

CONTENTS

	Page
ABSTRACT IN THAI.....	I
ABSTRACT IN ENGLISH.....	III
ACKNOWLEDGEMENT	V
CONTENTS	VI
LIST OF TABLES.....	VIII
LIST OF FIGURES	IX
LIST OF ABBREVIATIONS	XI
CHAPTER	
I INTRODUCTION.....	1
1.1 Background/Problem.....	1
1.2 Research objectives.....	4
1.3 Research hypothesis.....	4
1.4 Scope and limitation of the study	4
II LITERATURE REVIEWS.....	6
2.1 Gold nanoparticles	6
2.2 Synthesis of gold nanoparticles	9
2.3 Biological synthesis of nanoparticles by streptomyces	9
2.4 Antibacterial activity of gold nanoparticles.....	13
III RESERCH METHODLOGY.....	15
3.1 Isolation and purification of streptomyces	15
3.2 Identification of streptomyces using 16S rRNA gene sequence analysis....	15
3.3 Preparation of streptomyces for biosynthesis.....	17
3.4 Biosynthesis of gold nanoparticles	17
3.5 Characterization of gold nanoparticles.....	18
3.5.1 Analysis of gold nanoparticles.....	18

CONTENTS (Continued)

	Page
3.5.2 Morphological characterization of gold nanoparticles.....	18
3.5.3 Fourier transform infrared (FTIR) spectroscopy analysis	18
3.5.4 X-ray absorption spectroscopy (XAS) analysis.....	19
3.6 Antimicrobial activity of gold nanoparticles	19
3.6.1 Antimicrobial activity determination using Agar well diffusion method.....	19
3.6.2 Determination of the minimum inhibitory concentration	20
IV RESULTS.....	21
4.1 Identification of Streptomyces	21
4.2 Biosynthesis of gold nanoparticles	22
4.3 Characterization of gold nanoparticles.....	25
4.3.1 UV-Vis spectroscopy analysis.....	25
4.3.2 X-ray diffraction (XRD) analysis.....	29
4.3.3 Zeta potential measurement and particle size distribution	30
4.3.4 Transmission electron microscopy (TEM) analysis	31
4.3.5 Energy-dispersive X-ray fluorescence (EDXRF) analysis.....	34
4.3.6 Fourier transform infrared (FTIR) analysis.....	34
4.3.7 X-ray absorption near edge structure (XANES) analysis	38
4.4 Antimicrobial activity of gold nanoparticles	39
V DISCUSSION AND CONCLUSION.....	42
REFERENCES	56
APPENDIX.....	77
CURRICULUM VITAE.....	91

LIST OF TABLES

Table	Page
1.2 The wavelengths of spherical AuNPs depend on size changing	7
2.2 Shapes of gold nanoparticles and their applications	8
4.1 Antimicrobial activity of MSK03-AuNPs and MSK05-AuNPs	40
4.2 MIC of MSK03-AuNPs and MSK05-AuNPs	41
5.1 Biosynthesis of AuNPs using <i>Streptomyces</i> spp.	45
5.2 Medicinal applications of AuNPs with different sizes	54

LIST OF FIGURES

Figure	Page
1.1 Mechanisms for antibacterial activity of nanoparticles	2
2.1 Various types of gold nanoparticles	6
2.2 The schematic representation of the top-down and bottom-up technique for nanoparticle preparation	10
2.3 Compilation of TEM images with various shapes of gold nanostructures synthesized by various methods	11
4.1 Colony morphology of soil isolated <i>Streptomyces</i> spp. on ISP2 media after 10 days of incubation	21
4.2 Neighbor-joining phylogenetic tree based on relative 16S rRNA gene sequence indicating the taxonomic position of strain MSK03, MSK05 and related species	23
4.3 Visible observation of the color change of biosynthesis AuNPs by <i>Streptomyces</i> sp.	24
4.4 Visible observation of the color change of biosynthesis AuNPs obtained by varying the ratio of extracellular cell-free supernatant of <i>Streptomyces</i> sp. to 1mM HAuCl ₄	25
4.5 UV-Vis spectra of precursor, MSK03-AuNPs, and MSK05-AuNPs incubated at 37 °C, 200 rpm for 24h	26
4.6 UV-Vis spectra of MSK03-AuNPs. (A) UV-Vis spectra of AuNPs in the following ratios: 9:1, 8:2, 7:3, 6:4, 5:5, 4:6, 3:7, 2:8, and 1:9 incubated at 37°C, 200 rpm for 24 h; (B) UV-Vis spectra of AuNPs at the ratio of 5:5 and incubating at 37°C, 200 rpm for 0, 18, 24, 48, and 72 h	27

LIST OF FIGURES (Continued)

Figure	Page
4.7 UV-Vis spectra of MSK05-AuNPs. (A) UV-Vis spectra of AuNPs in the following ratios: 9:1, 8:2, 7:3, 6:4, 5:5, 4:6, 3:7, 2:8, and 1:9 incubated at 37°C, 200 rpm for 24 h; (B) UV-Vis spectra of AuNPs at the ratio of 5:5 and incubating at 37°C, 200 rpm for 0, 6, 18, 24, 48, and 72 h	28
4.8 The X-ray diffraction pattern of biosynthesized AuNPs	29
4.9 The particle size distribution of AuNPs	30
4.10 Zeta potential of AuNPs	31
4.11 TEM image of biosynthesized MSK03-AuNPs. (A) The morphology of MSK03-AuNPs, scale bar=100 nm; (B) The particle size distribution of MSK03-AuNPs, n=130.....	32
4.12 TEM image of biosynthesized MSK05-AuNPs. (A) The morphology of MSK05-AuNPs, scale bar=100 nm; (B) The particle size distribution of MSK05-AuNPs, n=196.....	33
4.13 Energy dispersive spectra of biosynthesized AuNPs	35
4.14 FTIR spectra of the extracellular cell-free supernatant of <i>Streptomyces</i> sp. MSK03 and the AuNPs-MSK03	36
4.15 FTIR spectra of the extracellular cell-free supernatant of <i>Streptomyces</i> sp. MSK05 and the AuNPs-MSK05	37
4.16 XANES spectra of HAuCl ₄ , Au foil and MSK03-AuNPs	38
4.17 XANES spectra of HAuCl ₄ , Au foil and MSK05-AuNPs	39

LIST OF ABBREVIATIONS

AuNPs	= Gold nanoparticles
AIA	= Actinomycetes isolation agar
°C	= Degree Celsius
CFU	= Colony forming unit
cm	= Centimeter
DLS	= Dynamic light scattering
DMF	= Dimethylformamide
DNA	= Deoxyribonucleic acid
EDXRF	= Energy dispersive X-ray fluorescence
FT-IR	= Fourier transform infrared
h	= Hour
ISP2	= International <i>Streptomyces</i> Project 2
MHA	= Mueller Hinton agar
mg/g	= Milligram per gram
mg/mL	= Milligram per milliliter
mM	= Millimolar
MRSA	= Methicillin-resistant <i>Staphylococcus aureus</i>
MTT	= (3-(4,5-Dimethylthiazol-2-yl)-2,5-diphenyltetrazolium bromide
nm	= Nanometer
PCR	= Polymerase chain reaction
PDI	= Polydispersity Index
rpm	= Round per minute
rRNA	= Ribosomal ribonucleic acid
SEM	= Scanning electron microscope
SCB	= Starch Casein Broth
SPR	= Surface plasmon resonance
TEM	= Transmission electron microscope

LIST OF ABBREVIATIONS (Continued)

UV-Vis	= Ultraviolet-Visible
v/v	= Volume by volume
w/v	= Weight by volume
XANES	= X-ray absorption near edge structure
XAS	= X-ray absorption spectroscopy
XRD	= X-ray diffraction
µg/mL	= Microgram per milliliter
µL	= Microliter