

Copyright is owned by the Author of the thesis. Permission is given for a copy to be downloaded by an individual for the purpose of research and private study only. The thesis may not be reproduced elsewhere without the permission of the Author.

**Resolving problems affecting the processing of dried marrowfat
peas for fried foods:**

Hard-seededness and cooking temperature and time

A thesis

submitted in partial fulfilment of the requirements

for the degree of

Masters of Food Technology

Massey University

Palmerston North, New Zealand

Froilan T. Ayaquil

September 2017

ABSTRACT

The Midland Seed Ltd, a top agricultural seed producer in New Zealand, wishes to increase their level of technical knowledge regarding the processing of peas to assist with solving production problems. In this study, analyses were conducted to resolve if hard-seeded peas or the frying parameters caused the textural irregularities in fried marrowfat peas. Marrowfat peas (*pisum sativum* cv. Midichi and Midlea) from 16 different harvest locations and years (2014 to 2017) were subjected to tests such as hydration capacity, and sizing of peas were examined to ascertain how much hard-seeded peas were surfacing in a line batch and in different sizes (<6.7mm, 6.7-7.1 mm, 7.1 – 8.0 mm, and > 8.0mm) upon soaking (in different soaking times 12, 18 and 24 hours) and frying at 160°C for 12 minutes. Furthermore, frying conditions including, oil temperature, pea to oil ratio, were explored at a laboratory scale to obtain the most suitable frying parameters capable of producing fried marrowfat peas with consistent and highly acceptable organoleptic properties. It can be concluded from this study that the very low frequency of hard seeds found in marrowfat peas was not the cause of texture inconsistency generally. However, it was shown that cooling the oil to below 130°C, when peas were added to the oil, slowed temperature recovery of the oil and significantly increased pea hardness to unacceptable levels. Marrowfat peas fried at 160°C for 12 minutes, with a pea to oil ratio of between 1/20 and 1/40 resulted in peas consistently fried to a highly acceptable quality.

ACKNOWLEDGEMENTS

First of all, I would like to thank our Lord Jesus Christ for giving me an opportunity to do this research project and Master's programme.

I would also like to thank the New Zealand Ministry of Foreign Affairs and Trade and New Zealand Aid Development program for offering the opportunity and scholarship support to the whole Master's program.

Massey University International Student Support Office Sylvia, Dave, Jamie, Logan, Dianne, Tina, and Saba; they are our second family here in New Zealand, and have never stopped caring for us.

Midland Seeds Ltd, Brett Colgan and Krystyna Krivanek, for the research opportunity, trust, and support.

Allan Hardacre, for his constant guidance, support, great advice in academic and personal life, and his limitless patience especially in checking my writing.

I would also like to thank:

Steve Glasgow, Warwick Johnson, Michelle Tamehana, Peter Jefferies, Sue Nicholson, Byron McKillop, Gary Radford, Chris Hall, Michael Parker for their technical assistance and support in my study.

Ericka Ramirez and Edgar Santos for helping me in analysing my data and statistics.

Ruth Mortimer for proofreading and guiding me.

Sunny George Gwanpua, for his help and his mini-lecture to enable me to understand the topic easily.

My colleagues, Grace Ng, JieHong, TeckAnn, Zitong, Maheeka, Jessie, Peter, Zhenghao, Echo for sharing each other's lives in dealing with the struggles and challenges of postgraduate studies.

My friends Dominic Lomiwes, Spencer Secretario, Marc Icaro, Tracy Decena, Fem Socorro, Marvin Novio, Kaye Nono, Francis and Joanna Vattiprolu, and Vision Church for the unending support encouragement and great memories.

Our family, friends and relatives, Dr. Rosario Sagum , Tito Ansel and Tita Nenita Leonardo and family, Tito Ron and Babe Icaro and family, and Ayaquil, Tec and Cuico family.

And especially to my wife and life partner, Michelle Cuico, her never ending patience, support and love the keeps me going and reaching for success.

TABLE OF CONTENTS

ABSTRACT.....	iii
ACKNOWLEDGEMENTS	iv
TABLE OF CONTENTS.....	v
LIST OF FIGURES	v
LIST OF TABLES.....	ix
CHAPTER 1: INTRODUCTION.....	1
Objectives	3
General Objective.....	3
Specific Objectives	3
CHAPTER 2: LITERATURE REVIEW.....	4
2.1 LEGUMES AND PULSES	4
2.1.1 Structure of legume seed	5
2.1.2 Composition of legumes.....	6
2.1.3 Nutritional benefits of legume consumption	8
2.2.4 Quality standards and evaluation of pulses	10
2.2.5 The hard seed phenomenon in legumes	12
2.2 PEAS.....	18
2.2.1 Garden and field peas.....	18
2.2.2 Growth and development	19
2.2.3 Adaptation.....	20
2.2.4 Pea seed structure and function.....	21
2.2.5 Pea size grading	23
2.2.6 Current use and possible opportunities for peas	23
2.2.7 Marrowfat peas	23
2.3 SOAKING AND COOKING	25
2.4 FRYING.....	25
2.4.1 Effects of frying	26

CHAPTER 3: MATERIALS AND METHODOLOGY	28
3.1 MATERIALS	28
3.2 GENERAL METHODOLOGY	30
3.2.1 PHYSICAL TEST METHODS.....	30
3.2.2 MOISTURE CONTENT	30
3.2.3 TEXTURE	30
3.2.4 DATA ANALYSIS	31
CHAPTER 4: HYDRATION AND HARD-SEEDED PEAS	32
4.1 INTRODUCTION	32
4.2 MATERIALS AND METHODOLOGY.....	32
4.2.1 Sizing of peas	32
4.2.2 Hydration capacity.....	32
4.3 RESULTS AND DISCUSSION	34
4.4 CONCLUSION.....	38
CHAPTER 5: FRYING OF PEAS	39
5.1 INTRODUCTION	39
5.2 MATERIALS AND METHODOLOGY.....	39
5.2.1 Analysis of benchmark samples	39
5.2.2 Effect of frying temperature and time.....	39
5.2.3 Frying peas at different frying loads.....	40
5.2.4 Frying of different batches (line number) of marrowfat peas	41
5.2.5 Frying of peas soaked in different salt solutions	41
5.3 RESULTS AND DISCUSSION	42
5.3.1 Analysis of benchmark samples	42
5.3.2 Effect of frying temperature and time.....	43
5.3.3 Frying peas at different frying loads.....	47
5.3.4 Soaking solutions	50
5.4 CONCLUSION.....	51
CHAPTER 6: STARCH AND PROTEIN	52

6.1 INTRODUCTION	52
6.2 MATERIALS AND METHODS	52
6.2.1 Protein Content	52
6.2.2 Starch Isolation	53
6.2.3 Pasting Properties of Pea Starch	54
6.3 RESULTS AND DISCUSSION	54
6.4 CONCLUSION.....	56
CHAPTER 7: OVERALL CONCLUSION.....	57
CHAPTER 8: RECOMMENDATIONS	58
REFERENCES	59
APPENDIX A	64
APPENDIX B	67

LIST OF FIGURES

Figure 1 Seed Structure of (a) French Bean and (b) Pea	5
Figure 2 Hydration rate of marrowfat peas stabbed, split and normal peas	14
Figure 3 Percent moisture uptake of whole and dehulled HTC pinto beans	15
Figure 4 Percentage moisture uptake (dry basis) of ETC (Rose Coco) and HTC (Pinto) beans	16
Figure 5 Effect of soaking on (A) ETC and (B) HTC beans	17
Figure 6 Hydration rates of faba beans soaked at different pH levels	17
Figure 7. The pea seed	21
Figure 8 Seed coat layers of Wild Pea (<i>Pisum elatius</i>)	22
Figure 9 Dried marrowfat peas	29
Figure 10 Texture Analyzer - 25 mm flat cylinder attachment	31
Figure 11 Soaking marrowfat peas in water	33
Figure 12 Size distribution of marrowfat peas	34
Figure 13 Hydrated marrowfat peas (MF1644)	35
Figure 14 Frying oil temperature log for different frying loads	49

LIST OF TABLES

Table 1 Nutrient composition of pulses, wheat and maize (in %, dry basis)	6
Table 2 Thermal properties of starch from different pulses and corn	8
Table 3 Micronutrient composition of pulses, wheat and maize (in %, dry basis)	9
Table 4 Quality parameters commercial quality pulses	10
Table 5 Quality parameters identified by IPQC	11
Table 6 Type of peas, seed characteristics and colour of cultivar	19
Table 7 2014 – 2017 Marrowfat peas line number and location	28
Table 8 Sample of marrowfat peas from different dressing processes	29
Table 9 Hard-seeded peas and water absorbed of different marrowfat peas' sizes	34
Table 10 Hard-seeded peas at different soaking times of 2016 marrowfat pea lines	35
Table 11 Percentage of hard-seeded peas from different harvesting locations	36
Table 12 Water absorbed of marrowfat peas (2017) in different soaking times	37
Table 13 Water absorbed of marrowfat peas from the seven dressing processes	37
Table 14 Moisture content, volume and break force of different benchmark samples	42
Table 15 Moisture content, volume and break force of fried peas (MF1638A) 160°C	43
Table 16 Comparison of moisture, volume and break force of benchmark samples and laboratory fried peas	44
Table 17 Moisture content and texture of marrowfat peas fried at different temperatures and time	45
Table 18 Fried peas yield and quality defects after frying	46
Table 19 Different pea batches fried at 160°C for 12 minutes	47
Table 20 Peas fried at different frying loads	48
Table 21 Correlation between physicochemical properties of dried and fried marrowfat peas	50
Table 22 Moisture content and texture of fried (160°C, 12 min) marrowfat peas with treatment in soaking solutions	51
Table 23 Protein of normal peas and hard-seeded peas	54
Table 24 Pasting properties of marrowfat peas starch	55