Table of Contents

1. Introduction	3
1.1.Agricultural by-products	3
1.1.1. Rice and wheat by-products	3
1.1.2. Chickpea and moong bean by-products	4
1.1.3. Health benefits of agricultural (Milling) by-products and prevention of	6
diseases	
1.2. A review on agricultural by-products: Nutrient composition, health	7
benefits, food formulation and storage stability	
1.2.1. Nutrient composition and the bioactive properties of the milling by-	9
products	
1.2.1.1. Rice Bran	9
1.2.1.2. Wheat Bran	13
1.2.1.3.Chickpea husk and moong bean hull	15
1.2.2. Formulated food products from the selected by-products	16
1.2.2.1.Rice Bran	16
1.2.2.2. Wheat Bran	17
1.2.2.3. Chickpea husk and moong hull	18
1.2.2.4.Sensory acceptance of the value added products	19
1.2.3. Stabilization of milling by-products and by-product-based food products	19
1.3. Food irradiation	22
1.3.1. Gamma radiation	25
1.3.2. Role of gamma radiation in the reduction of microbial load and nutrient	25
spoilage	
1.3.3. Effect of gamma radiation on food products	27
1.3.4. Impression of consumers on gamma irradiated products and the	33
acceptance rate	
1.4. Gap in the study	33
1.5. Objective of study carried out in present thesis	35
1.6. Scope of the study	36
1.7. Organization of thesis	36
2. Methodology	38
2.1. Introduction	38
2.2. Procurement and processing of raw ingredients	38
2.3. Formulation of value-added products using agricultural by-products	40
2.4. Measurement of Physico-chemical properties and nutrient composition	42
2.4.1. Physical parameters	42
2.4.1.1. Bulk density	42
2.4.1.2. Water absorption capacity	42
2.4.1.3. Oil absorption capacity	43
	44
2.4.1. Measurement of Proximate composition	

2.4.2.1. Moisture	44
2.4.2.2. Ash	45
2.4.2.3. Crude protein	46
2.4.2.4. Crude fat	48
2.4.1.5. Crude fibre	49
2.4.1.6. Total Carbohydrates	50
2.4.2. Sugars	51
2.4.3. Soluble and insoluble dietary fibre	52
2.4.4. Minerals	53
2.4.5. Antioxidants	54
2.4.6. Total phenolic activity	55
2.4.7. In vitro digestibility of Protein and Starch	55
2.4.8. Antinutrient	56
2.4.9. Determination of Vitamin C	56
2.5. Measurement of Shelf life evaluation of the preferred formulations	57
2.5.1. Sensory evaluation of products	57
2.5.2. Free Fatty Acid	57
2.5.3. Peroxide value	57
2.6. Determination of Microbial load	58
2.7. Statistical analysis	59
2.8. Enhancement of shelf life using Gamma radiation	60
2.8.1. Attenuation Co-efficient determination	60
	63
2.8.2. Irradiation of the formulated products	
2.8.3. Detection of counts using GM Counter	64
2.8.4. Detection of counts using Na(I)-TI Scintillation Detector	65
2.9. Popularization of the acceptable product and transfer the technology	68
regarding their preparation and utilization	
2.10. Summary	68
3. Development of fibre and micronutrient enriched fermented products	69
3.1. Introduction	69
3.2. Processing and valorisation of the milling by-products	70
3.3. Results and Discussions	75
3.3.1. Physico-chemical properties	75
3.3.1.1. Bulk density	75
3.3.1.2. Water absorption capacity	75
3.3.1.3. Oil absorption capacity	75
3.3.2. Proximate composition of the milling by-products	76
3.3.3. Nutrient composition of the milling by-products	77
3.3.4. Proximate composition of fruit by-products (peels)	80
3.3.5. Nutrient composition of fruit by-products (peels)	80

3.3.6. Sensory evaluation of the value added products (Instant Mix and Bran	82
Paneer)	
3.3.7. Microbiological safety of developed products (Instant Mix and Bran	83
Paneer)	
3.3.8. Detailed study of the nutritional attributes of the formulated products	84
(Instant Mix and Bran Paneer)	0.4
3.3.8.1. Proximate compositions	84
3.3.8.2. Sugar and starch	85
3.3.8.3. Minerals	86
3.3.8.4. Antinutrient factors	87
3.3.8.5. Phenolic compounds and antioxidant properties	87
3.3.8.6. In vitro protein and starch digestibility	89
3.3.8.7. Dietary fibre	89
3.3.9. Shelf life of the prepared products	89
3.3.10. Nutrient analysis of irradiated product	93
3.4. Summary	94
4. Formulation of novel value added Baked products: Cookies and Bread	95
4.1. Introduction	95
4.2. Processing of selected milling by-products for multibran cookies formulation	96
4.3. Experimental design to formulate cookies	97
4.3.1. Data analysis	97
4.4. Formulation of value added cookies	97
4.5. Formulation of nutrient rich baked product- Bread	98
4.6. Irradiation of the formulated bakery products	100
4.7. Results and discussion	100
4.7.1. Analysis of design and characterization of formulated cookies	101
4.7.1.1. Optimization and justification of response variables	101
4.7.1.2. Detailed study of nutritional compositions of MBC Cookies	100
4.7.1.2.1. Proximate compositions	100
4.7.1.2.1. Troximate compositions 4.7.1.2.2. Minerals	100
4.7.1.2.3. Antinutrient	107
4.7.1.2.4. Phenolic compounds and antioxidant properties	100
4.7.1.2.5. In vitro protein and starch digestibility	109
4.7.1.2.6. Dietary fibre	109
4.7.1.2.7. Sensory evaluation of cookies	110
4.7.1.2.7. Sensory evaluation of cookes 4.7.1.3. Shelf life of the prepared food products	111
4.7.1.4. Microbiological safety of food	111
4.7.2. Characterization of value added breads	111
4.7.2. Characterization of value added breads 4.7.3. Mass attenuation coefficient of formulated products	113
4.7.4. Improvement in shelf life of bread and cookies	113
	114
4.8. Summary	117

5. Cereal-legume milling by-products based snack products formulation	ucts 120
5.1. Introduction	120
5.2. Processing of the selected milling by-products	121
5.3. Formulation of value added food products- Bran Bar, Gram Pak, Papad	121
5.3.1. Bran Bar	121
5.3.2. Gram Pak (Dairy-based confectionary)	123
5.3.3. Papad (Roasted Product)	125
5.4. Result and discussion	126
5.4.1. Detailed study of the nutritional attribute of the formulated products	127
5.4.1.1. Proximate compositions	127
5.4.1.2. Sugar and starch	128
5.4.1.3. Minerals	129
5.4.1.4. Antinutrient factors	129
5.4.1.5. Phenolic compounds and antioxidant properties	131
5.4.1.6. In vitro protein and starch digestibility	131
5.4.1.7. Dietary fibre	134
5.4.2. Sensory evaluation of prepared products	134
5.4.3. Microbiological safety of food	134
5.4.4. Shelf life of the prepared food products	134
5.5. Summary	139
6. Formulation of milling by-product based Nutrient Dense Hea Drink and Detox Tea-Substitute	alth 140
6.1. Introduction	140
6.2. Experimental Design to characterize the formulated products	141
6.2.1. Value added product (Health Drink Powder and Detox Tea-substit formulation	ute) 142
6.2.1.1. Formulation of Health Drinks Powder	142
6.2.1.2. Formulation of Detox Tea-substitute	143
6.2.1.3. Detection of adulterants in liquid products	145
6.3. Result and discussions	147
6.3.1. Sensory evaluation of prepared products	147
6.3.2. Detailed study of the nutritional attribute of the formulated products	147
6.3.2.1. Proximate compositions	147
6.3.2.2. Sugar and starch level	149
6.3.2.3. Minerals	149
6.3.2.4. Antinutrient factors	149
6.3.2.5. Phenolic compounds and antioxidant properties	150
6.3.2.6. In vitro protein and starch digestibility	151
6.3.2.7. Dietary fibre	151
6.3.2.8. Vitamin-C level in formulations	151
6.3.2.9. Shelf life of the prepared food products	152
6.3.2.10. Microbiological safety of food	152

6.3.2.11. Antioxidant activity of the stored products	153
6.3.3. Detection of adulterants in liquid products using gamma radiation	156
6.4. Summary	165
7. Summary and Outlook	167
7.1. Summary	167
7.2. Outlook	170
Bibliography	172
Annexures	200
Annexure- I	200