

## TABLE OF CONTENTS

	Page
ABSTRACT IN THAI.....	I
ABSTRACT IN ENGLISH.....	III
ACKNOWLEDGEMENT.....	V
TABLE OF CONTENTS.....	VI
LIST OF TABLES.....	VIII
LIST OF FIGURES.....	IX
LIST OF ABBREVIATIONS.....	XII
<b>CHAPTER</b>	
<b>I INTRODUCTION.....</b>	<b>1</b>
1.1 Introduction.....	1
1.2 Research objectives.....	3
1.3 Research hypothesis.....	3
1.4 Scope of research.....	3
<b>II LITERATURE REVIEW.....</b>	<b>4</b>
2.1 Spirulina Cultivation and Environmental Influences.....	4
2.1.1 Trends in the uses of spirulina microalgae.....	11
2.1.2 Commercial Applications.....	13
2.1.3 Assessment of Spirulina Quality.....	20
2.2 FTIR (Fourier Transform Infrared Spectroscopy).....	21
2.3 Partial Least Squares (PLS-DA).....	25
2.4 Quasar.....	26
<b>III RESEARCH METHODOLOGY.....</b>	<b>28</b>
3.1 Materials.....	28
3.2 Growth medium and culture method.....	28

## TABLE OF CONTENTS (Continued)

	Page
3.3 Photoperiod lengths treatment.....	28
3.4 Water Source treatment.....	29
3.5 Indoor and Outdoor cultured conditions.....	29
3.6 Focal Plane Array (FPA) FT-IR spectroscopy.....	29
3.7 FT-IR spectroscopy measurements.....	29
3.8 Multivariate statistical analysis.....	30
<b>IV RESULTS AND DISCUSSION.....</b>	<b>31</b>
4.1 Spirulina Strain Classification by FTIR and PLS-DA.....	31
4.2 Effect of Light Conditions on Biochemical Profile of Spirulina H53.....	43
4.3 Effect of Water Types in Culture Medium on Biochemical Profile.....	48
4.4 Comparison of Indoor vs. Outdoor Cultivation Systems.....	54
<b>V CONCLUSION.....</b>	<b>60</b>
REFERENCES.....	61
APPENDIX.....	74
BIOGRAPHY.....	76

## LITS OF TABLE

Table	Page
2.1 Typical analysis of the composition of Spirulina.....	5
2.2 Trends in the uses of Spirulina microalgae.....	12
2.3 Industrial Applications and Cultivation.....	16
2.4 Product Forms and Their Industrial Utilization.....	18
2.5 Recent Industrial Innovations and Emerging Applications.....	19
4.1 The integral area of the average spectrum of Spirulina culture (H53 strain) from different photo periods.....	47
4.2 The integral area of average spectrum of Spirulina culture (H53 strain) from different water source treatment.....	53
4.3 The integral area of average spectrum of Spirulina culture (H53 strain) from different indoor and outdoor conditions.....	58

## LITS OF FIGURES

Figure	Page
2.1 Microscopic examination of Spirulina under light microscope and scanning electron microscope.....	4
2.2 Regulation of light conditions for Spirulina.....	7
2.3 Phylogenetic tree of <i>Arthrospira</i> and <i>Limnospira</i> .....	10
2.4 A simplified scheme of taxonomic positioning of Spirulina.....	11
2.5 Assignments of the main absorption bands in the FTIR spectrum of Spirulina.....	23
2.6 Infrared absorption frequencies of various functional groups.....	24
2.7 A graphical representation of the different analytical approaches and informatics techniques employed in metabolomics studies.....	25
2.8 An illustration of partial least squares-discriminant analysis (PLS-DA).....	26
4.1 Morphological comparison of seven Spirulina strains (H53, SB, SL, SBL, Rev, C005L, C005H) under light microscopy.....	32
4.2 Growth curves of seven Spirulina strains measured by optical density at 560 nm (OD560) over the cultivation period.....	33
4.3 Average spectrum obtained from FTIR spectroscopy of 7 strains (H53, SB, SL, SBL, Rev, C005L, C005H).....	35
4.4 PCA score plot based on average FTIR spectra of 7 strains (H53, SB, SL, SBL, Rev, C005L, C005H).....	36
4.5 PCA loading plot (PC1) of FTIR spectra from C005H, C005L and SB strains.....	36
4.6 Distributions of reference and predicted values for the calibration sample sets from the C005H strains, C005L strains, and SB strains. Distributions of the reference and predicted values determined by the PLS-DA model.....	37
4.7 Second derivative of C005H, C005L and SB strains.....	38

## LITS OF FIGURES (Continued)

		Page
4.8	Second derivative FTIR spectra of C005H, C005L, and SB strains in the lipid region.....	39
4.9	PCA loading plot (PC1) of FTIR spectra from of C005H, C005L, and SB strains in the lipid region.....	39
4.10	Second derivative FTIR spectra of C005H, C005L, and SB strains in the protein region.....	40
4.11	PCA loading plot (PC1) of FTIR spectra from of C005H, C005L, and SB strains in the protein region.....	40
4.12	Second derivative FTIR spectra of C005H, C005L, and SB strains in the polysaccardes region.....	41
4.13	PCA loading plot (PC1) of FTIR spectra from of C005H, C005L, and SB strains in the polysaccharides region.....	42
4.14	Confusion Matrix for Support Vector Machine (SVM) Classification of Astronomical Objects from Quasar Dataset.....	43
4.15	Average spectrum obtained from FTIR spectroscopy of Culture at 8, 12, and 24 hours under light conditions after smoothing, baseline correction, and extended multiplicative scatter correction (EMSC).....	45
4.16	Second derivative of Photoperiod lengths treatment.....	46
4.17	PCA loading plot (PC1) of FTIR spectra from photoperiod length treatments....	46
4.18	Biochemical composition under different photoperiod lengths.....	47
4.19	3D Model PCA of Spirulina Culture in Photoperiod Lengths treatment.....	48
4.20	Average spectrum obtained from FTIR spectroscopy of Culture in Tap water and Ground water after smoothing, baseline correction, and extended multiplicative scatter correction (EMSC).....	51
4.21	Second derivative of Photoperiod lengths treatment.....	52
4.22	PCA loading plot (PC1) of FTIR spectra from Culture in Tap water and Ground water treatments.....	52

LITS OF FIGURES (Continued)

	<b>Page</b>
4.24 3D Model PCA of Spirulina Culture in water source treatment.....	54
4.25 Average spectrum obtained from FTIR spectroscopy of Culture in indoor and outdoor conditions after smoothing, baseline correction, and extended multiplicative scatter correction (EMSC).....	56
4.26 Second derivative of Culture in indoor and outdoor conditions.....	57
4.27 PCA loading plot (PC1) of FTIR spectra from Culture in indoor and outdoor conditions.....	57
4.28 Biochemical composition under different Culture in indoor and outdoor conditions.....	58
4.29 3D Model PCA of Spirulina Culture in Indoor and Outdoor cultured conditions.....	59