

**Physicochemical characteristics of conditioned and micronised cowpeas and
functional properties of the resultant flours**

By

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DEDICATION

This thesis is dedicated to the memory of my beloved mother, late Dorothy Irene Mvula
and

To the Lord my God, my ever present help in times of need;

I lift my eyes to the hills
where does my help come from
my help comes from the Lord
maker of heaven and earth.

DECLARATION

I declare that the thesis which I hereby submit for the degree PhD (Food Science) at the University of Pretoria is my own work and has not previously been submitted by me for a degree at another university or institution of higher education.

Agnes Mbachu Mwangwela

2006

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ABSTRACT

Physicochemical characteristics of conditioned and micronised cowpeas and functional properties of the resultant flours

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Cowpea (*Vigna unguiculata* L. Walp) is an important source of protein in some parts of sub Saharan Africa. In southern Africa, it is mainly boiled into a stew, and long cooking time is a concern. Micronisation of preconditioned seeds has been used to reduce the cooking time of other dry legume seeds such as lentils. Hence micronisation (moisture conditioning and infrared heating) presents an opportunity for processing cowpeas to alleviate long cooking time and provide a convenient product as well as diversify cowpea products. In addition, potential exists for using flour milled from micronised (moisture conditioned and infrared heated) seeds in food systems. However, variations in raw material physicochemical properties (seeds) and micronisation temperature would affect the efficacy of the process to produce products with desired properties. Mild (130 and 153 °C) and severe (170 °C) final surface temperatures were used to determine the extent of micronisation-induced changes in cowpea structure and physicochemical properties and functionality of the resultant flours.

Two cowpea varieties (Bechuana white and Var. 462; 41 % moisture) micronised to 153 °C were used to study the effect of micronisation on physicochemical and structural properties of cowpea seeds. Bechuana white (41 % moisture) micronised to three

temperatures (130, 153 and 170 °C) was used to study the micronisation temperature effect on physicochemical properties of cowpeas and functional properties of resultant flours. Scanning electron microscopy (SEM) and environmental scanning electron microscopy (ESEM) were used to study seed structure, while light microscopy was used for the flour. Gel permeation high performance liquid chromatography (GP-HPLC), differential scanning calorimetry (DSC), and a rapid visco-analyser (RVA) were used to study starch-related properties, while fluorescence spectroscopy and electrophoresis (SDS-PAGE) were used to study physicochemical properties of isolated proteins. These physicochemical and structural properties were determined to aid in explaining the possible micronisation-induced changes in cooking characteristics of seeds and functional properties of the resultant flours.

Micronisation (41 % moisture, 153 °C) reduced cooking time (Bechuana white > Var. 462) and increased splitting (Var. 462 >Bechuana white) of the cowpeas during subsequent cooking. The micronised (41 % moisture, 153 °C) seeds were relatively softer than the unmicronised samples following subsequent cooking. The mild temperatures (130, 153 °C) were more effective in reducing cooking time than the higher temperature (170 °C). Micronisation (41 % moisture, 153 and 170 °C) caused physical fissuring of the seed coat, cotyledon, and parenchyma cell wall and reduced the bulk density of treated seeds. These changes in the physical structure improved the hydration rate of the seeds during cooking. There is a possibility that micronisation (41 % moisture, 130, 153, 170 °C) also caused the degradation of pectic substances of the middle lamella, since shorter cooking time was required for cotyledon parenchyma cells to separate during cooking.

Mild micronisation (41 % moisture, 130 and 153 °C) temperatures caused the disruption of the native starch granular order leading to retrogradation of amylose, while at higher micronisation (41 % moisture, 170 °C) temperatures the retrogradation of amylose was possibly accompanied by endodegradation of starch. Simultaneously, micronisation (41 % moisture, 130 and 170 °C) led to increased surface hydrophobicity and crosslinking of protein, which was more pronounced in M-170 °C samples. SDS-PAGE

indicated that disulphide bonds were formed in micronised (41 % moisture, 130 and 170 °C) samples; while isopeptide bonds, dityrosyl bonds and Maillard derived crosslinks are possibilities especially in the M-170 °C sample. The pronounced crosslinking of protein and possible depolymerisation of starch contributed to hardening of the cotyledon structure, consequently impacting negatively on the effectiveness of the micronisation (41 % moisture, 170°C) treatment in reducing cooking time.

These changes in seed structure and physicochemical properties of starch and protein contributed towards the reduction in cooking time and increased splitting of seeds and modified flour functionality. Cowpea flour foaming capacity was lost following micronisation (41 % moisture, 130 and 170 °C) possibly due to reduced solubility and crosslinking of protein. Micronisation (41 % moisture, 130 and 170 °C) reduced flour gelling and pasting properties while increasing the water absorption capacity, more so in M-170 °C samples than in M-130°C. Hence micronisation to mild temperatures (130 °C) has the potential of producing cowpeas with shorter cooking time, which can also be milled into flour with modified functionality. Thus micronisation of moisture-conditioned cowpeas to mild temperatures would contribute towards increased utilisation of cowpeas as well as improving household nutrition status.

TABLE OF CONTENTS

TITLE PAGE.....	i
DEDICATION.....	ii
DECLARATION.....	iii
ACKNOWLEDGEMENTS.....	iv
ABSTRACT.....	vi
TABLE OF CONTENTS.....	ix
LIST OF TABLES.....	xvi
LIST OF FIGURES.....	xviii
1 INTRODUCTION.....	1
2 LITERATURE REVIEW.....	4
2.1 Utilisation of cowpeas as a protein and energy source in sub-Saharan Africa	4
2.2 Structure and chemical composition of cowpea seeds	5
2.2.1 Seed coat and other external features of a cowpea seed.....	6
2.2.2 Structure and physicochemical characteristics of cowpea cotyledon.....	8
2.2.2.1 <i>Physicochemical and functional characteristics of cowpea protein.....</i>	8
2.2.2.2 <i>Physicochemical and functional characteristics of cowpea starch.....</i>	13
2.3 Mechanisms underlying structural and physicochemical changes of legume seeds during soaking.....	15
2.4 Mechanisms underlying structural and physicochemical changes of legume seeds during cooking.....	16
2.4.1 Physicochemical and structural changes occurring in the	

	middle lamella of parenchyma cells of the cowpea cotyledon ...	17
2.4.2	Gelatinisation of starch and protein denaturation during cooking of cowpea seeds.....	17
2.4.3	Splitting of cowpea seeds during cooking.....	19
2.5	Functional properties of cowpea flour.....	20
2.5.1	Nitrogen solubility of cowpea flour.....	21
2.5.2	Foaming capacity of cowpea flour.....	21
2.5.3	Water holding capacity of cowpea flour.....	22
2.5.4	Fat binding capacity of cowpea flour.....	22
2.5.5	Pasting and gelling properties of cowpea flour.....	23
2.5.6	Thermal properties of cowpea flour.....	23
2.6	Use of micronisation to precook grain legumes.....	24
2.6.1	Effect of micronisation on cooking characteristics of dry legume seeds.....	25
2.6.1.1	<i>Effect of micronisation on the middle lamella in the cotyledon of legume seeds.....</i>	26
2.6.1.2	<i>Effect of micronisation on physicochemical properties of starch in treated legume seeds</i>	26
2.6.1.3	<i>Effect of micronisation on physicochemical and functional properties of protein in treated legume seeds.....</i>	28
2.6.2	Effect of dry heat on functional properties of flour milled from treated legume seeds.....	32
2.7	Gaps in knowledge.....	34
2.8	Hypotheses.....	36
2.9	Objectives.....	36
3	RESEARCH.....	38
3.1	Physicochemical and cooking characterisation of nine cowpea (<i>Vigna unguiculata</i> L. Walp) varieties.....	39
3.1.1	Introduction.....	40

3.1.2	Materials and methods.....	41
3.1.2.1	<i>Moisture determination.....</i>	41
3.1.2.2	<i>Crude protein determination.....</i>	41
3.1.2.3	<i>Seed size determination.....</i>	41
3.1.2.4	<i>Determination of water absorption during soaking.....</i>	41
3.1.2.5	<i>Determination of water absorption during cooking.....</i>	42
3.1.2.6	<i>Determination of splitting during cooking of cowpea seeds.....</i>	42
3.1.2.7	<i>Determination of seed texture during cooking of cowpea seeds....</i>	42
3.1.2.8	<i>Statistical analysis.....</i>	43
3.1.3	Results and discussion.....	43
3.1.3.1	<i>Water uptake during soaking.....</i>	45
3.1.3.2	<i>Water absorption during cooking.....</i>	46
3.1.3.3	<i>Splitting of cowpea seeds during cooking.....</i>	47
3.1.3.4	<i>Texture of cooked cowpea seeds.....</i>	48
3.1.4	Conclusions.....	48
3.2	Hydrothermal treatments of two cowpea (<i>Vigna unguiculata</i> L. Walp) varieties: effect of micronisation on physicochemical and structural characteristics	49
3.2.1	Introduction.....	50
3.2.2	Materials and methods.....	52
3.2.2.1	<i>Raw materials.....</i>	52
3.2.2.2	<i>The hydrothermal process.....</i>	52
3.2.2.3	<i>Determination of seed moisture content.....</i>	54
3.2.2.4	<i>Determination of crude protein content.....</i>	54
3.2.2.5	<i>Determination of protein solubility.....</i>	54
3.2.2.6	<i>Determination of total and enzyme- susceptible starch.....</i>	54
3.2.2.7	<i>Determination of seed bulk density.....</i>	54
3.2.2.8	<i>Determination of water absorption during soaking and hydration capacity.....</i>	55
3.2.2.9	<i>Determination of water absorption during cooking.....</i>	55

3.2.2.10	<i>Determination of splitting during cooking.....</i>	55
3.2.2.11	<i>Determination of seed texture during cooking of cowpeas.....</i>	55
3.2.2.12	<i>Determination of cooking time.....</i>	55
3.2.2.13	<i>Scanning electron microscopy (SEM)</i>	56
3.2.2.14	<i>Enzyme digestion and environmental scanning electron microscopy (ESEM)</i>	56
3.2.2.15	<i>Statistical analysis.....</i>	56
3.2.3	Results and discussion.....	57
3.2.3.1	<i>Soaking and hydration characteristics.....</i>	57
3.2.3.2	<i>Cooking characteristics.....</i>	59
3.2.3.3	<i>Effect of micronisation (41 % moisture and 153 °C) on soaking and hydration characteristics of cowpeas.....</i>	67
3.2.3.4	<i>Effect of micronisation (41 % moisture and 153 °C) on cooking characteristics.....</i>	70
3.2.3.5	<i>Effect of micronisation (41 % moisture and 153 °C) on splitting of cooked seeds.....</i>	73
3.2.4	Conclusions.....	74
3.3	Cowpeas cooking characteristics as affected by micronisation temperature: a study of the physicochemical and functional properties of starch.....	75
3.3.1	Introduction.....	76
3.3.2	Materials and methods.....	77
3.3.2.1	<i>Raw materials.....</i>	77
3.3.2.2	<i>The hydrothermal process.....</i>	77
3.3.2.3	<i>Determination of moisture content.....</i>	77
3.3.2.4	<i>Determination of water absorption during soaking.....</i>	77
3.3.2.5	<i>Determination of water absorption during cooking.....</i>	79
3.3.2.6	<i>Splitting of cowpea seeds during cooking.....</i>	79
3.3.2.7	<i>Texture of cowpea seeds during cooking.....</i>	79
3.3.2.8	<i>Determination of cooking time.....</i>	79

3.3.2.9	<i>Cowpea flour preparation</i>	79
3.3.2.10	<i>Determination of total and enzyme-susceptible starch</i>	79
3.3.2.11	<i>Determination of digestible amylose</i>	80
3.3.2.12	<i>Determination of carbohydrate solubility using size exclusion HPLC-Gel permeation chromatography</i>	80
3.3.2.13	<i>Enzyme treatment and light microscopy of cowpea flour dispersions</i>	80
3.3.2.14	<i>Isolation of starch from micronised (41 % moisture, 130 and 170 °C) cowpeas</i>	81
3.3.2.15	<i>Thermal analysis of cowpea flour and extracted starch</i>	82
3.3.2.16	<i>Pasting properties of cowpea flour and isolated starch</i>	82
3.3.2.17	<i>Statistical analysis</i>	83
3.3.3	Results and discussion	83
3.3.3.1	<i>Cooking characteristics of cowpeas</i>	85
3.3.3.2	<i>Effect of micronisation temperature of cowpea seeds on starch-related properties</i>	89
3.3.4	Conclusions	100
3.4	Effect of micronisation temperature (130 °C and 170 °C) on functional properties of cowpea flour	101
3.4.1	Introduction	102
3.4.2	Material and methods	103
3.4.2.1	<i>Raw materials</i>	103
3.4.2.2	<i>Hydrothermal process and cowpea flour preparation</i>	103
3.4.2.3	<i>Colour values of the cowpea flour</i>	103
3.4.2.4	<i>Determination of moisture content</i>	104
3.4.2.5	<i>Determination of crude protein</i>	104
3.4.2.6	<i>Determination of nitrogen solubility index</i>	104
3.4.2.7	<i>Determination of water solubility index (WSI), water and oil absorption capacities (WAC, OAC)</i>	104

3.4.2.8	<i>Determination of swelling index.....</i>	105
3.4.2.9	<i>Determination of cowpea flour concentration on gelation.....</i>	105
3.4.2.10	<i>Determination of gel strength.....</i>	105
3.4.2.11	<i>Determination of foaming capacity of cowpea flour.....</i>	106
3.4.2.12	<i>Extraction of a protein-rich fraction.....</i>	106
3.4.2.13	<i>Determination of protein surface hydrophobicity.....</i>	107
3.4.2.14	<i>Determination of dityrosine</i>	107
3.4.2.15	<i>Gradient SDS – PAGE of the protein rich-fraction (PRF)</i>	107
3.4.2.16	<i>Statistical analysis.....</i>	108
3.4.3	Results and discussion.....	108
3.4.4	Conclusions	117
4	GENERAL DISCUSSION.....	119
4.1	Critical review of experimental design and methodologies.....	119
4.2	Effect of micronisation on (41 % moisture and infrared heating) physicochemical and structural properties of cowpea seeds, protein and starch.....	130
4.2.1	Effect of micronisation (41 % moisture and infrared heating) on cowpea seed structure.....	130
4.2.2	Effect of micronisation (41 % moisture and infrared heating) on physicochemical properties of cowpea protein and protein-related functional properties of the resultant flour.....	134
4.2.3	Effect of micronisation (41 % moisture and infrared heating) on cowpea starch and starch-related functional properties of the resultant flour.....	138
4.3	Proposed mechanism of micronisation-induced (41 % moisture and infrared heating) changes in cooking characteristics of cowpea seeds.....	141
4.4	Potential uses of cowpea flour from moisture-conditioned and micronised cowpea seeds.....	148

5	CONCLUSIONS AND RECOMMENDATIONS.....	150
6	REFERENCES.....	153
7	LIST OF PUBLICATIONS.....	177

LIST OF TABLES

Table 2.1	Chemical composition of whole cowpea seeds (Longe, 1980).....	8
Table 2.2	Cowpea protein fraction sub unit composition and molecular properties.....	10
Table 2.3	Amino acid profile of decorticated Bechuana white cowpea flour (Abu, Muller, Duodu & Minnaar, 2005).....	12
Table 3.1.1	Source and selected physicochemical characteristics of nine cowpea varieties.....	44
Table 3.2.1	Effect of variety and micronisation (41 % moisture, 153 °C) on physicochemical properties of cowpea seeds.....	59
Table 3.2.2	Effect of variety and micronisation (41 % moisture, 153 °C) on cooking characteristics of cowpeas after 60 min of cooking.....	64
Table 3.3.1	Effect of micronisation temperature (130, 153 and 170 °C) on some physicochemical characteristics of (Moisture-conditioned 41 %) cowpeas.....	84
Table 3.3.2	Effect of micronisation temperature on thermal properties of cowpea flour and isolated starch.....	90
Table 3.4.1	Effect of high (170 °C) and low (130 °C) final micronisation temperature for cowpea seeds (41 % moisture) on physicochemical properties of cowpea flour.....	109
Table 3.4.2	Effect of high (170 °C) and low (130 °C) final micronisation temperature for cowpea seeds (41 % moisture) on functional properties of cowpea flour.....	112
Table 4.1	Summary of changes in physicochemical properties of cowpea seeds, flour and protein fraction following micronisation to different temperatures in relation to unmicronised samples	133

Table 4.2	Summary of percentage change (%) in functional properties of cowpea flour from cowpea seeds micronised to 130 and 170 °C in relation to unmicronised samples	137
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LIST OF FIGURES

Figure 2.1	Morphology of the cowpea seed showing seed coat, hilum and cotyledon	5
Figure 2.2	Cross section of a dry Bechuana white cowpea (<i>Vigna unguiculata</i>) seed (Phadi, 2004).....	7
Figure 2.3	Cross section of tempered (41 % moisture) Bechuana white cowpea seed cotyledon (Phadi, 2004).....	9
Figure 2.4	A summary of crosslinking reactions that can occur during food processing (Gerrard, 2002).....	30
Figure 3.1.1	Water absorption patterns for 9 cowpea varieties during 6 h of soaking.....	45
Figure 3.1.2	Water absorption pattern for 9 varieties of cowpeas during 90 min of cooking.....	46
Figure 3.1.3	Splitting of cowpea seeds during 90 min of cooking	47
Figure 3.2.1	Flow diagram for the hydrothermal process used in micronising (41 % moisture, 153 °C) cowpea samples.....	53
Figure 3.2.2	Effect of micronisation (41 % moisture, 153 °C) on water absorption during the soaking of Var. 462 and Bechuana white cowpeas at 22 °C (vertical bars indicate standard deviations of the means, and U = Unmicronised (raw), M = Micronised (41 % moisture, 153 °C)).....	58
Figure 3.2.3	Varietal differences and micronisation (41 % moisture, 153 °C) effect on the cotyledon structure of two cowpea varieties: Cotyledon cross-section of raw Var. 462 (a); raw Bechuana white (b); micronised Var. 462 (c); micronised Bechuana white (d); Cw = Cell wall, IS = Inter cellular space, S- Starch granule.....	60
Figure 3.2.4	Effect of micronisation (41 % moisture, 153 °C) on the texture (work in Nmm) of Var. 462 and Bechuana white	

	cowpeas during 90 min of cooking (vertical bars indicate standard deviations of the means and U = Unmicronised (raw) and M = Micronised (41 % moisture, 153 °C)) 61
Figure 3.2.5	Cotyledon cross-sections of unmicronised (raw) and micronised (41 % moisture, 153 °C) cowpeas at half cooked and fully cooked stages: 30 min cooked unmicronised (a) Var. 462 and (b) Bechuana white; 15 min cooked micronised (c) Var. 462 and (d) Bechuana white; 60 min cooked micronised (e) Var. 462 and (f) Bechuana white; 30 min cooked micronised (g) Var. 462 and (h) Bechuana white; Cw = Cell wall; Cc = Cellular contents; and IS = intercellular spaces..... 62
Figure 3.2.6	Environmental scanning micrographs (ESEM) of unmicronised (raw) cowpea seed cotyledon cooked for 30 min showing the effect of enzyme digestion: (a) = no enzyme treatment, (b) = pectinase, (c) = proteinase..... 63
Figure 3.2.7	Effect of micronisation (41 % moisture, 153 °C) on water absorption during 90 min of cooking of Var. 462 and Bechuana white cowpeas (vertical bars indicate standard deviations of the means, U = Unmicronised (raw) and M = Micronised (41 % moisture, 153 °C))..... 65
Figure 3.2.8	Effect of micronisation (41 % moisture, 153 °C) on splitting of Var. 462 and Bechuana white cowpeas during 90 min of cooking (vertical bars indicate standard deviations of the means U = Unmicronised (raw); M = Micronised (41 % moisture, 153 °C)); 66
Figure 3.2.9	Cooked Bechuana white seeds (unmicronised) showing the pattern of splitting during cooking..... 66
Figure 3.2.10	Effect of micronisation (41 % moisture, 153 °C) on structure of cowpea seed coat layers: outer surface of unmicronised (a) Var. 462 and (b) Bechuana white; outer surface of

	micronised (c) Var. 462 and (d) Bechuana white; inner surface of outer integument of unmicronised (e) Var. 462 and (f) Bechuana white, inner surface of outer integument of micronised (g) Var. 462 and (h) Bechuana white; outer surface of inner integument of unmicronised (i) Var. 462 and (j) Bechuana white; outer surface of the inner integument of micronised (k) Var. 462 and (l) Bechuana white.....	68
Figure 3.2.11	Formation of a cavity in the cotyledon of micronised (41 % moisture, 153 °C) cowpea seed.....	70
Figure 3.2.12	Cotyledon cross section of Bechuana white cowpea showing separation of parenchyma cells following micronisation; (a) unmicronised, (b) moisture-conditioned and (c) micronised (41 % moisture, 153 °C)	72
Figure 3.2.13	Varietal differences and micronisation (41 % moisture, 153 °C) effect on the cotyledon structure of two cowpea varieties: cotyledon cross section of micronised (41 % moisture, 153 °C) and soaked Var. 462 (a) and Bechuana white (b).....	73
Figure 3.3.1	Experimental flow diagram.....	78
Figure 3.3.2	Effect of micronisation temperature (130 °C, 153 °C and 170 °C) on water absorption during 6 h of soaking (22 °C) Bechuana white cowpeas (vertical bars indicate standard deviations of the means, U = Unmicronised (raw) and M = Micronised (41 % moisture, 130, 153 and 170 °C)).....	85
Figure 3.3.3	Effect of micronisation temperature (130 °C, 153 °C and 170 °C) on texture (Work, N mm) during 90 min of cooking Bechuana white cowpeas (vertical bars indicate standard deviations of the means, U = Unmicronised (raw) and M = Micronised (41 % moisture, 130, 153 and 170 °C)).....	86
Figure 3.3.4	Effect of micronisation temperature (130 °C, 153 °C and	

	170 °C) on water absorption during 90 min of cooking Bechuana white cowpeas (vertical bars indicate standard deviations of the means, U = Unmicronised (raw) and M = Micronised (41 % moisture, 130, 153 and 170 °C)).....	87
Figure 3.3.5	Effect of micronisation temperature (130 °C, 153 °C and 170 °C) on splitting (%) during 90 min of cooking Bechuana white cowpeas (vertical bars indicate standard deviations of the means, U = Unmicronised (raw) and M = Micronised (41 % moisture, 130, 153 and 170 °C)).....	88
Figure 3.3.6	Effect of micronisation temperatures on cowpea flour from micronised (41 % moisture, 130 °C and 170°C) seeds during sequential enzyme digestion (stained with acid Fuchsin): 1 = No enzyme treatment, 2 = α -amylase, 3 = α -amylase - protease, and 4 = α -amylase-protease- α -amylase; a = unmicronised, b = M-130 °C and c = M-170 °C, Bar ~50 nm..	92
Figure 3.3.7	Effect of micronisation temperature on pasting properties of cowpea flour from micronised (41 % moisture, 130 °C and 170°C) seeds; Unmicronised = Raw and M = Micronised (41 % moisture, 130, and 170 °C).....	93
Figure 3.3.8	Effect of micronisation temperature of 170 °C on solubility of amylopectin, amylose, oligosaccharides and sugars from micronised (41 % moisture 170 °C) seeds, (vertical bars indicate standard deviations of the means M - 170 °C = Micronised (41 % moisture 170 °C)).....	96
Figure 3.3.9	Effect of micronisation temperature (130 °C and 170 °C) on pasting properties of cowpea starch isolated from micronised seeds, (Unmicronised= Raw, M= Micronised (41 % moisture, 130 and 170 °C)).....	97
Figure 3.3.10	Effect of micronisation temperatures (130 °C, 153 °C and 170 °C) on cowpea flour from micronised (41 % moisture, infrared heating) seeds stained for damaged starch with	

	Congo red: a = M-130 °C, b = M-153 °C and c = M-170 °C, Bar ~ 50 nm.....	98
Figure 3.3.11	Effect of micronisation temperatures on cowpea flour from micronised (41 % moisture, 130 °C and 170°C) seeds during sequential enzyme digestion (stained with acid Fuchsin): 1 = No enzyme treatment, 2 = α -amylase, 3 = α -amylase - protease, and 4 = α -amylase-protease- pectin; a = unmicronised, b = M-130 °C and c = M-170 °C, Bar ~50 nm...	99
Figure 3.4.1	Effect of high (170 °C) and low (130 °C) final micronisation temperature for cowpea seeds (41 % moisture) on recovery of protein rich fraction (PRF) from cowpea seeds and its protein content (purity) (Yield has been expressed as percentage of crude protein content of the cowpeas).....	110
Figure 3.4.2	SDS-gradient gel electrophoresis profiles of cowpea protein extracts from unmicronised (raw) and micronised (41 % moisture, 130 and 170 °C) seeds under non reducing (a) and reducing conditions (b); lane 1 = molecular markers; lane 2 = unmicronised; lane 3 = micronised to 130 °C and lane 4 = micronised to 170 °C; changes in protein band profile are denoted with (i) to (vi).....	116
Figure 4.1	Proposed mechanisms of the effect of micronisation (41 % moisture, 130, 153 and 170 °C) on cowpea seed structure and the physicochemical properties as related to cooking characteristics of cowpea seeds	131
Figure 4.2	Postulated effect of cowpea seed micronisation (41 % moisture, 130 and 170 °C) on physicochemical properties of starch and protein and functional properties of flour milled from the micronised (41 % moisture, 130 and 170 °C) seeds; NSI = Nitrogen solubility index, WAC = Water absorption capacity.....	132

Figure 4.3	Diagram showing the suggested changes in cowpea structure at the microscopical level that lead to softening of texture during cooking of unmicronised (raw) cowpeas (Based on the mechanism proposed by Liu <i>et al.</i>, 1992; Liu <i>et al.</i>, 1993a; and Liu <i>et al.</i>, 1993b).....	142
Figure 4.4	Diagram showing the suggested changes in cowpea structure that lead to softening of texture during cooking of micronised (41 % moisture, 130, 153 and 170 °C) cowpeas.....	143