

## Table of contents

<b>Contents</b>	<b>Page No.</b>
<b>Dedication</b>	
<b>Abstract</b>	i-v
<b>Declaration</b>	vi
<b>Certificates</b>	viii
<b>Acknowledgements</b>	x
<b>List of Tables</b>	xi
<b>List of Figures</b>	xiv
<b>List of Abbreviation</b>	xvii
<b>Chapter 1 Introduction</b>	1
1.1 Introduction	3
1.2 Hypothesis	3
1.3 Technical objectives	3
References	4
<b>Chapter 2 Review of Literature</b>	6
2.1 Pigmented rice	6
2.1.1 Nutritional composition	6
2.1.2 Various bioactive compounds of pigmented rice	9
2.1.2.1 Anthocyanin	9
2.1.2.2 Proanthocyanidins	9
2.1.2.3 Phenolic acids	10
2.1.2.4 Flavonoids	11
2.1.2.5 $\gamma$ -oryzanol (Steryl ferulate)	12
2.1.2.6 Vitamin E	12
2.1.2.7 Minerals	12
2.1.3. Health benefits of bioactive compounds	12
2.1.3.1 Antiallergic activities	13
2.1.3.2 Antidiabetic activities	13
2.1.3.3 Antiinflammatory effects	14
2.1.3.4 Anticancer activity	14
2.1.3.5 Antitumor Activities	14
2.1.3.6 Alleviating gallstones	15
2.1.3.7 Internal rejuvenation	15
2.1.3.8 Other bioactivities	15
2.1.4 Passion fruit	15
2.1.4.1 Health benefits	18
2.1.4.2 Foam mat drying	19
2.1.4.3 Foam generating methods	19
2.1.4.3.1 Whipping	20
2.1.4.3.2 Shaking	20
2.1.4.3.3 Bubbling	20
2.1.5 Extrusion cooking technology	20
2.1.6 Rheology	21
2.1.7 Fuzzy logic tool	23
2.1.8 Moisture sorption isotherm(MSI)	23
2.1.9 Dipeptidyl peptidase-4 (DPP-4) inhibitory activity and GLP-1 secretion Diabetes mellitus	25
2.1.9.1 Diabetes mellitus	25

## Table of contents

2.1.9.2 Incretin System	25
2.1.9.3 Dipeptidyl peptidase-4 (DPP-4) inhibitory activity	26
2.1.9.4 GLP-1 secretion	26
2.1.9.5 Mechanism of action	27
References	28
<b>Chapter 3 Physicochemical analysis of pigmented and nonpigmented rice and phytochemical analysis of purple passion fruit</b>	<b>45</b>
<b>(A) Physicochemical analysis of pigmented and nonpigmented rice cultivars</b>	<b>45</b>
3.1 Introduction	45
3.2 Materials and methods	46
3.2.1 Materials	46
3.2.2 Proximate compositions	46
3.2.3 Physical properties of rice	46
3.2.3.1 Moisture and ash content	46
3.2.3.2 Axial dimensions	46
3.2.3.3 Bulk and true densities	47
3.2.3.4 Porosity	47
3.2.3.5 Angle of repose	48
3.2.3.6 Color	48
3.2.4 Mineral profile	48
3.2.5 Pasting properties	48
3.2.6 Cooking characteristics	49
3.2.6.1 Optimal cooking time	49
3.2.6.2 Water uptake ratio	49
3.2.7 Texture profile analysis (TPA)	49
3.2.8 Differential scanning calorimeter (DSC)	49
3.2.9 X-ray diffraction analysis (XRD)	50
3.2.10 Fourier transform infrared (FT-IR) spectra	50
3.2.11 Phytochemicals and antioxidant activities	50
3.2.11.1 Sample extraction	50
3.2.11.2 Total phenolics content	50
3.2.11.3 Total monomeric anthocyanins	51
3.2.11.4 DPPH scavenging activity	51
3.2.11.5 Metal chelating activity	52
3.2.12 High-performance liquid chromatography (HPLC) analysis of phenolic compounds	52
3.2.12.1 Sample preparation	52
3.2.12.2 Detection	52
3.2.13 Statistical analysis	53
3.3 Results and discussion	53
3.3.1 Nutritive quality	53
3.3.2 Physical properties	53
3.3.3 Mineral profile	55
3.3.4 Pasting properties	56
3.3.5 Cooking characteristics	58
3.3.6 Texture profile analysis (TPA)	59
3.3.7 Differential scanning calorimetry (DSC)	60
3.3.8 X-ray diffraction analysis (XRD)	62

## Table of contents

3.3.9	Phytochemicals and antioxidant activities	63
3.3.8.1	Total phenolic content	63
3.3.8.2	Chelating activity	64
3.3.8.3	DPPH scavenging activity	64
3.3.8.4	Fourier transform infrared (FT-IR) spectra analysis	67
3.3.8.5	Reverse phase-High-performance liquid chromatography (RP-HPLC) analysis	68
3.4	Conclusion	71
	References	72
	<b>(B) Physicochemical and phytochemical analysis of purple passion fruit</b>	79
3.5	Introduction	79
3.6	Material and methods	79
3.6.1	Raw material	79
3.6.2	The color measurement	80
3.6.3	Phytochemicals and antioxidant activities	80
3.6.3.1	Ascorbic acid (vitamin C)	80
3.6.3.2	Total phenolic content	80
3.6.3.3	DPPH scavenging activity	80
3.6.3.4	Attenuated total reflectance Fourier transform infrared spectroscopy (ATR-FTIR) analysis	80
3.6.3.5	RP-HPLC analysis of phenolic acids	81
3.6.3.5.1	Sample preparation	81
3.6.3.6	Reverse phase-High-performance liquid chromatography (RP-HPLC) analysis of ( $\pm$ ) $\alpha$ -tocopherol, D- $\alpha$ -tocotrienol and $\beta$ -carotene	81
3.6.3.6.1	Sample preparation	81
3.6.3.6.2	Detection	81
3.6.4	Statistical analysis	81
3.7	Results and discussion	82
3.7.1	Moisture content (%), ash content (%),total soluble solid ( $^{\circ}$ Brix) and pH	82
3.7.2	Phytochemical analysis	82
3.7.2.1	Vitamin C	82
3.7.2.2	Total phenolic content	83
3.7.2.3	DPPH scavenging activity	83
3.7.2.4	Attenuated total reflectance Fourier transform infrared spectroscopy ATR-FT-IR analysis	83
3.7.2.5	Reverse phase-High-performance liquid chromatography (RP-HPLC) analysis	84
3.8	Conclusion	85
	References	86
	<b>Chapter 4 Foam mat drying of purple passion fruit and characterization of the powder</b>	89
4.1	Introduction	89
4.2	Materials and methods	90
4.2.1	Plant material	90
4.2.2	Chemicals	90
4.2.3	Foam mat drying	90
4.2.4	Analysis	91

## Table of contents

4.2.4.1	Vitamin C	91
4.2.4.2	Total phenolic content	91
4.2.4.3	DPPH scavenging activity	91
4.2.4.4	Hygroscopicity	91
4.2.5	Experimental design	91
4.2.6	Artificial neural networks (ANN)	92
4.2.7	Phytochemical analysis	93
4.2.7.1	Fourier transform infrared spectroscopy (FT-IR) analysis	93
4.2.7.2	Reverse phase-High-performance liquid chromatography (RP-HPLC) analysis of phenolic acids	93
4.2.7.3	Reverse phase-High-performance liquid chromatography (RP-HPLC) analysis of $\beta$ -carotene ( $\pm$ ) $\alpha$ -tocopherol and D- $\alpha$ -tocotrienol	93
4.2.8	Statistical analysis	93
4.3	Results and discussion	93
4.3.1	Preliminary trial	93
4.3.2	Model fitting	96
4.3.2.1	Response surface analysis of vitamin C	97
4.3.2.2	Response surface analysis of total phenolic content	98
4.3.2.3	Response surface analysis of hygroscopicity	99
4.3.3	Optimization and validation of foam mat drying parameter	104
4.3.4	Artificial-neural-network (ANN) modeling	104
4.3.5	Physical and chemical compositions of juice and powder	107
4.3.6	Phytochemical analysis	107
4.3.6.1	Fourier transform infrared spectroscopy (FT-IR) analysis	107
4.3.6.2	Reverse phase-High-performance liquid chromatography (RP-HPLC)	109
4.4	Conclusion	110
	References	111
	<b>Chapter 5 Effect of extrusion cooking on the physicochemical and phytochemical properties of passion fruit powder incorporated red rice extrudates, rheology of doughs and sensory evaluation of product</b>	116
	<b>A) Effect of extrusion parameters on the physicochemical and phytochemical properties of passion fruit powder incorporated red rice product</b>	116
5.1	Introduction	116
5.2	Material and Methods	117
5.2.1	Raw Material	117
5.2.2	Chemicals	117
5.2.3	Extrusion experiments	117
5.2.3.1	Expansion ratio	118
5.2.3.2	Water absorption index	119
5.2.3.3	Total phenolic content	119
5.2.3.4	DPPH scavenging activity	119
5.2.4	Fourier transform infrared spectroscopy (FT-IR) analysis	119
5.2.5	Differential scanning calorimeter (DSC) analysis	120
5.2.6	X-ray diffraction (XRD) analysis	120
5.2.7	Morphological structure analysis by scanning electron microscopy (SEM)	120
5.2.8	Phytochemical profiling	120

## Table of contents

5.2.8.1	Determination of ( $\pm$ )- $\alpha$ -tocopherol, D- $\alpha$ -tocotrienol, $\beta$ -carotene	120
5.2.8.2	Determination of cyanidin-3-glucoside (C-3-G) and peonidin-3-d- glucoside (P-3-G)	121
5.2.8.3	Purification of sample	121
5.2.9	Statistical analysis	121
5.3	Results and discussion	121
5.3.1	Model fitting	121
5.3.1.1	Response surface analysis of expansion ratio	124
5.3.1.2	Response surface analysis of water absorption index	124
5.3.1.3	Response surface analysis of total phenolic content	126
5.3.1.4	Response surface analysis of DPPH Scavenging activity	127
5.3.2	Optimization and validation	132
5.3.3	Characterization	132
5.3.3.1	Fourier transform infrared spectroscopy (FT-IR) analysis	132
5.3.3.2	Differential scanning calorimeter (DSC) analysis	133
5.3.3.3	X-ray diffraction (XRD) analysis	134
5.3.3.4	Morphological structure analysis by scanning electron microscopy (SEM)	136
5.3.3.5	Phytochemical profile of sample	137
5.4	Conclusion	138
	References	139
	<b>B) Rheological Properties of gluten free dough</b>	144
5.5	Introduction	144
5.6	Materials and methods	145
5.6.1	Materials	145
5.6.2	Sample preparation	145
5.6.3	Shear rheological study	145
5.6.3.1	Power law	145
5.6.3.2	Bingham model	145
5.6.3.3	Herschel –Bulkley model	146
5.6.3.4	Casson model	146
5.6.3.5	Mizrahi and Berk model	146
5.6.4	Dynamic rheological properties	146
5.6.5	Statistical analysis	147
5.7	Results and discussion	148
5.7.1	Steady shear rheological analysis	148
5.7.2	Dynamic oscillatory rheology	151
5.8	Conclusion	152
	References	152
	<b>C) Sensory evaluation of red rice based extruded products by fuzzy logic tool</b>	156
5.9	Introduction	156
5.10	Materials and method	156
5.10.1	Raw material	156
5.10.2	Sensory evaluation of extrudates	157
5.10.3	Fuzzy analysis	157
5.11	Results and discussion	158
5.11.1	Triplets associated with sensory scales	159
5.11.2	Triplets associated with sensory quality scales	160

## Table of contents

5.11.3 Triplets for judges' preference to the importance of quality attribute	161
5.11.4 Overall sensory scores of the extruded samples triplets	161
5.11.5 Standard fuzzy scale and ranking of products	163
5.11.6 Quality attribute ranking of extruded samples in general	164
5.11.7 Membership function of overall sensory scores	165
5.11.8 Similarity analysis for products	165
5.12 Conclusion	166
References	167
<b>Chapter 6 Moisture sorption isotherm and antioxidant activity study of products during storage</b>	169
6.1 Introduction	169
6.2 Materials and methods	170
6.2.1 Raw materials	170
6.2.2 Antioxidant stability during storage	170
6.2.3 Moisture sorption isotherm (MSI) studies	170
6.2.4 Mathematical model fitting and data analysis	171
6.3 Results and discussion	172
6.3.1 Antioxidant stability during storage	172
6.3.2 Mathematical modeling and fitting of moisture sorption data	175
6.4 Conclusion	177
References	177
<b>Chapter 7 Assessment of the antidiabetic potential of red rice and rice-based products</b>	181
7.1 Introduction	181
7.2 Materials and methods	183
7.2.1 Material	183
7.2.2 Extraction	185
7.2.3 Determination of DPP-4 inhibition activity	186
7.2.4 STC-1 pGIP/Neo cell culture studies	186
7.2.5 Measurement of cell viability	186
7.2.6 Determining GLP-1 secretion from STC-1 pGIP/Neo cells	186
7.2.7 Inductively coupled plasma mass spectrometry (ICP-MS) of samples	186
7.2.7.1 Sample preparation for As speciation	187
7.2.7.2 Chemical analysis	187
7.2.8 Statistical analysis	187
7.3 Results and discussion	187
7.3.1 Inhibition of DPP-4 activity	188
7.3.2 GLP-1 secretion	189
7.3.3. Inductively coupled plasma mass spectrometry (ICP-MS) for elemental analysis	191
7.4 Conclusion	192
References	193
<b>Chapter 8 Conclusion and future scope</b>	200
8.1 Conclusion	200
8.2 Future scope of the present investigation	203
List of Publication	204
Conferences /Seminars /Workshops	204