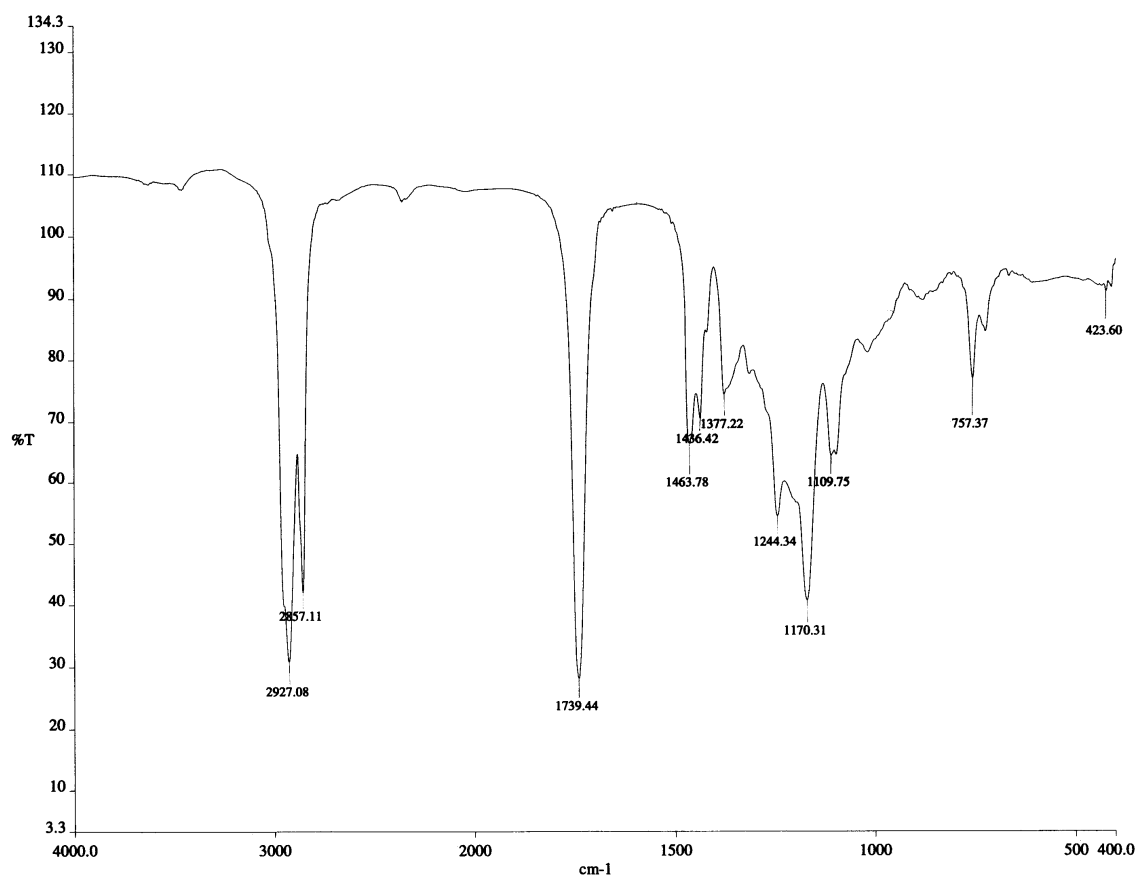


Fig.S18. IR spectrum of Hexyloxy Ester of Hydroxylated Karanja fatty acid Methyl Esters:

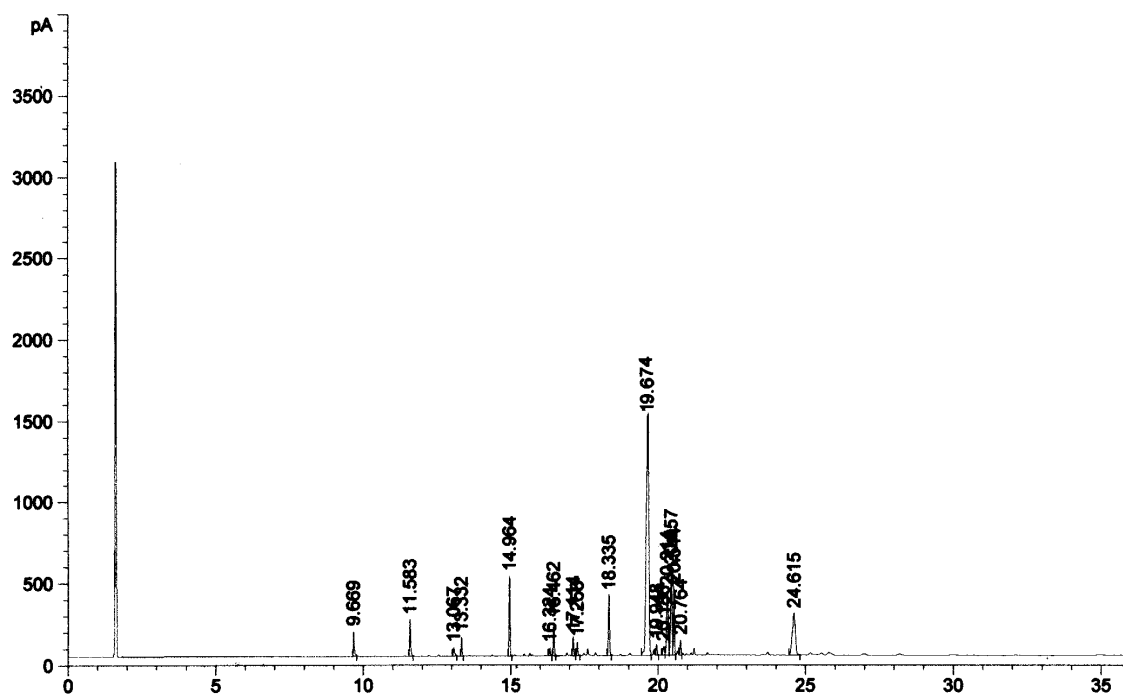


Fig.S19. GCMS Spectrum of Hexyloxy Ester of Hydroxylated Karanja Fatty Acid Methyl Esters

**BUTYLOXY ESTER OF HYDROXYLATED KARANJA FATTY ACID
METHYL ESTERS**

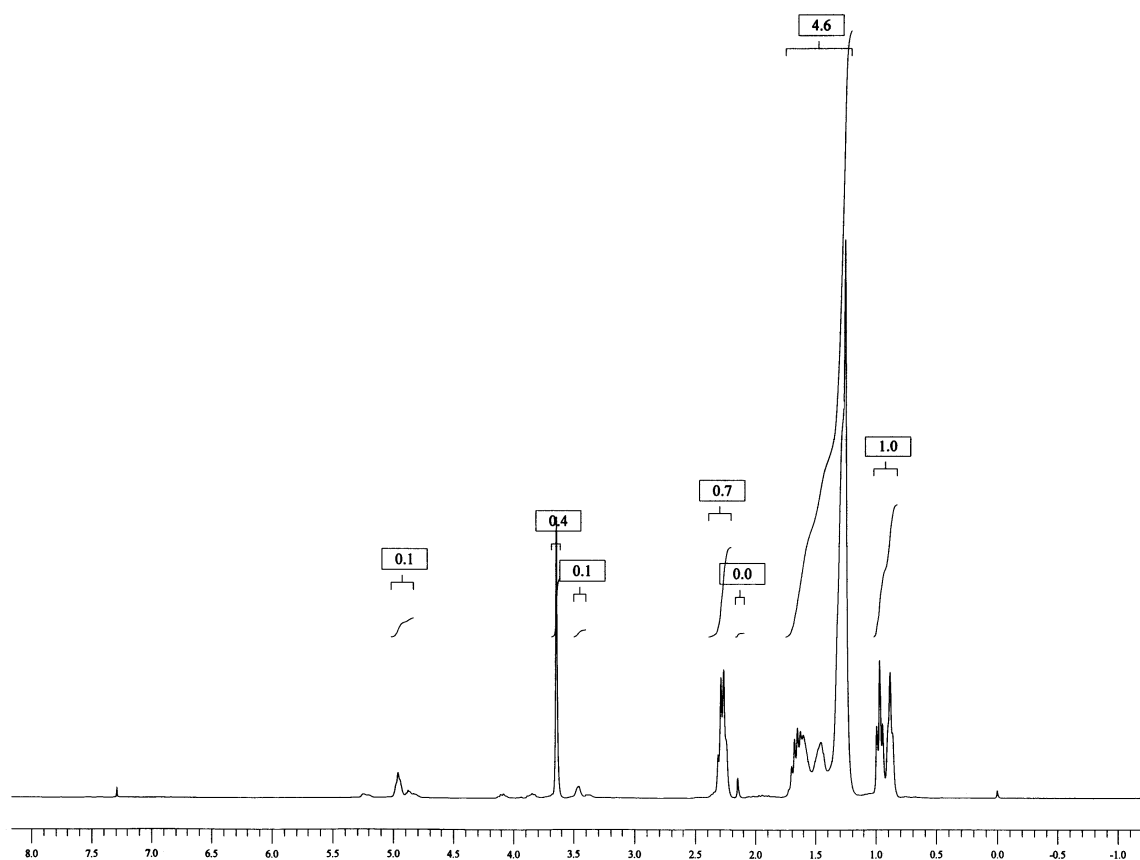


Fig.S20. ^1H NMR spectrum of Butyloxy Ester of Hydroxylated Karanja Fatty Acid Methyl Esters

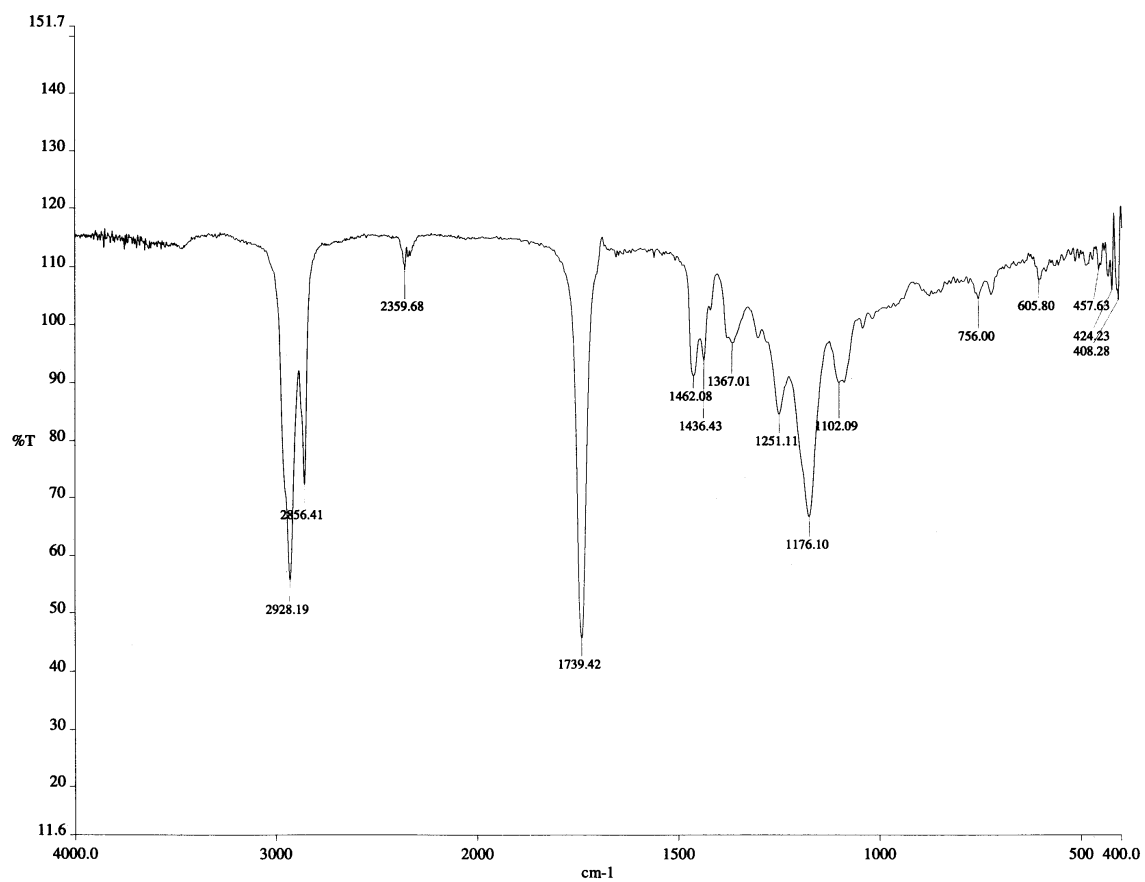


Fig.S21. IR spectrum of Butyloxy Ester of Hydroxylated Karanja Fatty Acid Methyl Esters

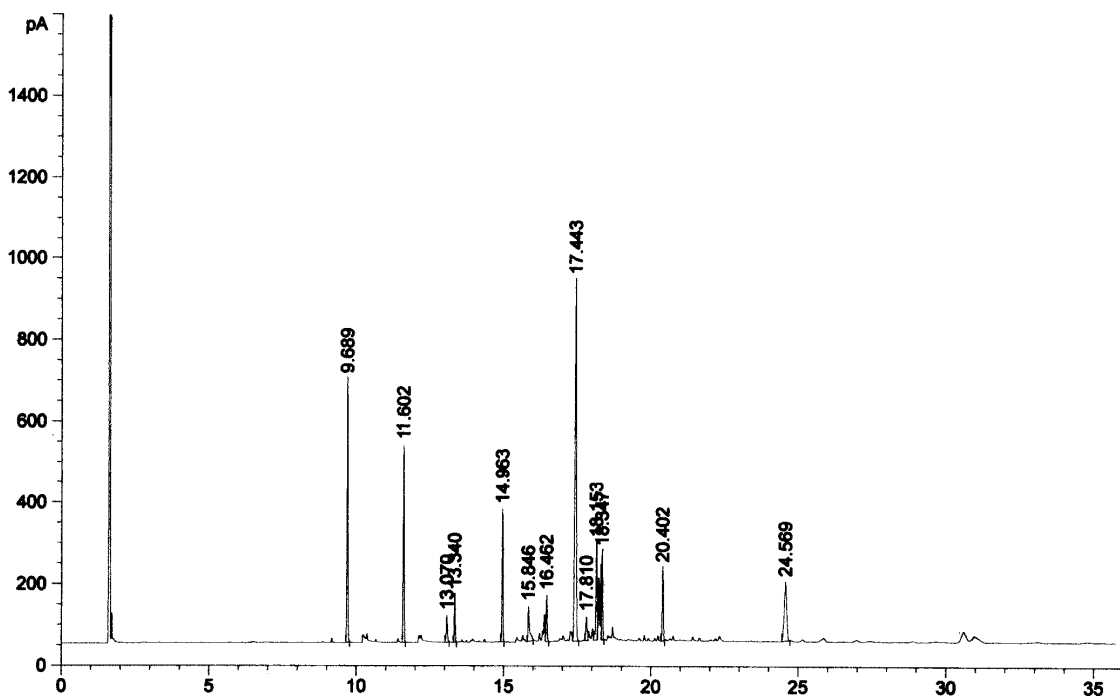


Fig.S22. GC spectrum of Butyloxy Ester of Hydroxylated Karanja Fatty Acid Methyl Esters

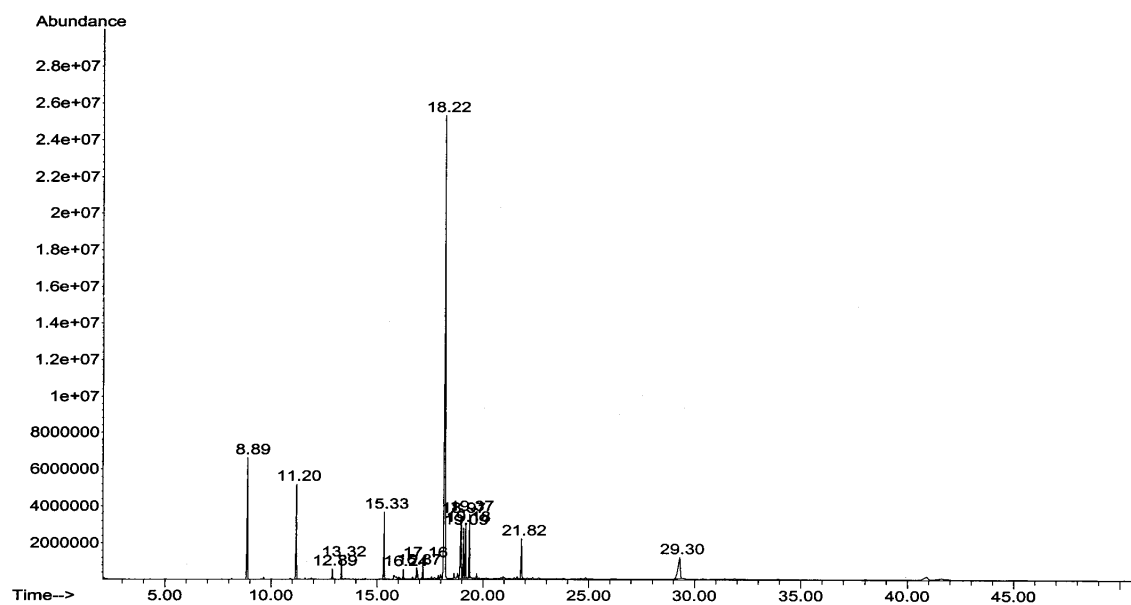


Fig.S23. GCMS spectrum of Butyloxy Ester of Hydroxylated Karanja Fatty Acid Methyl Esters