

CONTENTS

| | Page |
|--|-------------|
| Abstract (in Thai) | iii |
| Abstract (in English) | vi |
| Acknowledgements | ix |
| Contents | xi |
| List of Tables | xiii |
| List of Illustrations | xv |
| Abbreviations and Symbols | xx |
| Chapter | |
| 1. Introduction | 1 |
| 1.1 Introduction | 1 |
| 1.2 Review of Literatures | 2 |
| 1.2.1 The Chemical Constituents of <i>Cratoxylum</i> genus (2005-2007) | 2 |
| 1.2.2 The Biological Activities of <i>Cratoxylum</i> genus (2005-2007) | 2 |
| 1.2.3 <i>Cratoxylum cochinchinense</i> | 5 |
| 1.3 Objective | 18 |
| 2. Experimental | 19 |
| 2.1 General Method | 19 |
| 2.2 Plant Material | 20 |
| 2.3 Extraction and Isolation | 20 |
| 2.3.1 Purification of dichloromethane extract of twigs | 22 |
| 2.3.2 Purification of acetone extract of twigs | 26 |
| 2.3.3 Purification of dichloromethane extract of fruits | 30 |
| 2.3.4 Purification of acetone extract of fruits | 34 |
| 2.3.5 Purification of dichloromethane extract of roots | 34 |
| 2.3.6 Purification of methanol extract of roots | 40 |

CONTENTS (Continued)

| | Page |
|---|-------------|
| 3. Results and Discussion | 48 |
| 3.1 Structure Determination | 48 |
| 3.1.1 PS1 | 52 |
| 3.1.2 PS2 | 53 |
| 3.1.3 PS3 | 55 |
| 3.1.4 PS4 | 57 |
| 3.1.5 PS5 | 59 |
| 3.1.6 PS6 | 62 |
| 3.1.7 PS7 | 64 |
| 3.1.8 PS8 | 66 |
| 3.1.9 PS9 | 68 |
| 3.1.10 PS10 | 69 |
| 3.1.11 PS11 | 71 |
| 3.1.12 PS12 | 73 |
| 3.1.13 PS13Ac | 74 |
| 3.1.14 PS14 | 77 |
| 3.1.15 PS15 | 79 |
| 3.1.16 PS16 | 81 |
| 3.1.17 PS17 | 83 |
| 3.1.18 PS18 | 85 |
| 3.1.19 PS19 | 87 |
| 3.2 Evaluation of Biological activities | 89 |
| Reference | 93 |
| Appendix | 96 |
| Vitae | 187 |

LIST OF TABLES

| Table | | Page |
|--------------|--|-------------|
| 1 | Compounds isolated from the <i>Cratoxylum</i> genus (2005-2007) | 6 |
| 2 | Physical characteristic and weight of fractions from dichloromethane extract | 22 |
| 3 | Physical characteristic and weight of fractions from acetone extract | 26 |
| 4 | Physical characteristic and weight of fractions from dichloromethane extract | 30 |
| 5 | Physical characteristic and weight of fractions from dichloromethane extract | 35 |
| 6 | Physical characteristic and weight of fractions from methanol extract | 41 |
| 7 | NMR spectral data of PS1 | 53 |
| 8 | NMR spectral data of PS2 | 54 |
| 9 | NMR spectral data of PS3 | 56 |
| 10 | NMR spectral data of PS4 | 58 |
| 11 | NMR spectral data of PS5 | 61 |
| 12 | NMR spectral data of PS6 | 63 |
| 13 | NMR spectral data of PS7 | 65 |
| 14 | NMR spectral data of PS8 | 67 |
| 15 | NMR spectral data of PS9 | 69 |
| 16 | NMR spectral data of PS10 | 70 |
| 17 | NMR spectral data of PS11 | 72 |
| 18 | NMR spectral data of PS12 | 74 |
| 19 | NMR spectral data of PS13Ac | 76 |
| 20 | NMR spectral data of PS14 | 78 |
| 21 | NMR spectral data of PS15 | 80 |
| 22 | NMR spectral data of PS16 | 82 |

LIST OF TABLES (Continued)

| Table | | Page |
|--------------|--|-------------|
| 23 | NMR spectral data of PS17 | 84 |
| 24 | NMR spectral data of PS18 | 86 |
| 25 | NMR spectral data of PS19 | 88 |
| 26 | Antibacterial activity of crude extracts | 89 |
| 27 | Antibacterial activity of pure compounds | 90 |
| 28 | Cytotoxic activity of pure compounds | 91 |

LIST OF ILLUSTRATIONS

| Scheme | | Page |
|---------------|--|------|
| 1 | Extraction of crude extract from the twigs | 21 |
| 2 | Isolation of compounds PS1-3 from dichloromethane extract of twigs | 23 |
| 3 | Isolation of compounds PS1-2 from acetone extract of twigs | 27 |
| 4 | Extraction of crude extract from the fruits | 29 |
| 5 | Isolation of compounds PS4-6 from dichloromethane extract of fruits | 31 |
| 6 | Isolation of compounds PS7-12 from dichloromethane extract of roots | 36 |
| 7 | Isolation of compounds PS2, PS11-PS20 from crude methanol of roots | 42 |
| Figure | | |
| 1 | <i>Cratoxylum cochinchinense</i> | 4 |
| 2 | ¹ H NMR (300 MHz) (CDCl ₃) spectrum of PS1 | 98 |
| 3 | ¹ H NMR (300 MHz) (CDCl ₃) spectrum of PS2 | 99 |
| 4 | UV (EtOH) spectrum of PS3 | 100 |
| 5 | FT-IR (KBr) spectrum of PS3 | 100 |
| 6 | ¹ H NMR (300 MHz) (CDCl ₃) spectrum of PS3 | 101 |
| 7 | ¹³ C NMR (75 MHz) (CDCl ₃) spectrum of PS3 | 102 |
| 8 | DEPT 135° (CDCl ₃) spectrum of PS3 | 102 |
| 9 | ¹ H- ¹ H COSY spectrum of PS3 | 103 |
| 10 | 2D HMQC spectrum of PS3 | 104 |
| 11 | 2D HMBC spectrum of PS3 | 105 |
| 12 | UV (EtOH) spectrum of PS4 | 106 |
| 13 | FT-IR (KBr) spectrum of PS4 | 106 |
| 14 | ¹ H NMR (300 MHz) (CDCl ₃) spectrum of PS4 | 107 |
| 15 | NOEDIFF spectrum of PS4 after irradiation at δ_{H} 4.51 | 108 |

LIST OF ILLUSTRATIONS (Continued)

| Figure | | Page |
|--------|--|------|
| 16 | NOEDIFF spectrum of PS4 after irradiation at δ_{H} 4.61 | 108 |
| 17 | ^{13}C NMR (75 MHz) (CDCl_3) spectrum of PS4 | 109 |
| 18 | DEPT 135 $^\circ$ (CDCl_3) spectrum of PS4 | 109 |
| 19 | ^1H - ^1H COSY spectrum of PS4 | 110 |
| 20 | 2D HMQC spectrum of PS4 | 111 |
| 21 | 2D HMBC spectrum of PS4 | 112 |
| 22 | UV (EtOH) spectrum of PS5 | 113 |
| 23 | FT-IR (KBr) spectrum of PS5 | 113 |
| 24 | EI-MS spectrum of PS5 | 114 |
| 25 | ^1H NMR (300 MHz) (CDCl_3) spectrum of PS5 | 115 |
| 26 | NOEDIFF spectrum of PS5 after irradiation at δ_{H} 4.62 | 116 |
| 27 | NOEDIFF spectrum of PS5 after irradiation at δ_{H} 6.39 | 116 |
| 28 | ^{13}C NMR (75 MHz) (CDCl_3) spectrum of PS5 | 117 |
| 29 | DEPT 135 $^\circ$ (CDCl_3) spectrum of PS5 | 117 |
| 30 | ^1H - ^1H COSY spectrum of PS5 | 118 |
| 31 | 2D HMQC spectrum of PS5 | 119 |
| 32 | 2D HMBC spectrum of PS5 | 120 |
| 33 | UV (EtOH) spectrum of PS6 | 121 |
| 34 | FT-IR (KBr) spectrum of PS6 | 121 |
| 35 | ^1H NMR (300 MHz) (Acetone- d_6) spectrum of PS6 | 122 |
| 36 | ^{13}C NMR (75 MHz) (Acetone- d_6) spectrum of PS6 | 123 |
| 37 | 2D HMQC spectrum of PS6 | 124 |
| 38 | 2D HMBC spectrum of PS6 | 125 |
| 39 | ^1H NMR (300 MHz) (CDCl_3) spectrum of PS7 | 126 |
| 40 | NOEDIFF spectrum of PS7 after irradiation at δ_{H} 4.09 | 127 |
| 41 | NOEDIFF spectrum of PS7 after irradiation at δ_{H} 6.76 | 127 |

LIST OF ILLUSTRATIONS (Continued)

| Figure | | Page |
|--------|--|------|
| 42 | ^{13}C NMR (125 MHz) (CDCl_3) spectrum of PS7 | 128 |
| 43 | DEPT 135° (CDCl_3) spectrum of PS7 | 128 |
| 44 | ^1H - ^1H COSY spectrum of PS7 | 129 |
| 45 | 2D HMQC spectrum of PS7 | 130 |
| 46 | 2D HMBC spectrum of PS7 | 131 |
| 47 | UV (EtOH) spectrum of PS8 | 132 |
| 48 | FT-IR (KBr) spectrum of PS8 | 132 |
| 49 | ^1H NMR (300 MHz) (CDCl_3 +DMSO- d_6) spectrum of PS8 | 133 |
| 50 | ^{13}C NMR (75 MHz) (CDCl_3 +DMSO- d_6) spectrum of PS8 | 134 |
| 51 | ^1H NMR (300 MHz) (CDCl_3) spectrum of PS9 | 135 |
| 52 | ^1H NMR (300 MHz) (CDCl_3) spectrum of PS10 | 136 |
| 53 | UV (EtOH) spectrum of PS11 | 137 |
| 54 | FT-IR (KBr) spectrum of PS11 | 137 |
| 55 | ^1H NMR (300 MHz) (CDCl_3) spectrum of PS11 | 138 |
| 56 | NOEDIFF spectrum of PS11 after irradiation at δ_{H} 3.89 | 139 |
| 57 | NOEDIFF spectrum of PS11 after irradiation at δ_{H} 6.40 | 139 |
| 58 | ^{13}C NMR (75 MHz) (CDCl_3) spectrum of PS11 | 140 |
| 59 | DEPT 135° (CDCl_3) spectrum of PS11 | 140 |
| 60 | ^1H - ^1H COSY spectrum of PS11 | 141 |
| 61 | 2D HMQC spectrum of PS11 | 142 |
| 62 | 2D HMBC spectrum of PS11 | 143 |
| 63 | ^1H NMR (500 MHz) (CDCl_3 +DMSO- d_6) spectrum of PS12 | 144 |
| 64 | UV (EtOH) spectrum of PS13Ac | 145 |
| 65 | FT-IR (KBr) spectrum of PS13Ac | 145 |
| 66 | EI-MS spectrum of PS13Ac | 146 |
| 67 | ^1H NMR (300 MHz) (CDCl_3) spectrum of PS13Ac | 147 |

LIST OF ILLUSTRATIONS (Continued)

| Figure | | Page |
|--------|---|------|
| 68 | NOEDIFF spectrum of PS13Ac after irradiation at δ_{H} 3.32 | 148 |
| 69 | NOEDIFF spectrum of PS13Ac after irradiation at δ_{H} 13.39 | 148 |
| 70 | ^{13}C NMR (75 MHz) (CDCl_3) spectrum of PS13Ac | 149 |
| 71 | DEPT 135° (CDCl_3) spectrum of PS13Ac | 149 |
| 72 | ^1H - ^1H COSY spectrum of PS13Ac | 150 |
| 73 | 2D HMQC spectrum of PS13Ac | 151 |
| 74 | 2D HMBC spectrum of PS13Ac | 152 |
| 75 | UV (EtOH) spectrum of PS14+PS15 | 153 |
| 76 | FT-IR (neat) spectrum of PS14+PS15 | 153 |
| 77 | EI-MS spectrum of PS14 | 154 |
| 78 | ^1H NMR (500 MHz) (CDCl_3) spectrum of PS14+PS15 | 155 |
| 79 | ^{13}C NMR (125 MHz) (CDCl_3) spectrum of PS14+PS15 | 156 |
| 80 | DEPT 135° (CDCl_3) spectrum of PS14+PS15 | 156 |
| 81 | ^1H - ^1H COSY spectrum of PS14+PS15 | 157 |
| 82 | 2D HMQC spectrum of PS14+PS15 | 158 |
| 83 | 2D HMBC spectrum of PS14+PS15 | 159 |
| 84 | UV (EtOH) spectrum of PS15 | 160 |
| 85 | FT-IR (neat) spectrum of PS15 | 160 |
| 86 | ^1H NMR (500 MHz) (CDCl_3 +DMSO- d_6) spectrum of PS15 | 161 |
| 87 | NOEDIFF spectrum of PS15 after irradiation at δ_{H} 7.32 | 162 |
| 88 | ^{13}C NMR (125 MHz) (CDCl_3 + DMSO- d_6) spectrum of PS15 | 163 |
| 89 | DEPT 135° (CDCl_3 +DMSO- d_6) spectrum of PS15 | 163 |
| 90 | ^1H - ^1H COSY spectrum of PS15 | 164 |
| 91 | 2D HMQC spectrum of PS15 | 165 |
| 92 | 2D HMBC spectrum of PS15 | 166 |
| 93 | UV (EtOH) spectrum of PS16 | 167 |

LIST OF ILLUSTRATIONS (Continued)

| Figure | | Page |
|--------|--|------|
| 94 | FT-IR (KBr) spectrum of PS16 | 167 |
| 95 | ^1H NMR (300 MHz) ($\text{CDCl}_3+\text{DMSO}-d_6$) spectrum of PS16 | 168 |
| 96 | ^{13}C NMR (75 MHz) ($\text{CDCl}_3+\text{DMSO}-d_6$) spectrum of PS16 | 169 |
| 97 | DEPT 135 $^\circ$ ($\text{CDCl}_3+\text{DMSO}-d_6$) spectrum of PS16 | 169 |
| 98 | $^1\text{H}-^1\text{H}$ COSY spectrum of PS16 | 170 |
| 99 | 2D HMQC spectrum of PS16 | 171 |
| 100 | 2D HMBC spectrum of PS16 | 172 |
| 101 | ^1H NMR (500 MHz) ($\text{CDCl}_3+\text{DMSO}-d_6$) spectrum of PS17 | 173 |
| 102 | 2D HMQC spectrum of PS17 | 174 |
| 103 | 2D HMBC spectrum of PS17 | 175 |
| 104 | UV (EtOH) spectrum of PS18 | 176 |
| 105 | FT-IR (KBr) spectrum of PS18 | 176 |
| 106 | EI-MS spectrum of PS18 | 177 |
| 107 | ^1H NMR (500 MHz) ($\text{CDCl}_3+\text{DMSO}-d_6$) spectrum of PS18 | 178 |
| 108 | DEPTQGPSP (CD_3OD) spectrum of PS18 | 179 |
| 109 | $^1\text{H}-^1\text{H}$ COSY spectrum of PS18 | 180 |
| 110 | 2D HMQC spectrum of PS18 | 181 |
| 111 | 2D HMBC spectrum of PS18 | 182 |
| 112 | UV (EtOH) spectrum of PS19 | 182 |
| 113 | FT-IR (KBr) spectrum of PS19 | 183 |
| 114 | ^1H NMR (300 MHz) ($\text{CDCl}_3+\text{DMSO}-d_6$) spectrum of PS19 | 184 |
| 115 | ^{13}C NMR (75 MHz) ($\text{CDCl}_3+\text{DMSO}-d_6$) spectrum of PS19 | 185 |
| 116 | 2D HMQC spectrum of PS19 | 186 |
| 117 | 2D HMBC spectrum of PS19 | 187 |

ABBREVIATIONS AND SYMBOLS

| | | |
|------------------|---|-------------------------------------|
| <i>s</i> | = | <i>singlet</i> |
| <i>d</i> | = | <i>doublet</i> |
| <i>t</i> | = | <i>triplet</i> |
| <i>m</i> | = | <i>multiplet</i> |
| <i>br s</i> | = | <i>broad singlet</i> |
| <i>br t</i> | = | <i>broad triplet</i> |
| <i>dd</i> | = | <i>doublet of doublet</i> |
| g | = | gram |
| kg | = | kilogram |
| mg | = | milligram |
| μg | = | microgram |
| mL | = | milliliter |
| <i>m/z</i> | = | a value of mass divided by charge |
| % | = | percent |
| nm | = | nanometer |
| cm ³ | = | cubic centimeter |
| m.p. | = | melting point |
| cm ⁻¹ | = | reciprocal centimeter (wave number) |
| δ | = | chemical shift relative to TMS |
| <i>J</i> | = | coupling constant |
| [α] _D | = | specific rotation |
| λ _{max} | = | maximum wavelength |
| ν | = | absorption frequencies |
| ε | = | Molar extinction coefficient |
| °C | = | degree celsius |
| MHz | = | megahertz |
| ppm | = | part per million |
| <i>c</i> | = | concentration |

ABBREVIATIONS AND SYMBOLS (Continued)

| | | |
|--------------------------|---|---|
| EI-MS | = | Electron Impact Mass Spectra |
| MS | = | Mass spectroscopy |
| IR | = | Infrared |
| UV | = | Ultraviolet |
| ^1H NMR | = | Proton Nuclear Magnetic Resonance |
| ^{13}C NMR | = | Carbon Nuclear Magnetic Resonance |
| 2D NMR | = | Two Dimensional Nuclear Magnetic Resonance |
| COSY | = | Correlated Spectroscopy |
| DEPT | = | Distortionless Enhancement by Polarization Transfer |
| HMBC | = | Heteronuclear Multiple Bond Correlation |
| HMQC | = | Heteronuclear Multiple Quantum Coherence |
| NOE | = | Nuclear Overhauser Effect |
| CC | = | Column Chromatography |
| QCC | = | Quick Column Chromatography |
| TMS | = | tetramethylsilane |
| Acetone- d_6 | = | Deuteroacetone |
| DMSO- d_6 | = | Deuterodimethylsulphoxide |
| CDCl_3 | = | Deuteriochloroform |
| MeOH | = | Methanol |
| EtOH | = | Ethanol |
| CH_2Cl_2 | = | Dichloromethane |
| TLC | = | Thin-Layer Chromatography |
| MIC | = | Minimum Inhibition Concentration |