

CONTENTS

	Page
Acknowledgement	iv
Abstract in Thai	v
Abstract in English	viii
List of Table	xvii
List of Figures	xxi
List of Abbreviations	xxviii
Statement of Originality in Thai	xxix
Statement of originality in English	xxx
Chapter1 General Introduction and Thesis Outline	1
Chapter 2 Literature Reviews	4
2.1 Skin Anatomy	4
2.1.1 Epidermis	4
2.1.2 Dermis	5
2.1.3 Subcutaneous tissue	5
2.2 Normal microbial flora of the skin	6
2.3 Common bacterial skin infectious diseases	6
2.3.1 Cellulitis	7
2.3.2 Erysipelas	7
2.3.3 Impetigo	7
2.3.4 Folliculitis	8
2.3.5 Furuncle and carbuncle	8
2.4 Mode of action of antibiotic agents	9

2.4.1	Inhibition of cell wall synthesis	9
2.4.2	Inhibition of protein synthesis	9
2.4.3	Interference with nucleic acid synthesis	10
2.4.4	Inhibition of metabolic pathway	10
2.4.5	Interference with cell membrane integrity	10
2.5	Mechanism of antibiotic resistance in bacteria	11
2.5.1	Antibiotic inactivation	11
2.5.2	Target modification	11
2.5.3	Interference of protein synthesis	12
2.5.4	Interference of DNA synthesis	12
2.5.5	Interference of efflux pumps and outer membrane (OM) permeability	12
2.6	Skin disease causing bacteria	15
2.6.1	<i>Escherichia coli</i>	15
2.6.2	<i>Pseudomonas aeruginosa</i>	15
2.6.3	<i>Propionibacterium acnes</i>	15
2.6.4	<i>Streptococcus pyogenes</i>	16
2.6.5	<i>Staphylococcus epidermidis</i>	16
2.6.6	<i>Staphylococcus aureus</i>	16
2.7	Virulence factor of <i>Staphylococcus aureus</i>	17
2.7.1	Adherence factors	17
2.7.2	Secreted factors	18
2.8	Antibiotic resistance in <i>S. aureus</i>	19
2.9	Gene involved in methicillin resistance <i>S. aureus</i> (MRSA)	19
2.10	Free Radicals	21
2.10.1	Reactive oxygen species (ROS)	22
2.10.2	Reactive nitrogen species (RNS)	24
2.11	Reaction of free radicals with biomolecules	25
2.11.1	Cellular components	25
2.11.2	Nucleic acid oxidation	26
2.11.3	Carbohydrates	26
2.11.4	Protein oxidation	26

2.12	Antioxidants	28
2.12.1	Type of antioxidant	28
2.13	Phenolic compounds	32
2.14	Measurement of Total antioxidant activity	34
2.14.1	Hydrogen atom transfer (HAT) reaction base assay	34
2.14.2	Single electron transfer (SET) reaction base assay	34
2.15	Method for antioxidant activity testing	35
2.15.1	DPPH method	35
2.15.2	ABTS method	36
2.15.3	FRAP assay	37
2.15.4	Total phenolic content by Folin-Ciocalteau method	38
2.16	Plant extraction	38
2.16.1	Water	39
2.16.2	Acetone	39
2.16.3	Alcohol	39
2.16.4	Chloroform	39
2.17	Medicinal plants used in this study	40
2.17.1	<i>Andrographis paniculata</i> Nees	40
2.17.2	<i>Cissus quadrangularis</i> L.	41
2.17.3	<i>Coscinium fenestratum</i> (Gaertn.) Colebr.	42
2.17.4	<i>Derris scandens</i> (Roxb.) Benth.	43
2.17.5	<i>Eclipta prostrata</i> (L.) L.	44
2.17.6	<i>Glycyrrhiza glabra</i> L.	45
2.17.7	<i>Gynostemma pentaphyllum</i> (Thunb.) Makino	46
2.17.8	<i>Hiptage</i> cf. <i>benghalensis</i> ssp. <i>benghalensis</i>	47
2.17.9	<i>Houttuynia cordata</i> Thunb.	48
2.17.10	<i>Momordica charantia</i> L.	49
2.17.11	<i>Phyllanthus amarus</i> Schumach.	50
2.17.12	<i>Pluchea indica</i> (L.) Less.	51
2.17.13	<i>Pseuderanthemum palatiferum</i> (Nees) Radlk. ex Lindau	52
2.17.14	<i>Rhinacanthus nasutus</i> Kuntze	53
2.17.15	<i>Schefflera leucantha</i> R.Vig.	54

2.17.16 <i>Senna alata</i> (L.) Roxb.	55
2.17.17 <i>Stemona</i> sp.	56
2.17.18 <i>Stephania venosa</i> (Blume) Spreng.	57
2.17.19 <i>Thunbergia laurifolia</i> Lindl.	58
2.17.20 <i>Tinospora crispa</i> (L.) Hook.f. & Thomson	59
2.17.21 <i>Vernonia cinerea</i> (L.) Less.	60
2.17.22 <i>Zingiber montanum</i> Link ex A. Dietr.	61
2.18 Antimicrobial and antioxidant properties of medicinal plants	62

Chapter 3 Antibacterial Activity from Thai Medicinal Plants

3.1 Introduction	66
3.2 Materials and methods	68
3.2.1 Detection of methicillin resistance of <i>Staphylococcus aureus</i>	68
3.2.2 Detection of <i>mecA</i> gene by PCR	69
3.2.3 Medicinal plants and extraction procedure	70
3.2.4 Investigation of antibacterial activity	70
3.2.5 Effect of plant extracts on bacterial cell morphology using scanning electron microscopy (SEM)	72
3.2.6 Effect of ethanolic extracts of <i>C. fenestratum</i> and <i>S. venosa</i> on gene expression in <i>S. aureus</i> and MRSA	73
3.2.7 Effect of plant extracts on PBP2a protein in MRSA	76
3.2.8 Preparation of plant extracts	78
3.2.9 Identification of <i>C. fenestratum</i> extract by GC/MS	82
3.3 Results and Discussion	83
3.3.1 Characterization of methicillin resistant <i>S. aureus</i>	83
3.3.2 <i>mecA</i> gene mutation analysis by DNA sequencing technique	87
3.3.3 Plant extraction	96
3.3.4 Antibacterial activity	100
3.3.5 Determination of plant extracts on bacterial cell morphology using scanning electron microscope (SEM)	137
3.3.6 Effect of <i>C. fenestratum</i> and <i>S. venosa</i> extracts on gene expression in <i>S. aureus</i> and MRSA	143

3.3.7 Effect of <i>C. fenestratum</i> and <i>S. venosa</i> extracts on PBP2a expression in MRSA	149
3.3.8 Plant Isolation and their antibacterial activity	154
Chapter 4 Antioxidant Activity of Medicinal Plant Extracts	171
4.1 Introduction	171
4.2 Materials and Methods	172
4.2.1 Antioxidant activity	172
4.2.2 Inhibition of oxidative protein damage by medicinal plant extracts	174
4.2.3 Preparation of crude plant extracts	175
4.3 Results and Discussion	177
4.3.1 Antioxidant activity	177
4.3.2 Protection of oxidative protein damage	190
4.3.3 Plant isolation and their antioxidant activity	203
Chapter 5 Conclusion	221
Bibliography	225
List of Publication	256
Appendix	
Appendix A Culture media	257
Appendix B Chemical reagents for DNA extraction and agarose gel electrophoresis	259
Appendix C Real time PCR	262
Appendix D Chemical reagents for Western blotting	265
Appendix E Chemical reagents for antioxidant activity	269
Appendix F Standard Curves of Antioxidant Activity Test	274
Curriculum Vitae	277

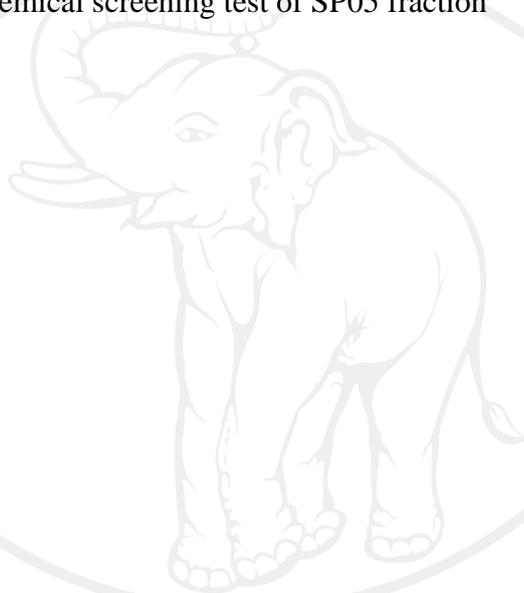
LIST OF TABLES

	Page
Table 2.1 Description of six common bacterial skin diseases	6
Table 2.2 Mechanisms of bacterial resistance to antibiotics	14
Table 2.3 Examples of biological oxidants formed	22
Table 2.4 Protein oxidative modification and disease	27
Table 2.5 Mechanism of action of various antioxidants against deferent disease	30
Table 2.6 The important classes of phenolic compounds in plants	33
Table 2.7 Solvents used for active component extraction	38
Table 2.8 Main groups of plant compounds with antimicrobial activity	63
Table 3.1 Interpretive standards breakpoint values for <i>Staphylococcus</i> spp. <i>mecA</i> -mediated resistance	69
Table 3.2 Amount of the samples in test tubes for determination of MIC and MBC	72
Table 3.3 Chemical component for reverse transcription reaction	74
Table 3.4 Gene and their protein of <i>S. aureus</i> and MRSA analyzed in this study	75
Table 3.5 Oligonucleotide primers for real-time quantitative PCR	75
Table 3.6 Chemical components for quantitative polymerase chain reaction (qPCR) reaction	76
Table 3.7 Amount of the samples in test tubes for tannin detection	82
Table 3.8 Biochemical test of ten isolates of <i>S. aureus</i>	85
Table 3.9 Antibiotic susceptibility testing of clinical isolates MRSA using oxacillin and cefoxitin disc	85
Table 3.10 Plant materials used in this study	97
Table 3.11 Percentage yield of plant extracts	98
Table 3.12 Inhibitory effect of plant extracts on pathogenic bacteria using agar disc diffusion method	103

Table 3.13	Inhibitory effect of plant extracts on methicillin resistant <i>S. aureus</i> (MRSA) using agar disc diffusion method	108
Table 3.14	Minimal inhibitory concentration (MIC) and minimal bactericidal concentration (MBC) values of crude plant extracts against pathogenic bacteria using broth dilution method	113
Table 3.15	Minimal inhibitory concentration (MIC) and minimal bactericidal concentration (MBC) values of crude plant extracts against methicillin resistant <i>S. aureus</i> (MRSA) using broth dilution method	116
Table 3.16	Antibacterial activity of <i>C. fenestratum</i> in four different solvent extractions	122
Table 3.17	Antibacterial activity of <i>S. venosa</i> in four different solvent extractions	123
Table 3.18	Minimal inhibitory concentration (MIC) and minimal bactericidal concentration (MBC) of methanolic and dichloromethane extracts of <i>C. fenestratum</i>	124
Table 3.19	Minimal inhibitory concentration (MIC) and minimal bactericidal concentration (MBC) of methanolic and dichloromethane extracts of <i>S. venosa</i>	125
Table 3.20	Time killing of plant extract on pathogenic bacteria	129
Table 3.21	Effect of <i>C. fenestratum</i> fractions on growth of pathogenic bacteria by agar disc diffusion method	156
Table 3.22	Minimal inhibitory concentration (MIC) and minimal bactericidal concentration (MBC) of <i>C. fenestratum</i> fractions against pathogenic bacteria using broth dilution method	157
Table 3.23	Effect of <i>C. fenestratum</i> fractions on growth of pathogenic bacteria by agar disc diffusion method	161
Table 3.24	Effect of <i>C. fenestratum</i> fractions on growth of MRSA by agar disc diffusion method	161
Table 3.25	Primary chemical screening test of CF01 fraction of <i>C. fenestratum</i>	163
Table 3.26	Effect of <i>S. venosa</i> fractions on growth of pathogenic bacteria by agar disc diffusion method	165

Table 3.27	Minimal inhibitory concentration (MIC) and minimal bactericidal concentration (MBC) of <i>S. venosa</i> fractions against pathogenic bacteria by broth dilution method	166
Table 3.28	R _f values of the partial purified fraction of <i>S. venosa</i> extract	168
Table 3.29	Primary chemical screening test of chloroform fraction of <i>S. venosa</i>	170
Table 4.1	Amount of sample used in oxidative protein damage model	174
Table 4.2	IC ₅₀ values of plant extracts after determination of free radical inhibition by ABTS decolorization assay	179
Table 4.3	Antioxidant activity of plant extracts assessed by ABTS decolorization assay	180
Table 4.4	IC ₅₀ values of plant extracts after determination of free radical inhibition by DPPH radical scavenging assay	183
Table 4.5	Antioxidant activity of plant extracts assessed by DPPH radical scavenging assay	184
Table 4.6	Antioxidant activity of extracts assessed by FRAP assay	186
Table 4.7	Total phenolic content of extracts assessed by Folin-Ciocalteu assay	188
Table 4.8	Pearson's correlation coefficients of antioxidant activities by ABTS, DPPH, FRAP and total phenolic content	190
Table 4.9	Antioxidant activity of <i>E. prostrata</i> fractions by ABTS and DPPH method	204
Table 4.10	Total phenolic compound content of <i>E. prostrata</i> fractions	204
Table 4.11	Percentage yield of each fraction from <i>E. prostrata</i> after separating by column chromatography using celite as a stationary phase	206
Table 4.12	Antioxidant activity of <i>E. prostrata</i> fractions by ABTS, DPPH method and total phenolic compound content	207
Table 4.13	Total phenolic compound content of <i>E. prostrata</i> fractions	208
Table 4.14	Percentage yield of 16 subfraction by column chromatography using silica gel as stationary phase	209
Table 4.15	Antioxidant activity of <i>E. prostrata</i> fractions by DPPH radical scavenging assay and total phenolic compound content	211
Table 4.16	Primary chemical screening test of crude ethanolic extract of <i>E. prostrata</i>	212

Table 4.17	Antioxidant activity and total phenolic content of crude and fractions of <i>Hiptage</i> sp.	214
Table 4.18	Total phenolic content of crude and fractions of <i>Hiptage</i> sp.	214
Table 4.19	Percentage yield of each fraction from <i>Hiptage</i> sp.	215
Table 4.20	Antioxidant activity of <i>Hiptage</i> sp. fractions by ABTS decolorization assay	217
Table 4.21	Total phenolic compound content of <i>Hiptage</i> sp. fractions	217
Table 4.22	Percentage yield of each fraction from SP05 fraction	218
Table 4.23	Antioxidant activity of SP05 fractions by ABTS decolorization assay	219
Table 4.24	Total phenolic compound content of SP05 fractions	219
Table 4.25	Primary chemical screening test of SP05 fraction	220



CHIANG MAI UNIVERSITY 1964

ลิขสิทธิ์มหาวิทยาลัยเชียงใหม่

Copyright© by Chiang Mai University
All rights reserved

LIST OF FIGURES

	Page
Figure 2.1 Skin structure	4
Figure 2.2 Modes of action of some major antimicrobial chemotherapeutic agents	9
Figure 2.3 Virulence factors of <i>S. aureus</i>	17
Figure 2.4 The induction of PBP2a and penicillinase control by regulatory system of <i>mecA</i> and <i>BlaZ</i> , respectively	21
Figure 2.5 The process of formation of reactive oxygen species (ROS)	23
Figure 2.6 Basic structure of phenolic	32
Figure 2.7 Plant phenolic compounds	33
Figure 2.8 DPPH structure	35
Figure 2.9 Structure of 2, 2'- azinobis (3-ethylbenzothiazoline-6-sulfonic acid) cation (ABTS •+)	36
Figure 2.10 Reaction of the ABTS radical in the presence of the antioxidant compound during the ABTS assay	37
Figure 2.11 Reaction for FRAP assay	37
Figure 2.12 <i>Andrographis paniculata</i> Nees	40
Figure 2.13 <i>Cissus quadrangularis</i> L.	41
Figure 2.14 <i>Coscinium fenestratum</i> (Gaertn.) Colebr.	42
Figure 2.15 <i>Derris scandens</i> (Roxb.) Benth.	43
Figure 2.16 <i>Eclipta prostrata</i> (L.) L.	44
Figure 2.17 <i>Glycyrrhiza glabra</i> L.	45
Figure 2.18 <i>Gynostemma pentaphyllum</i> (Thunb.) Makino	46
Figure 2.19 <i>Hiptage</i> cf. <i>benghalensis</i> ssp. <i>benghalensis</i>	47
Figure 2.20 <i>Houttuynia cordata</i> Thunb..	48
Figure 2.21 <i>Momordica charantia</i> L.	49
Figure 2.22 <i>Phyllanthus amarus</i> Schumach.	50

Figure 2.23 <i>Pluchea indica</i> (L.) Less.	51
Figure 2.24 <i>Pseuderanthemum palatiferum</i> (Nees) Radlk. ex Lindau	52
Figure 2.25 <i>Rhinacanthus nasutus</i> Kuntze	53
Figure 2.26 <i>Schefflera leucantha</i> R. Vig.	54
Figure 2.27 <i>Senna alata</i> (L.) Roxb.	55
Figure 2.28 <i>Stemona</i> sp.	56
Figure 2.29 <i>Stephania venosa</i> (Blume) Spreng.	57
Figure 2.30 <i>Thunbergia laurifolia</i> Lindl.	58
Figure 2.31 <i>Tinospora crispa</i> (L.) Hook.f. & Thomson	59
Figure 2.32 <i>Vernonia cinerea</i> (Linn.) Less.	60
Figure 2.33 <i>Zingiber montanum</i> Link ex A. Dietr.	61
Figure 3.1 Western blotting	78
Figure 3.2 Antibiotic susceptibility testing of S 32 and S 72 using oxacillin (1µg) and cefoxitin (30µg) antibiotic disc	86
Figure 3.3 PCR product of methicillin resistant gene (<i>mecA</i>) of ten methicillin resistant <i>S. aureus</i> (MRSA) isolates	86
Figure 3.4 Specific primers MR1 and MR2 on <i>mecA</i> gene in <i>S. aureus</i> subsp. <i>aureus</i> USA300_TCH1516	89
Figure 3.5 The 843 bp DNA sequence of MRSA 50	90
Figure 3.6 The 844 bp DNA sequence of MRSA 64	91
Figure 3.7 The 844 bp DNA sequence of MRSA 66	92
Figure 3.8 The 843 bp DNA sequence of MRSA 67	93
Figure 3.9 The 843 bp DNA sequence of MRSA 72	94
Figure 3.10 The 838 bp DNA sequence of MRSA 80	95
Figure 3.11 Aqueous and ethanolic extract of 22 medicinal plants	99
Figure 3.12 Inhibitory effect of ethanolic extract of <i>V. cinerea</i> , <i>E. prostrata</i> , <i>C. fenestratum</i> , <i>S. leucantha</i> and gentamycin (40 mg/ml) on growth of <i>S. aureus</i> , <i>S. epidermidis</i> , MRSA 64, MRSA 65, MRSA 66 and MRSA 67 by agar disc diffusion method	102
Figure 3.13 Inhibitory effect of ethanolic extract of <i>V. cinerea</i> , <i>E. prostrata</i> , <i>C. fenestratum</i> , <i>S. leucantha</i> on growth of <i>P. acnes</i> by agar disc diffusion method	102

Figure 3.14 Antibacterial effect of methanolic and dichloromethane extracts of <i>C. fenestratum</i> and <i>S. venosa</i> on <i>S. aureus</i> , <i>S. epidermidis</i> , <i>St. pyogenes</i> , MRSA 64, MRSA 65, MRSA 66, MRSA67, <i>E. coli</i> O157: H7 and <i>Ps. aeruginosa</i> by agar disc diffusion method	126
Figure 3.15 Antibacterial effect of methanolic and dichloromethane extracts of <i>C. fenestratum</i> and <i>S. venosa</i> on <i>P. acnes</i> by agar disc diffusion method	126
Figure 3.16 Time-killing curves of the bacterial growth of the <i>E. coli</i> O157: H7 after incubating with ethanolic extracts of plant extracts and gentamycin was used as a positive control	133
Figure 3.17 Time-killing curves of the bacterial growth of the <i>Ps. aeruginosa</i> after incubating with ethanolic extracts of plant extracts and gentamycin was used as a positive control	133
Figure 3.18 Time-killing curves of the bacterial growth of the <i>S. aureus</i> after incubating with ethanolic extracts of five plant extracts and gentamycin was used as a positive control	134
Figure 3.19 Time-killing curves of the bacterial growth of the <i>S. epidermidis</i> after incubating with ethanolic extracts of five plant extracts and gentamycin was used as a positive control	134
Figure 3.20 Time-killing curves of the bacterial growth of the MRSA 64 after incubating with ethanolic extracts of five plant extracts and gentamycin was used as a positive control	135
Figure 3.21 Time-killing curves of the bacterial growth of the MRSA 72 after incubating with ethanolic extracts of five plant extracts and gentamycin was used as a positive control	135
Figure 3.22 Time-killing curves of the bacterial growth of the MRSA 80 after incubating with ethanolic extracts of five plant extracts and gentamycin was used as a positive control	136
Figure 3.23 Time-killing curves of the bacterial growth of the <i>St. pyogenes</i> after incubating with ethanolic extracts of five plant extracts and gentamycin was used as a positive control	136

Figure 3.24 Time-killing curves of the bacterial growth of the <i>P. acnes</i> after incubating with ethanolic extracts of five plant extracts and gentamycin was used as a positive control	137
Figure 3.25 Scanning electron micrograph of <i>S. aureus</i> treated with ethanolic extract of <i>C. fenestratum</i> and <i>S. venosa</i> at 37 °C for 24 hours from different concentration	139
Figure 3.26 Scanning electron micrograph of <i>S. epidermidis</i> treated with ethanolic extract of <i>C. fenestratum</i> and <i>S. venosa</i> at 37 °C for 24 hours from different concentration	140
Figure 3.27 Scanning electron micrograph of MRSA 64 treated with ethanolic extract of <i>C. fenestratum</i> and <i>S. venosa</i> at 37 °C for 24 hours from different concentration	141
Figure 3.28 Scanning electron micrograph of MRSA 80 treated with ethanolic extract of <i>C. fenestratum</i> and <i>S. venosa</i> at 37 °C for 24 hours from different concentration	142
Figure 3.29 Scanning electron micrograph of <i>E. coli</i> O157: H7 treated with ethanolic extract of <i>S. venosa</i> at 37 °C for 24 hours from different concentration	143
Figure 3.30 Effect of ethanolic extracts of <i>C. fenestratum</i> and <i>S. venosa</i> on the transcription of α - toxin gene (<i>hla</i>) in <i>S. aureus</i> and MRSA 80	145
Figure 3.31 Schematic diagram of <i>mecA</i> expression regulation controlled by regulatory gene <i>mecR1</i> (transducer gene) and <i>mecI</i> (repressor gene)	146
Figure 3.32 Effect of ethanolic extracts of <i>C. fenestratum</i> and <i>S. venosa</i> on the transcription of <i>mecI</i> , <i>mecR1</i> and <i>mecA</i> of MRSA 80	148
Figure 3.33 Effect of ethanolic extracts of <i>C. fenestratum</i> and <i>S. venosa</i> on the transcription of nucleaseA gene (<i>nucA</i>) in <i>S. aureus</i> and MRSA 80	149
Figure 3.34 Effect of <i>S. venosa</i> extract on PBP2a expression in MRSA 80 detected by Western blotting analysis	152
Figure 3.35 Effect of <i>S. venosa</i> extract on PBP2a expression in MRSA 80 detected by Western blotting analysis	153
Figure 3.36 Percentage of PBP2a protein inhibition after treatment with <i>C. fenestratum</i> and <i>S. venosa</i> extracts	154

Figure 3.37 Schematic diagram shows the isolation procedure of <i>C. fenestratum</i> by partition technique	155
Figure 3.38 The effect of four fractions of <i>C. fenestratum</i> on the growth of <i>S. aureus</i> , <i>S. epidermidis</i> , <i>St. pyogenes</i> , MRSA 64, MRSA 65, MRSA 66 and MRSA, <i>E. coli</i> O157: H7 and <i>Ps. aeruginosa</i> using agar disc diffusion method	158
Figure 3.39 The effect of partial purified fraction of <i>C. fenestratum</i> fraction on the growth of <i>P. acnes</i> by agar disc diffusion method	158
Figure 3.40 Schematic diagram shows the isolation procedure of <i>C. fenestratum</i> by column chromatography	159
Figure 3.41 The effect of four fractions of <i>C. fenestratum</i> on the growth of <i>S. aureus</i> , <i>S. epidermidis</i> , <i>St. pyogenes</i> , MRSA 64, MRSA 65, MRSA 66 and MRSA, <i>E. coli</i> O157: H7 and <i>Ps. aeruginosa</i> using agar disc diffusion method	160
Figure 3.42 GC chromatograms of ethanolic extracts of <i>C. fenestratum</i>	164
Figure 3.43 Schematic diagram shows the isolation procedure of <i>S. venosa</i> by partition technique	164
Figure 3.44 The effect of four fractions of <i>S. venosa</i> on the growth of <i>S. aureus</i> , <i>S. epidermidis</i> , <i>St. pyogenes</i> , MRSA 64, MRSA 65, MRSA 66 and MRSA, <i>E. coli</i> O157: H7 and <i>Ps. aeruginosa</i> using agar disc diffusion method	167
Figure 3.45 The effect of partial purified fraction of <i>S. venosa</i> on the growth of <i>P. acnes</i> by agar disc diffusion method	167
Figure 3.46 TLC chromatograms of partial purified fractions of <i>S. venosa</i> fractions	168
Figure 4.1 PAGE profile of BSA protein and percent of BSA protein protection after treatment with aqueous extract of <i>D. scandens</i>	193
Figure 4.2 PAGE profile of BSA protein and percent of BSA protein protection after treatment with aqueous extract of <i>P. amarus</i>	194
Figure 4.3 PAGE profile of BSA protein and percent of BSA protein protection after treatment with aqueous extract of <i>R. nasatus</i>	195

Figure 4.4	PAGE profile of BSA protein and percent of BSA protein protection after treatment with aqueous extract of <i>S. alata</i>	196
Figure 4.5	PAGE profile of BSA protein and percent of BSA protein protection after treatment with aqueous extract of <i>Shenodesme</i> sp	197
Figure 4.6	PAGE profile of BSA protein and percent of BSA protein protection after treatment with ethanolic extract of <i>E. prostrata</i>	198
Figure 4.7	PAGE profile of BSA protein and percent of BSA protein protection after treatment with ethanolic extract of <i>H. cordata</i>	199
Figure 4.8	PAGE profile of BSA protein and percent of BSA protein protection after treatment with ethanolic extract of <i>P. amarus</i>	200
Figure 4.9	PAGE profile of BSA protein and percent of BSA protein protection after treatment with ethanolic extract of <i>P. platiferum</i>	201
Figure 4.10	PAGE profile of BSA protein and percent of BSA protein protection after treatment with ethanolic extract of <i>Hiptage</i> sp	202
Figure 4.11	Schematic diagram shows the isolation procedure of <i>E. prostrata</i> by partition technique	203
Figure 4.12	Schematic diagram shows the isolation procedure of <i>E. prostrata</i> by column chromatography	205
Figure 4.13	TLC Chromatograms of isolated fractions of 12 subfraction of <i>E. prostrate</i>	206
Figure 4.14	Schematic diagram shows the isolation procedure of <i>Hiptage</i> sp. by partition technique	213
Figure 4.15	Schematic diagram shows the isolation procedure of <i>Hiptage</i> sp. by column chromatography	215
Figure C.1	Fluorescence curve from SYBR Green I detection of <i>hla</i> gene in <i>S. aureus</i> and MRSA after treatment with <i>C. fenestratum</i> and <i>S. venosa</i> extracts	262
Figure C.2	Fluorescence curve from SYBR Green I detection of <i>mecR</i> , <i>mecI</i> and <i>mecA</i> gene in MRSA after treatment with <i>C. fenestratum</i> and <i>S. venosa</i> extracts	263

Figure C.3 Fluorescence curve from SYBR Green I detection of <i>nucA</i> gene in <i>S. aureus</i> and MRSA after treatment with <i>C. fenestratum</i> and <i>S. venosa</i> extracts	264
Figure F.1 The dose response curve of percentage of inhibition of radical generated from ABTS by trolox solution after measuring absorbance at 734 nm	274
Figure F.2 The dose response curve of percentage of inhibition of radical generated from DPPH by gallic acid solution after measuring absorbance at 517 nm	275
Figure F.3 Calibration curve for the absorbance at 593 nm of FRAP method as a function of concentration of ferric sulfate standard solution	275
Figure F.4 Calibration curve for the absorbance at 725 nm of Folin-Ciocalteu method as a function of concentration of gallic acid standard solution	276

LIST OF ABBREVIATIONS

APS	Ammonium Persulfate
BSA	Bovin Serum Albumin
CFU/ml	Colony Forming Unit per Milliliter
DMSO	Dimethyl Sulfoxide
DNA	Deoxyribonucleic Acid
GSH	Glutathione
H ₂ O ₂	Hydrogen Peroxide
IgG	Immunoglobulin G
M	Molar
mg	Milligram
mm	Millimeter
mM	Millimolar
μl	Microliter
OD	Optical Density
O ₂ ^{•-}	Superoxide Anion
•OH	Hydroxyl Radical
PCR	Polymerase Chain Reaction
PBS	Phosphate Buffered Saline
pH	Power of Hydrogen Ion
RNA	Ribonucleic Acid
RNS	Reactive Nitrogen Species
ROS	Reactive Oxygen Species
SDS-PAGE	Sodium Dodecyl Sulfate Polyacrylamide Gel Electrophoresis
SOD	Superoxide Dismutase
TLC	Thin Layer Chromatography
UV	Ultra Violet Radiation
w/v	Weight by Volume

ข้อความแห่งการริเริ่ม

วิทยานิพนธ์นี้ได้นำเสนอการค้นหาพืชสมุนไพรที่มีประสิทธิภาพดีที่สุดในการยับยั้งการเจริญของแบคทีเรียก่อโรคผิวหนังบางชนิด และมีประสิทธิภาพสูงในการต้านอนุมูลอิสระเพื่อพัฒนาเป็นยาหรือผลิตภัณฑ์อาหารเสริมชนิดใหม่ ต่อไปในอนาคต โดยได้ทำการวิจัยที่ สาขาจุลชีววิทยา ภาควิชาชีววิทยา คณะวิทยาศาสตร์ มหาวิทยาลัยเชียงใหม่และบางส่วนของงานได้ทำการวิจัยที่คณะเภสัชศาสตร์ มหาวิทยาลัยเชียงใหม่

ลิขสิทธิ์มหาวิทยาลัยเชียงใหม่
Copyright © by Chiang Mai University
All rights reserved

STATEMENTS OF ORIGINALITY

This thesis was conducted to find the efficacy of medicinal plants in Thailand which had the highest antibacterial activity against some bacteria causing skin disease and antioxidant activity in order to improve new pharmacology or food supplement products in the future. This work conducted at Division of Microbiology, Faculty of Science, Chiang Mai University and some part was performed at Faculty of Pharmacy, Chiang Mai University.

ลิขสิทธิ์มหาวิทยาลัยเชียงใหม่
Copyright© by Chiang Mai University
All rights reserved