

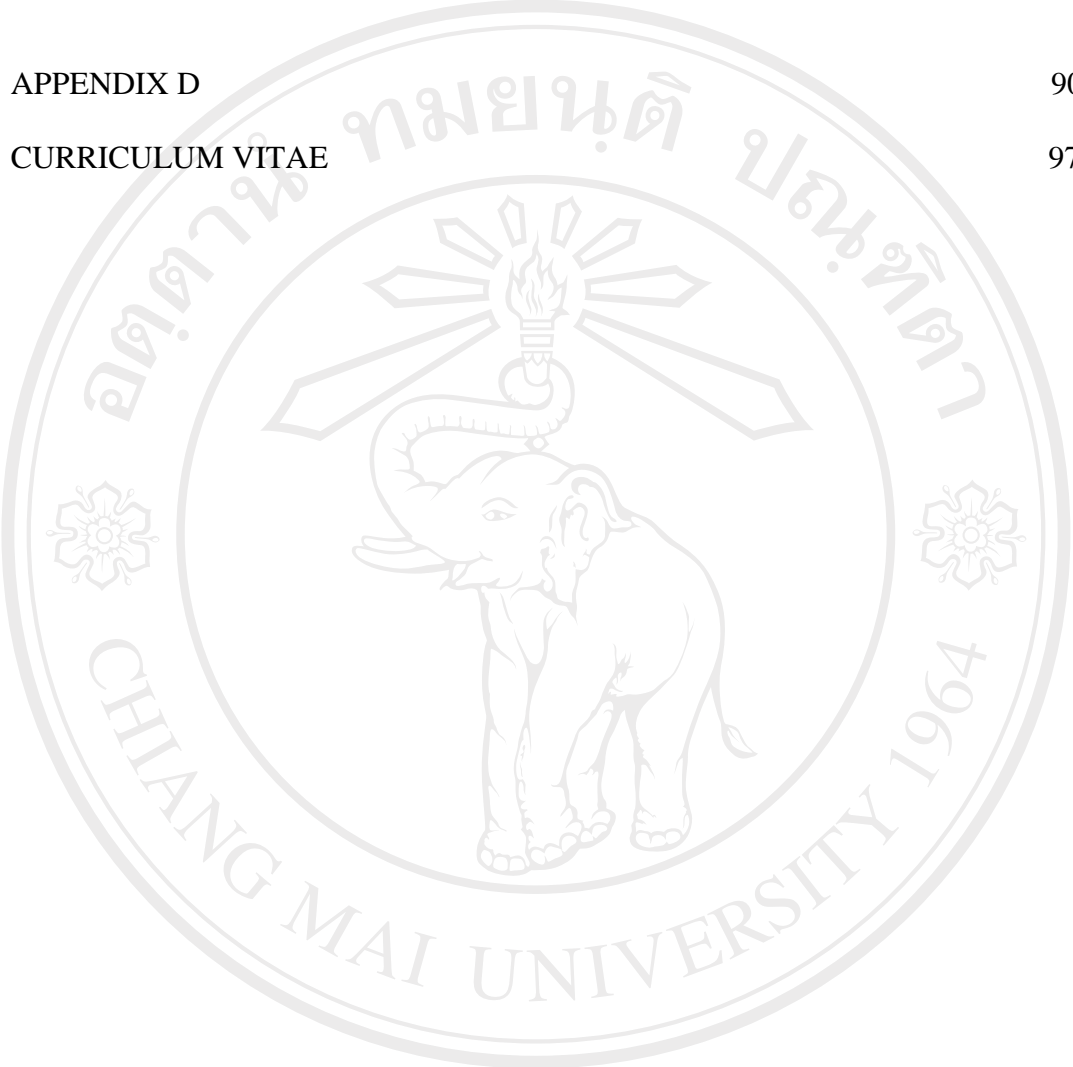
## CONTENTS

	<b>Page</b>
ACKNOWLEDGEMENTS	iii
ABSTRACT (ENGLISH)	iv
ABSTRACT (THAI)	vii
LIST OF TABLES	xiv
LIST OF ILLUSTRATIONS	xvii
ABBREVIATIONS AND SYMBOLS	xix
CHAPTER 1 INTRODUCTION	
1.1 Statement and significance of the problem	1
1.2 Cabbage	3
1.3 Previous analytical method for pyrethroid	4
1.4 Classification of insecticide	8
1.4.1 Organophosphorus	8
1.4.2 Organochlorine	9
1.4.3 Carbamate	10
1.4.4 Pyrethroid	11
1.5 Cypermethrin insecticide	13
1.6 Fenvalerate insecticide	16
1.7 Gas chromatography	19
1.7.1 Theoretical principles	19

	<b>Page</b>
1.7.2 Instrumental	21
1.7.3 Qualitative and quantitative analysis by gas chromatography	26
1.8 Desorption process	27
1.9 The scope and aims of this research	30
<b>CHAPTER 2 MATERIALS AND METHODS</b>	
2.1 Apparatus and chemical used in this study	31
2.1.1 Apparatus	31
2.1.2 Chemicals	32
2.2 Standard insecticides	32
2.3 Insecticide used in desorption study	32
2.4 Washing liquid for vegetables and fruits	33
2.5 Cabbage samples	33
2.6 Methods	34
2.6.1 Preparation of standard solutions	34
2.6.2 Optimization of experimental parameter of GC-ECD	35
2.6.3 Extraction	36
2.6.4 Validation of method	38
2.6.5 Determination of cypermethrin and fenvalerate insecticides in cabbage using standard addition method	39

	<b>Page</b>
2.6.6 Desorption of cypermethrin and fenvalerate insecticides in cabbage	39
<b>CHAPTER 3 RESULTS</b>	
3.1 The suitable GC-ECD conditions for analysis of cypermethrin and fenvalerate insecticides	43
3.2 The retention time of cypermethrin and fenvalerate insecticides	45
3.3 Investigation of suitable solvent for extraction of cypermethrin and fenvalerate insecticide residues from cabbage samples	49
3.4 Validation of the method	51
3.5 Determination of cypermethrin and fenvalerate insecticides residues in cabbages	55
3.6 Desorption study	57
<b>CHAPTER 4 DISCUSSION AND CONCLUSIONS</b>	
4.1 Discussion	63
4.2 Conclusions	70
THE RELEVANCE OF THE RESEARCH WORK TO THAILAND	72
REFERENCES	73
APPENDIX A	77
APPENDIX B	78
APPENDIX C	88

	<b>Page</b>
APPENDIX D	90
CURRICULUM VITAE	97



ลิขสิทธิ์มหาวิทยาลัยเชียงใหม่  
Copyright© by Chiang Mai University  
All rights reserved

## LIST OF TABLES

<b>Table</b>	<b>Page</b>
1.1 Reported procedures for pyrethroid residues determination in different samples	6
1.2 Properties of cypermethrin	14
1.3 Properties of fenvalerate	17
2.1 Details of the cabbage samples collected for the determination of cypermethrin and fenvalerate in this study	33
2.2 Composition of the standard solutions	35
3.1 Conditions of GC-ECD employed	43
3.2 Retention time of cypermethrin insecticide standard (n=10)	45
3.3 Retention time of fenvalerate insecticide standard (n=10)	46
3.4 Comparison of SD, % RSD, % Recovery and % Error of cypermethrin and fenvalerate at the each solvent mixture ratio (n=5)	49
3.5 Detection limits of cypermethrin and fenvalerate insecticides, using GC-ECD analytical method	52
3.6 The ECD response (peak area) of cypermethrin with variation of concentration	53
3.7 The ECD response (peak area) of fenvalerate with variation of concentration	54

<b>Table</b>	<b>Page</b>
3.8 Cypermethrin and fenvalerate insecticide residues in cabbage samples	55
3.9 Comparison of time profile for desorption of cypermethrin from cabbage, using in water and in washing liquid at room temperature	57
3.10 Comparison of time profile for desorption of cypermethrin from cabbage, using in water and in washing liquid at 90 °C	58
3.11 Comparison of time profile for desorption of fenvalerate from cabbage, using in water and in washing liquid at room temperature	60
3.12 Comparison of time profile for desorption of fenvalerate from cabbage, using in water and in washing liquid at 90 °C	61
4.1 Desorption study of cypermethrin and fenvalerte insecticides at room temperature (28 ° C)	68
4.2 Desorption study of cypermethrin and fenvalerte insecticides at 90 °C	69
B-1 Amount of cypermethrin insecticide detected after spiked cypermethrin standard in cabbage sample (0.5 mg/L)	80
B-2 Amount of cypermethrin insecticide detected after spiked cypermethrin standard in cabbage sample (3.0 mg/L)	82
B-3 The data used for calculation of the detection limit of cypermethrin	87
D-1 The data used for constructed calibration curve and desorption study of cypermethrin at room temperature (28 °C)	91

<b>Table</b>	<b>Page</b>
D-2 The data used for constructed calibration curve and desorption study of cypermethrin at 90 °C	94
D-3 The data used for constructed calibration curve and desorption study of fenvalerate at room temperature (28 °C)	95
D-4 The data used for constructed calibration curve and desorption study of fenvalerate at 90 °C	96

## LIST OF ILLUSTRATIONS

<b>Figure</b>	<b>Page</b>
1.1 Structure of cypermethrin	13
1.2 Structure of fenvalerate	16
1.3 Schematic of a typical gas chromatograph	21
1.4 Schematic of a typical ECD	25
2.1 Schematic diagram of sample extraction	37
2.2 Schematic diagram of desorption of cypermethrin and fenvalerate insecticides in cabbage at room temperature (28 °C)	41
3.1 GC-ECD chromatogram of cabbage extract under optimum condition	47
3.2 GC-ECD chromatogram of cypermethrin standard solution with 2 mg/L, (1) cypermethrin 1, (2) cypermethrin 2, (3) cypermethrin 3, (4) cypermethin 4	48
3.3 GC-ECD chromatogram of fenvalerate standard solution with 2 mg/L, (1) fenvalerate 1, (2) fenvalerate 2	48
3.4 Linearity plot of peak area against concentration of cypermethrin under the optimized condition	53
3.5 Linearity plot of peak area against concentration of fenvalerate under the optimized condition	54
3.6 Relationship between peak area and concentration of cypermethrin insecticide in sample No. 3 by standard addition method	56



Figure	Page
3.7 Relationship between peak area and concentration of fenvalerate insecticide in sample No. 3 by standard addition method	56
3.8 Desorption time profile of cypermethrin insecticide residue from cabbage (28 °C and 90 °C) by in water and in washing liquid	59
3.9 Desorption time profile of fenvalerate insecticide residue from cabbage (28 °C and 90 °C) by in water and in washing liquid	62
B-1 Calibration curve of cypermethrin for calculating of the detection limit at optimum condition	86
D-1 Calibration curve of standard cypermethrin solution (0.1-2.0 mg/L) for desorption study at room temperature (28 °C)	92
D-2 Calibration curve of standard cypermethrin solution (0.1-2.0 mg/L) for desorption study at 90 °C	94
D-3 Calibration curve of standard fenvalerate solution (0.1-2.0 mg/L) for desorption study at room temperature (28 °C)	95
D-4 Calibration curve of standard fenvalerate solution (0.1-2.0 mg/L) for desorption study at 90 °C	96