CONTENTS

	Page
บทคัดย่อ	(3)
ABSTRACT	(7)
ACKNOWLEDGEMENT	(11)
THE RELEVANCE OF THE RESEARCH WORK TO THAILAND	(12)
CONTENTS	(13)
LIST OF TABLES	(16)
LIST OF ILLUSTRATIONS	(22)
ABBREVIATIONS AND SYMBOLS	(27)
1. INTRODUCTION	1
1.1 Introduction	1
1.2 Review of literatures	3
2. EXPERIMENTAL	12
2.1 Instruments and chemicals	12
2.2 Plant material	13
2.3 Extraction	13
2.4 Isolation and chemical investigation	14
2.4.1 Investigation of the solid precipitate of hexane extract	14
from the leaves of <i>C. decandra</i>	
2.4.2 Investigation of the crude hexane extract from	18
the leaves of <i>C. decandra</i>	
2.4.3 Investigation of the crude methylene chloride extract	25
from the leaves of C. decandra	

CONTENTS (Continued)

		Page
3.	RESULTS AND DISCUSSION	30
	3.1 Srtucture elucidation of compounds from the leaves of <i>C. decandra</i>	30
	3.1.1 Compound PTH1	31
	3.1.2 Compound PTH2	37
	3.1.3 Compound PTH3	42
	3.1.4 Compound PTH4	48
	3.1.5 Compound PTH5	54
	3.1.6 Compound PTH6	60
	3.1.7 Compound PTH7	66
	3.1.8 Compound PTH8	72
	3.1.9 Compound PTH9	78
	3.1.10 Compound PTH10	84
	3.1.11 Compound PTH11	89
	3.1.12 Compound PTH12	96
	3.1.13 Compound PTH13	102
	3.1.14 Compound PTH14	108
	3.1.15 Compound PTH15	114
	3.1.16 Compound PTH16	121
	3.1.17 Compound PTH17	127
	3.1.18 Compounds PTH18 and PTH19	133
	3 1 19 Compounds PTH20 and PTH21	134

CONTENTS (Continued)

	Page
3.1.20 Compound PTM1	135
3.1.21 Compound PTM2	142
3.1.22 Compound PTM3	146
3.1.23 Compound PTM4	149
3.1.24 Compound PTM5	155
3.2 Biological activities of the pure compounds from C. decandra	162
REFERENCES	163
APPENDIX	168
PUBLICATIONS AND PROCEEDINGS	248
VITAE	250

LIST OF TABLES

Table		Page
1	Compounds from plant of Ceriops genus	4
2	¹ H, ¹³ C NMR and HMBC spectral data of compound PTH1	33
3	Comparison of ¹ H NMR spectral data between lupeol and	34
	compound PTH1 (recorded in CDCl ₃)	
4	Comparison of ¹³ C NMR spectral data between lupeol and	35
	compound PTH1 (recorded in CDCl ₃)	
5	¹ H, ¹³ C NMR and HMBC spectral data of compound PTH2	38
6	Comparison of ¹ H NMR spectral data between compounds PTH1 and PTH2 (recorded in CDCl ₃)	40
7	Comparison of ¹³ C NMR spectral data of lupenone, compounds PTH1	41
	and PTH2 (recorded in CDCl ₃)	
8	¹ H, ¹³ C NMR and HMBC spectral data of compound PTH3	44
9	Comparison of ¹ H NMR spectral data of betulin, compounds PTH1	45
	and PTH3 (recorded in CDCl ₃)	
10	Comparison of ¹³ C NMR spectral data of betulin, compounds PTH1	46
	and PTH3 (recorded in CDCl ₃)	
11	¹ H, ¹³ C NMR and HMBC spectral data of compound PTH4	49
12	Comparison of ¹ H NMR spectral data of betulinaldehyde, compounds	51
	PTH1 and PTH4 (recorded in CDCl ₃)	
13	Comparison of ¹³ C NMR spectral data of betulinaldehyde, compounds	52
	PTH1 and PTH4 (recorded in CDCl ₃)	
14	¹ H, ¹³ C NMR and HMBC spectral data of compound PTH5	55
15	Comparison of ¹ H NMR spectral data between betulinic acid,	57
	compounds PTH4 and PTH5 (recorded in CDCl ₂)	

Tabl	e	Page
16	Comparison of ¹³ C NMR spectral data of betulinic acid (recorded in	58
	pyridine- d_5), compounds PTH4 and PTH5 (recorded in CDCl ₃ +CD ₃ OD)	
17	¹ H, ¹³ C NMR and HMBC spectral data of compound PTH6	61
18	Comparison of ¹ H NMR spectral data of 3-epi-betulinic acid	63
	(recorded in CDCl ₃), compounds PTH5 (recorded in CDCl ₃) and	
	PTH6 (recorded in CDCl ₃ + CD ₃ OD)	
19	Comparison of ¹³ C NMR spectral data of 3-epi-betulinic acid,	64
	compounds PTH5 and PTH6 (recorded in CDCl ₃ +CD ₃ OD)	
20	¹ H, ¹³ C NMR and HMBC spectral data of compound PTH7	67
21	Comparison of ¹ H NMR spectral data of lup-20(29)-en-3 β , 30-diol,	69
	compounds PTH1 and PTH7 (recorded in CDCl ₃)	
22	Comparison of 13 C NMR spectral data of lup-20(29)-en-3 β , 30-diol,	70
	compounds PTH1 and PTH7 (recorded in CDCl ₃)	
23	¹ H, ¹³ C NMR and HMBC spectral data of compound PTH8	73
24	Comparison of ¹ H NMR spectral data of 30-nor-lupan-3β-ol-20-one,	75
	compounds PTH1 and PTH8 (recorded in CDCl ₃)	
25	Comparison of ¹³ C NMR spectral data of 30-nor-lupan-3β-ol-20-one,	76
	compounds PTH1 and PTH8 (recorded in CDCl ₃)	
26	¹ H, ¹³ C NMR and HMBC spectral data of compound PTH9	79
27	Comparison of ¹ H NMR spectral data between compounds PTH1	81
	and PTH9	
28	Comparison of ¹³ C NMR spectral data between compounds PTH1	82
	and PTH9	

Table		Page
29	¹ H, ¹³ C NMR and HMBC spectral data of compound PTH10	85
30	Comparison of ¹ H NMR spectral data of compounds PTH1	87
	and PTH10 (recorded in CDCl ₃)	
31	Comparison of 13 C NMR spectral data of 3β , 20-dihydroxylupane,	88
	compounds PTH1 and PTH10 (recorded in CDCl ₃)	
32	¹ H, ¹³ C NMR and HMBC spectral data of compound PTH11	91
33	Comparison of ${}^{1}H$ NMR spectral data of 3β -E-coumaroyllupeol	92
	compounds PTH1 and PTH11 (recorded in CDCl ₃)	
34	Comparison of 13 C NMR spectral data of 3β -E-coumaroyllupeol,	94
	compounds PTH1 and PTH11 (recorded in CDCl ₃)	
35	¹ H, ¹³ C NMR and HMBC spectral data of compound PTH12	97
36	Comparison of ¹ H NMR spectral data between compounds	99
	PTH11 and PTH12 (recorded in CDCl ₃)	
37	Comparison of ¹³ C NMR spectral data between compounds	100
	PTH11 and PTH12 (recorded in CDCl ₃)	
38	¹ H, ¹³ C NMR and HMBC spectral data of compound PTH13	103
39	Comparison of ¹ H NMR spectral data between compounds	105
	PTH12 and PTH13 (recorded in CDCl ₃)	
40	Comparison of ¹³ C NMR spectral data between compounds	106
	PTH12 and PTH13 (recorded in CDCl ₃)	
41	¹ H, ¹³ C NMR and HMBC spectral data of compound PTH14	110
42	Comparison of ¹³ C NMR spectral data between compounds	111
	PTH11 and PTH14 (recorded in CDCL)	

Table		Page
43	Comparison of ¹³ C NMR spectral data between compounds	112
	PTH11 and PTH14 (recorded in CDCl ₃)	
44	¹ H, ¹³ C NMR and HMBC spectral data of compound PTH15	116
45	Comparison of ¹ H NMR spectral data between compounds	117
	PTH14 and PTH15 (recorded in CDCl ₃)	
46	Comparison of ¹³ C NMR spectral data between compounds	119
	PTH14 and PTH15 (recorded in CDCl ₃)	
47	¹ H, ¹³ C NMR and HMBC spectral data of compound PTH16	122
48	Comparison of ${}^{1}H$ NMR spectral data of 3β -E- feruloylbetulin,	124
	compounds PTH14 and PTH16 (recorded in CDCl ₃)	
49	Comparison of 13 C NMR spectral data of 3β -E-feruloylbetulin,	125
	compounds PTH14 and PTH16 (recorded in CDCl ₃)	
50	¹ H, ¹³ C NMR and HMBC spectral data of compound PTH17	126
51	Comparison of ¹ H NMR spectral data of 3β-E-caffeoyl lupeol,	130
	compounds PTH14 and PTH17 (recorded in CDCl ₃)	
52	Comparison of 13 C NMR spectral data of 3β -E-caffeoyllupeol,	131
	compounds PTH14 and PTH17 (recorded in CDCl ₃)	
53	¹ H, ¹³ C NMR and HMBC spectral data of compound PTM1	136
54	Comparison of ¹ H NMR spectral data of compounds PTH3 ,	138
	PTH7, and PTM1 (recorded in CDCl ₃)	
55	Comparison of ¹³ C NMR spectral data of compounds PTH3 ,	139
	PTH7 and PTM1 (recorded in CDCl ₃)	

Table		Page
56	Comparison of 1 H NMR spectral data between 3β , 28, 30-lup-	140
	20(29)-en-triol and PTM1 (recorded in CDCl ₃)	
57	Comparison of 13 C NMR spectral data between 3 β , 28, 30-lup-	141
	20(29)-en-triol and compound PTM1	
58	¹ H, ¹³ C NMR and HMBC spectral data of compound PTM2	144
59	Comparison of ¹ H NMR spectral data between blumenol A and	145
	compound PTM2 (recorded in CDCl ₃)	
60	Comparison of ¹³ C NMR spectral data between blumenol A and	145
	compound PTM2 (recorded in CDCl ₃)	
61	¹ H, ¹³ C NMR and HMBC spectral data of compound PTM3	147
62	Comparison of ¹ H NMR spectral data of dehydrovomifoliol,	148
	compounds PTM2 and PTM3 (recorded in CDCl ₃)	
63	Comparison of ¹³ C NMR spectral data of dehydrovomifoliol,	148
	compounds PTM2 and PTM3 (recorded in CDCl ₃)	
64	300 MHz COSY Correlation of some protons of compound PTM4	151
65	300 MHz NOESY Correlation of some protons of compound PTM4	151
66	¹ H, ¹³ C NMR and HMBC spectral data of compound PTM4	152
67	Comparison of ¹ H NMR spectral data between lyoniresinol	153
	and compound PTM4	
68	Comparison of ¹³ C NMR spectral data between lyoniresinol	154
	and compound PTM4	
69	¹ H, ¹³ C NMR and HMBC spectral data of compound PTM5	157

Гable		Page
70	Comparison of ¹ H NMR spectral data between atroside and	158
	compound PTM5	
71	Comparison of ¹³ C NMR spectral data between atroside and	159
	compound PTM5	

LIST OF ILLUSTRATIONS

Figur	e	Page
1	Ceriops decandra (Griff.) Ding Hou and the hypocotyl of	2
	Ceriops tagal (Rhizophoraceae)	
2	X-ray ORTEP diagram of compound PTH9	80
3	The structure of atroside	161
4	IR (KBr) spectrum of compound PTH1	169
5	¹ H NMR (300 MHz) (CDCl ₃) spectrum of compound PTH1	170
6	¹³ C NMR (75 MHz) (CDCl ₃) spectrum of compound PTH1	171
7	DEPT 135° (CDCl ₃) spectrum of compound PTH1	172
8	DEPT 90° (CDCl ₃) spectrum of compound PTH1	172
9	2D COSY (CDCl ₃) spectrum of compound PTH1	173
10	2D HMQC (CDCl ₃) spectrum of compound PTH1	174
11	2D HMBC (CDCl ₃) spectrum of compound PTH1	175
12	IR (KBr) spectrum of compound PTH2	176
13	¹ H NMR (300 MHz) (CDCl ₃) spectrum of compound PTH2	177
14	¹³ C NMR (75 MHz) (CDCl ₃) spectrum of compound PTH2	178
15	¹ H NMR (300 MHz) (CDCl ₃) spectrum of compound PTH3	179
16	¹³ C NMR (75 MHz) (CDCl ₃) spectrum of compound PTH3	180
17	¹ H NMR (300 MHz) (CDCl ₃) spectrum of compound PTH4	181
18	¹³ C NMR (75 MHz) (CDCl ₃) spectrum of compound PTH4	182
19	IR (KBr) spectrum of compound PTH5	183
20	¹ H NMR (300 MHz) (CDCl ₃) spectrum of compound PTH5	184
21	¹³ C NMR (75 MHz) (CDCl ₃) spectrum of compound PTH5	185
22	¹ H NMR (300 MHz) (CDCl ₂ +CD ₂ OD) spectrum of compound PTH6	186

Figure		Page
23	¹³ C NMR (75 MHz) (CDCl ₃ +CD ₃ OD) spectrum of compound PTH6	187
24	¹ H NMR (300 MHz) (CDCl ₃) spectrum of compound PTH7	188
25	¹³ C NMR (75 MHz) (CDCl ₃) spectrum of compound PTH7	189
26	¹ H NMR (300 MHz) (CDCl ₃) spectrum of compound PTH8	190
27	¹³ C NMR (75 MHz) (CDCl ₃) spectrum of compound PTH8	191
28	¹ H NMR (300 MHz) (CDCl ₃ +CD ₃ OD) spectrum of compound PTH9	192
29	¹³ C NMR (75 MHz) (CDCl ₃ +CD ₃ OD) spectrum of compound PTH9	193
30	¹ H NMR (300 MHz) (CDCl ₃) spectrum of compound PTH10	194
31	¹³ C NMR (75 MHz) (CDCl ₃) spectrum of compound PTH10	195
32	UV (MeOH) spectrum of compound PTH11	196
33	IR (KBr) spectrum of compound PTH11	196
34	¹ H NMR (300 MHz) (CDCl ₃) spectrum of compound PTH11	197
35	¹³ C NMR (75 MHz) (CDCl ₃) spectrum of compound PTH11	198
36	¹ H NMR (300 MHz) (CDCl ₃) spectrum of compound PTH12	199
37	¹³ C NMR (75 MHz) (CDCl ₃) spectrum of compound PTH12	200
38	¹ H NMR (300 MHz) (CDCl ₃) spectrum of compound PTH13	201
39	DEPT 135° (CDCl ₃) spectrum of compound PTH13	202
40	DEPT 90° (CDCl ₃) spectrum of compound PTH13	202
41	2D COSY (CDCl ₃) spectrum of compound PTH13	203
42	2D HMBC (CDCl ₃) spectrum of compound PTH13	204
43	EI-MS mass spectrum of compound PTH13	205
44	UV (MeOH) spectrum of compound PTH14	206
45	IR (KBr) spectrum of PTH14	206

Figur	e	Page
46	¹ H NMR (300 MHz) (CDCl ₃) spectrum of compound PTH14	207
47	¹³ C NMR (75 MHz) (CDCl ₃) spectrum of compound PTH14	208
48	DEPT 135° (CDCl ₃) spectrum of compound PTH14	209
49	DEPT 90° (CDCl ₃) spectrum of compound PTH14	209
50	2D COSY (CDCl ₃) spectrum of compound PTH14	210
51	2D HMQC (CDCl ₃) spectrum of compound PTH14	211
52	2D HMBC (CDCl ₃) spectrum of compound PTH14	212
53	ESI-TOF-MS mass spectrum of compound PTH14	213
54	UV (MeOH) spectrum of compound PTH15	214
55	IR (KBr) spectrum of compound PTH15	214
56	¹ H NMR (300 MHz) (CDCl ₃) spectrum of compound PTH15	215
57	¹³ C NMR (75 MHz) (CDCl ₃) spectrum of compound PTH15	216
58	DEPT 135° (CDCl ₃) spectrum of compound PTH15	217
59	DEPT 90° (CDCl ₃) spectrum of compound PTH15	217
60	2D COSY (CDCl ₃) spectrum of compound PTH15	218
61	2D HMQC (CDCl ₃) spectrum of compound PTH15	219
62	2D HMBC (CDCl ₃) spectrum of compound PTH15	220
63	ESI-TOF-MS mass spectrum of compound PTH15	221
64	¹ H NMR (300 MHz) (CDCl ₃) spectrum of compound PTH16	222
65	¹³ C NMR (75 MHz) (CDCl ₃) spectrum of compound PTH16	223
66	¹ H NMR (300 MHz) (CDCl ₃) spectrum of compound PTH17	224
67	¹³ C NMR (75 MHz) (CDCl ₃) spectrum of compound PTH17	225

Figur	e	Page
68	¹ H NMR (300 MHz) (CDCl ₃ +CD ₃ OD) spectrum of compound	226
	PTH18 and PTH19	
69	¹ H NMR (300 MHz) (CDCl ₃) spectrum of compound	227
	PTH20 and PTH21	
70	¹ H NMR (300 MHz) (CDCl ₃) spectrum of compound PTM1	228
71	¹³ C NMR (75 MHz) (CDCl ₃) spectrum of compound PTM1	229
72	UV (MeOH) spectrum of compound PTM2	230
73	IR (neat) spectrum of compound PTM2	230
74	¹ H NMR (300 MHz) (CDCl ₃) spectrum of compound PTM2	231
75	¹³ C NMR (75 MHz) (CDCl ₃) spectrum of compound PTM2	232
76	DEPT 135° (CDCl ₃) spectrum of compound PTM2	233
77	DEPT 90° (CDCl ₃) spectrum of compound PTM2	233
78	2D COSY (CDCl ₃) spectrum of compound PTM2	234
79	2D HMQC (CDCl ₃) spectrum of compound PTM2	235
80	2D HMBC (CDCl ₃) spectrum of compound PTM2	236
81	¹ H NMR (300 MHz) (CDCl ₃) spectrum of compound PTM3	237
82	¹³ C NMR (75MHz) (CDCl ₃) spectrum of compound PTM3	238
83	UV (MeOH) spectrum of compound PTM4	239
84	IR (neat) spectrum of compound PTM4	239
85	¹ H NMR (300 MHz) (CDCl ₃) spectrum of compound PTM4	240
86	¹³ C NMR (75 MHz) (CDCl ₃) spectrum of compound PTM4	241
87	DEPT 135° (CDCl ₃) spectrum of compound PTM4	242
88	DEPT 90° (CDCl ₂) spectrum of compound PTM4	242

Figure	Figure	
89	2D COSY (CDCl ₃) spectrum of compound PTM4	243
90	2D HMQC (CDCl ₃) spectrum of compound PTM4	244
91	2D HMBC (CDCl ₃) spectrum of compound PTM4	245
92	¹ H NMR (300 MHz) (CDCl ₃ +CD ₃ OD) spectrum of compound PTM5	246
93	¹³ C NMR (75 MHz) (CDCl ₃ +CD ₃ OD) spectrum of compound PTM5	247
Scheme		Page
1	Extraction of the leaves of <i>C. decandra</i>	14
2	Isolation of compounds PTH1, PTH3-PTH6, PTH11, PTH12, PTH18	15
	and PTH19 from the leaves of C. decandra	
3	Isolation of PTH1, PTH2, PTH6-PTH17, PTH20 and PTH21 from the	18
	crude hexane extract	
4	Isolation of compounds PTH1, PTH3, PTH6, PTH13 and	25
	PTM1-PTM5 from the crude methylene chloride extract	

ABBREVIATIONS AND SYMBOLS

s = singlet

d = doublet

t = triplet

q = quartet

m = multiplet

dd = doublet of doublet

dt = doublet of triplet

brs = broad singlet

 R_f = Retention factor

g = gram

nm = nanometer

mp = melting point

cm⁻¹ = reciprocol centimeter (wave number)

 δ = chemical shift relative to TMS

J = coupling constant

 $[\alpha]_D$ = specific rotation

 λ_{max} = maximum wavelength

v = absorption frequencies

 ε = molar extinction coefficient

m/z = a value of mass divided by charge

°C = degree celcius

MHz = Megahertz

ppm = part per million

c = concentration

ABBREVIATIONS AND SYMBOLS (Continued)

IR = Infrared

UV-VIS = Ultraviolet-Visible

MS = Mass Spectroscopy

ESI TOF MS = Electrospray Ionization Time of Flight Mass

Spectroscopy

EI MS = Electron Impact Mass Spectroscopy

NMR = Nuclear Magnetic Resonance

2D NMR = Two Dimensional Nuclear Magnetic Resonance

COSY = Correlation Spectroscopy

DEPT = Distortionless Enhancement by Polarization Transfer

HMBC = Heteronuclear Multiple Bond Correlation

HMQC = Heteronuclear Multiple Quantum Coherence

NOESY = Nuclear Overhauser Effect Spectroscopy

CC = Column Chromatography

QCC = Quick Column Chromatography

PLC = Preparative Thin Layer Chromatography

TMS = tetramethylsilane

CDCl₃ = deuterochloroform

CD₃OD = deuteromethanol