CONTENTS

			Page
ACKNOWLEDGEMENTS			
ABSTRACT (EN	NGLI	SH)	iv
ABSTRACT (TI	HAI)		V
LIST OF TABL	ES		xii
LIST OF FIGU	RES		xiv
LIST OF ABBR	EVIA	TIONS	XV
CHAPTER I	INT	RODUCTION	1
CHAPTER II	OBJ	IECTIVES	3
CHAPTER III	LIT	ERATURE REVIEWS	4
	3.1	Pigmented Rice	4
	3.2	Anthocyanins in Pigmented Rice	5
	3.3	Fermented Rice (Khao-Mak)	9
	3.4	Free Radicals and Antioxidants	11
	3.5	Maillard Reaction	12
	3.6	Effect of Storage on Antioxidant Activity, Total	13
		Phenolic Content, Anthocyanin Content, and	
		Antimutagenicity	
	3.7	Somatic Mutation and Recombination Test	15
		(SMART)	
	3.8	Urethane: A Standard Mutagen	16
	3.9	Functional Food and Health Benefits	19
CHAPTER IV	MA	TERIALS AND METHODS	23
	4.1	Chemicals	23
	4.2	Preparation of Fermented Rice	23

			Page
4.3	Antio	xidant Activities, Total Phenolic and	24
	Antho	hocyanin Contents	
	4.3.1	Samples Extraction	24
	4.3.2	Free Radical Scavenging Activity Method	24
		(DPPH) Assay	
	4.3.3	Ferric Reducing Antioxidant Power Method	24
		(FRAP) Assay	
	4.3.4	Determination of Total Phenolic Content	25
	4.3.5	Determination of Anthocyanin Content	25
	4.3.6	Statistical Methods	26
4.4	Antim	utagenicity Study using the SMART	26
	4.4.1	Drosophila Stock	26
	4.4.2	Standard Medium	26
	4.4.3	Experimental Medium	27
	4.4.4	Mutagenicity Assay	27
	4.4.5	Antimutagenicity Assay	29
	4.4.6	Statistical Methods	30
4.5	The O	ptimal Fermented Rice for Using in the	30
	Formu	lation of a New Functional Food Product	
4.6	Cereal	Bar Containing Dried Fermented Rice	31
	4.6.1	Control Cereal Bar	31
	4.6.2	Sensory Screening Test for a Selected	32
		Control Cereal Bar	
	4.6.3	Formulation of Cereal Bar Containing Dried	32
		Fermented Rice	

				Page	
		4.6.4	Sensory Screening Test for Selecting the	33	
			Optimum Level of Dried Fermented Rice in		
			Cereal Bar		
		4.6.5	In-House Consumer Test	33	
		4.6.6	Statistical Methods	33	
	4.7	Physic	cal Properties of the Control Cereal Bar and	34	
		Cereal	Bar Containing Dried Fermented Rice		
	4.8	Antioxidant Activities, Total Phenolic conte		35	
		Antho	Anthocyanin Content, and Antimutagenicity of the		
		Contro	Control Cereal Bar and New Cereal Bar		
	4.9	Nutritive Values of the Control Cereal Bar and New			
		Cereal Bar			
	4.10	Effect	of Storage on Various Properties of the New	35	
		Cereal	l Bar		
CHAPTER V	RESULTS				
	5.1	Total	Phenolic Content, Anthocyanin Content, and	37	
		Antio	kidant Activities of Fermented Pigmented		
		Rice			
	5.2	Mutag	enicity of Unfermented and Fermented	38	
		Pigme	nted Rice		
	5.3	Antim	utagenicity of Six Cultivars of Pigmented	50	
		Rice			
5.4 The Optimal Fermented Rice for Using in the		ptimal Fermented Rice for Using in the	54		
		Formu	llation of a New Functional Food Product		
		5.4.1	Ranking and Scoring of the Dried	54	
			Fermented Rice		

Page

		5.4.2 Nutritive Values of Selected Pigmented Rice		54	
	5.5	Cereal	l Bar Con	taining Dried Fermented Rice	55
		5.5.1	Preparation of Control Cereal Bar		55
		5.5.2	Cereal I	Bar Containing Fermented Black	58
			Glutino	us Rice	
			5.5.2.1	Sensory Screening Test on New	58
				Formulated Cereal Bar	
			5.5.2.2	In-House Consumer Test	58
	5.6	Chara	cteristics	of Cereal Bar Containing Dried	62
		Ferme	ented blac	k glutinous Rice	
		5.6.1	Physica	l Properties	62
		5.6.2	5.6.2 Total Phenolic content and Anthocyanin		64
			Content, and Antioxidant Activities		
		5.6.3	5.6.3 Antimutagenicity of Cereal Bar		65
		5.6.4	5.6.4 Antimutagenicity of the New Cereal Bar		68
		5.6.4	Nutritiv	e values	68
	5.7	Effect	of Storag	ge on Various Properties of the New	70
		Cereal	l Bar		
CHAPTER VI	DIS	CUSSION		84	
	6.1	Total	Phenolic	Content, Anthocyanin Content, and	84
		Antioxidant Activities of Fermented Pigmented rice			
	6.2	Antimutagenicity of Unfermented and Fermented		86	
		Pigme	ented Rice	2	
	6.3	Select	ion of Fe	rmented Pigmented Rice for a New	88
		Functi	Functional Food Product		

					Page
	6.4	Formulation of Cereal Bar Containing Dried		88	
		Ferme	Fermented Rice		
	6.5	Charao	cteris	stics of the Cereal Bar Containing	89
		Ferme	nted	Black Glutinous Rice	
		6.5.1	Phy	viscal Properties	89
		6.5.2	Tot	al Phenolic Content, Anthocyanin	90
			Cor	ntent, and Antioxidant Activities	
		6.5.3	Ant	imutagenicity	91
		6.5.4	Nut	aritive Values	91
	6.6	Storag	e Af	fected on Various Properties of the New	92
		Cereal	Bar		
		6.6.1	Sen	sory Acceptability Test and Physical	92
			Pro	perties	
		6.6.2	Tot	al Phenolic Content, Anthocyanin	93
			Cor	ntent, and Antioxidant Activities	
		6.6.3	Mu	tagenicity and Antimutagenicity of the	93
			Sto	red Sample	
CHAPTER VII	CON	NCLUS	ION		95
REFERENCES					96
APPENDICES					115
	APP	ENDIX	Α	Statistical consideration of smart	116
	APP	ENDIX	В	Sensory screening test questionnaire for	120
				a selected control cereal bar and in-	
				house consumer test	
	APP	ENDIX	С	Sensory screening test questionnaire for	122
				selecting the optimum level of cereal	
				bar containing dried fermented rice	

Page

APPENDIX D	Texture analysis graph of control cereal	124
	bar and cereal bar containing dried	
	fermented black glutinous rice	
APPENDIX E	Texture analysis graph of new cereal	125
	bar during storage for 90 days	
		126

BIOGRAPHY

xi

LIST OF TABLES

Table		Page
4.1	Formulation of control cereal bars	31
4.2	Formulation of cereal bars containing dried fermented rice	32
5.1	Total phenolics, anthocyanins, and antioxidant activities of	39
	unfermented and fermented pigmented rice	
5.2	The percentages of surviving adult flies brought up on control and	42
	experimental media	
5.3	Wing spot test data obtained with unfermented or fermented	44
	pigmented rice	
5.4	Antimutagenicity against urethane in Drosophila melanogaster of	51
	unfermented and fermented pigmented rice	
5.5	Rank and score of total phenolic content, anthocyanin content,	54
	antioxidant activities, and antimutagenicity of each dried fermented	
	rice	
5.6	Nutritive values of cooked and fermented black glutinous rice	55
5.7	Sensory acceptability scores of cereal bars (control formula)	57
5.8	Sensory acceptability scores from a screening test of the cereal bars	60
	containing dried fermented black glutinous rice	
5.9	Sensory acceptability scores between control cereal bar and new	61
	cereal bar	
5.10	Physical properties of the control cereal bar and cereal bars	63
	containing different percentage of dried fermented rice	
5.11	Total phenolic content, anthocyanin content, and antioxidant	64
	activities of the control cereal bar and new cereal bar	
5.12	The percentage of surviving adult flies fed on different media	65
5.13	Mutagenicity of the control cereal bar and new cereal bar	66
5.14	Antimutagenicity of the control cereal bar and new cereal bar.	69

LIST OF TABLES (cont.)

Table		Page
5.15	Nutritive values of the control cereal bar and new cereal bar	70
5.16	Sensory acceptability scores of the new cereal bar during storage for	71
	90 days	
5.17	Physical properties of the new cereal bar during storage for 90 days	72
5.18	Total phenolic content, anthocyanin content, and antioxidant	73
	activities of the new cereal bar during storage for 90 days	
5.19	The percentage of survival adult flies fed on control and	77
	experimental medium	
5.20	Mutagenicity of the new cereal bar stored for 0, 45 or 90 days	78
5.21	Antimutagenicity of the new cereal bar stored for 0, 45 and 90 days	81

LIST OF FIGURES

Figure		Page
3.1	Chemical structure of anthocyanidins	6
4.1	Normal half mesothorax showing the regions A-E of the wing	28
	surface scored for spots	
4.2	Antimutagenicity study of sample against of urethane induced wing	29
	spots of Drosophila melanogaster	
5.1	Total phenolic and anthocyanin contents of unfermented and	40
	fermented pigmented rice	
5.2	DPPH antioxidant activity and ferric reducing antioxidant power of	41
	unfermented and fermented pigmented rice	
5.3	Antimutagenicity effect of unfermented and fermented pigmented	53
	rice against urethane in SMART	
5.4	Appearance of control cereal bars	56
5.5	Appearance of cereal bars containing dried fermented black	59
	glutinous rice	
5.6	Total phenolic and anthocyanin contents of new cereal bar during	74
	storage for 90 days	
5.7	DPPH antioxidant activity and ferric reducing antioxidant power of	75
	new cereal bar during storage for 90 days	
5.8	Antimutagenicity effect of the new cereal bar stored for 0, 45 and	83
	90 days against urethane in SMART	

LIST OF ABBREVIATIONS

°C	Degree Celsius
mg	milligram
mM	millimolar
mmol	millimoles
g	gram
Min	minute
h	hour
d	day
ml	milliliter
L	liter
et al.	et alii (and other)