

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.

**SEED EXTRACTION METHODS AND QUALITY EFFECTS**

**IN *PINUS RADIATA* D. DON**

A thesis submitted in partial  
fulfilment of the requirements for the degree of  
Master of Applied Science in Seed Technology  
at Massey university, Palmerston North,  
New Zealand

**DZINGAI RUKUNI**

**1997**

MASSEY UNIVERSITY

1. (a) I give permission for my thesis, entitled:

*"Seed Extraction Methods and Quality Effects in Pinus Radiata D. Don"*

to be made available to readers in the Library under the conditions determined by the Librarian.

- (b) I agree to my thesis, if asked for by another institution, being sent away on temporary loan under conditions determined by the Librarian.
- (c) I also agree that my thesis may be copied for Library use.

2. I do not wish my thesis, entitled

*"Seed Extraction Methods and Quality Effects in Pinus Radiata D. Don"*

to be made available to readers or to be sent to other institutions without my written consent within the next two years.

Signed:



Date:

11<sup>th</sup> JULY 1997

Strike out the sentence or phrase which does not apply.

The Library  
Massey University  
Palmerston North, NZ

The copyright of this thesis belongs to the author. Readers must sign their name in the space below to show that they recognise this. They are asked to add their permanent address.

Name and Address

Date

Dzingai Rukuni

11 July 1997

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

**Dedicated to my daughter Nyasha Tanyaradzwa Rukuni**

## ABSTRACT

The current study aims to investigate the effectiveness of various heated air and microwave oven treatments on seed extraction efficiency and subsequent seed quality in *Pinus radiata*. Radiata pine cones were collected from Foxton from a commercial plantation and used in preliminary studies considering a range of both heated air and microwave oven treatments. Cones of different genetic families were collected from an open pollinated seed orchard owned by Carter Holt Harvey Forests at Matakana Island.

In the air oven extraction method temperature and duration combinations of 50°C and 24 hours or 60°C and 12 hours were found to be most suitable for seed extraction while giving good seed quality in preliminary experiments. A temperature of 40°C was found to be too low for efficient seed extraction while 70°C was found to be lethal to seeds. Various temperature and duration combinations gave similar results since a decrease in extraction temperature could, in some cases, be compensated by an increase in the extraction period.

Exposure of cones in a microwave oven affected germination, particularly when only 1 or 2 cones were heated at each exposure time. However when 3-5 cone samples were used heating for 30 or 40 seconds was sufficient to break scale resin bonding. Ambient storage of treated cones for up to 7 days following microwave oven treatment allowed full scale reflexing and high seed extraction efficiency.

Cones from 10 different families showed variable germination responses to different seed extraction conditions. Two families showed consistently high germination across all treatments while the rest showed reduced germination. Whether this reflects genetic differences in cone serotiny, seed thermosensitivity differences, cone wood density, resin bond strength, or is related to seed size and/or moisture content is not known. Seedling dry weight was not affected by extraction temperature and/or duration of heating, being found to be more a function of seed size.

## ACKNOWLEDGEMENTS

I would like to extend my sincere appreciation and thanks to my supervisors, Professor M.J. Hill and Associate Professor J.G. Hampton of the Seed Technology Centre for making this study a success. Many thanks to all staff at the Seed Technology Centre for all the help that I needed most.

I would also like to thank many friends and family members for the support during these studies, especially my mother and father Samuel, Crispen, Joyline, Knowledge, Misiyadzo, Ishewakatipa, Jealous and Pamhidzai. My memories go to my only sister Tadziripa Annastancia who passed away during the course of my studies.

I am particularly grateful to the New Zealand Government for providing the financial support.

## TABLE OF CONTENTS

	<del>page</del>
ABSTRACT .....	i
ACKNOWLEDGEMENTS .....	ii
TABLE OF CONTENTS .....	iii
LIST OF TABLES .....	vii
LIST OF FIGURES .....	ix
LIST OF PLATES .....	x
LIST OF APPENDICES .....	xi
 CHAPTER 1 .....	 1
1. INTRODUCTION .....	1
 CHAPTER 2 .....	 4
2. LITERATURE REVIEW .....	4
2.1 General .....	4
2.2 Cone structure and serotiny .....	7
2.3 Cone ripeness and seed maturity .....	9
2.4 Seed extraction methods .....	13
2.5 Variation in cone serotiny .....	17
2.6 Seed storability .....	21
2.7 Seed extraction by microwave oven heating .....	22
2.7.1 The nature of microwaves .....	22
2.7.2 The use of microwave heating in agriculture .....	23
2.7.3 The use of microwave heating in research and industry ...	25
2.7.4 Factors influencing microwave heating .....	26
2.7.5 Adverse effects of microwave heating .....	27

CHAPTER 3 .....	29
3. MATERIALS AND METHODS .....	29
3.1 Seed extraction by conventional electrical heating ovens .....	29
3.1.1 Preliminary studies .....	29
3.1.2 Extraction studies from cones of different families .....	30
3.1.3 Quality tests .....	30
3.2 Extraction using a microwave oven .....	31
3.2.1 Preliminary Studies .....	31
3.2.2 Final studies .....	31
3.2.3 Extraction studies from cones of different families .....	32
3.2.4 Quality tests .....	32
3.2.5 Cone heating studies .....	33
3.3 Seed quality assessment .....	33
3.3.1 Moisture content and seedling dry weight .....	33
3.3.2 Seed germination .....	33
3.3.3 Germination progress and seedling dry weight .....	35
4. RESULTS .....	37
4.1 PRELIMINARY STUDIES. ....	37
4.1.1 Heated air oven extraction .....	37
4.1.1.1 General .....	37
4.1.1.2 Seed extraction efficiency immediately after heating .....	38
4.1.1.3 Seed extraction efficiency after a 7 day delay .....	40
4.1.1.4 Effects of extraction treatments on seed quality of seed extracted immediately after heating. ....	43
4.1.1.5 Effects of extraction treatments on seed quality after a 7 day delay .....	43
4.1.1.6 Effects of extraction treatments on seed value for seed extracted immediately after heating .....	46
4.1.1.7 Effects of extraction treatments on seed value after a 7 day delay .....	46



4.1.1.8 Effects of extraction treatments on seedling dry weight for seed extracted immediately after heating . . . . .	48
4.1.1.9 Effects of extraction treatments on seedling dry weight after a 7 day delay . . . . .	48
4.1.1.10 Second conventional oven extraction experiment . . . . .	51
4.1.1.11 Seed and cone moisture studies . . . . .	52
Seed moisture content . . . . .	52
Cone Moisture content . . . . .	53
4.1.2 Preliminary microwave oven seed extraction studies . . . . .	54
4.1.2.2 Extraction using various cone numbers in the microwave oven. . .	54
4.1.2.2.1 Germination percentage and seedling dry weight . . . . .	55
4.1.2.2.2 Seed extraction percentage and seed value . . . . .	56
4.1.2.3 Extraction using single cones . . . . .	57
4.1.2.3.1 Seed extraction . . . . .	57
4.1.2.3.2 Seed germination percentage . . . . .	57
4.1.2.3.3 Seed value and seedling dry weight . . . . .	57
4.1.2.4 Extraction using 5 cone samples. . . . .	58
4.1.2.5 Microwave oven studies on cone heat gain. . . . .	59
 4.2 FINAL STUDIES . . . . .	 64
4.2.1 Conventional heated air ovens . . . . .	64
4.2.1.1 Effects on germination . . . . .	64
4.2.1.2 Effects on seedling dry weight . . . . .	65
4.2.2 Microwave oven . . . . .	66
4.2.2.1 Effects on germination . . . . .	66
4.2.2.2 Effects on seedling dry weight . . . . .	67
4.2.3 Conventional and microwave oven treatment comparisons. . . . .	67
4.2.3.1. Effects on germination. . . . .	67
4.2.3.2 Effects on seed and seedling weight . . . . .	68
4.2.4 Thousand-seed weight (TSW) comparisons by family . . . . .	69

CHAPTER 5 .....	70
5. DISCUSSION .....	70
5.1 General .....	70
5.2 Conventional oven .....	71
5.3 Microwave oven .....	73
 CHAPTER 7 .....	 75
7. CONCLUSIONS .....	75
Scope for further research .....	75
 REFERENCES .....	 77
APPENDICES .....	88

## LIST OF TABLES

	Page
<b>Table 1.</b> Effect of extraction temperature and duration of heating for wet and dry cones on mean extraction percentage for seed extraction immediately after heating or after extraction following seven days post-heating storage .....	42
<b>Table 2.</b> Effect of extraction temperature and duration of heating of wet or dry cones on mean germination for both extraction immediately after heating or after extraction following seven days post-heating storage .....	45
<b>Table 3.</b> Effect of extraction temperature and duration of heating of wet and dry cones on mean seed value for both seed extraction immediately after heating or after extraction following 7 days post-heating storage .....	47
<b>Table 4.</b> Effect of extraction temperature and duration of heating of wet and dry cones on mean seedling dry weight following extraction immediately after heating or after a seven day delay .....	50
<b>Table 5.</b> Results of the second oven extraction trial showing the extraction percentage, germination percentage, seed value and seedling dry weight ..	52
<b>Table 6.</b> Seed moisture content variation with extraction temperature and duration .....	53
<b>Table 7.</b> Effects of cone number on extraction percentage and seed quality following microwave heating at two different durations (seconds) .....	55

<b>Table 8.</b> Effects of microwave oven seed extraction duration (seconds) on mean seed extraction percentage after 2 days, 4 days, 7 days and the cumulative mean total, and effects on mean seed value . . . . .	56
<b>Table 9.</b> Effects of microwave oven extraction on seed extraction percentage, germination performance, seed value and seedling dry weight using single cones in the microwave oven . . . . .	58
<b>Table 10.</b> Effects of microwave oven seed extraction on extraction percentage, germination percentage, seed value and seedling dry weight when 5 cones were used . . . . .	58
<b>Table 11.</b> Comparison of germination percentage performance for the conventional and microwave oven treatments and the control . . . . .	65
<b>Table 12.</b> Comparison of overall seedling dry weight (grams) performance for the conventional and microwave oven treatments and the control . . . . .	66
<b>Table 13.</b> Mean thousand seed weight (grams) shown by family . . . . .	69

## LIST OF FIGURES

Page

**Figure 1.** Cooling curves of 5 cones of various weights following  
removal from a microwave oven after heating for 2 minutes ..... 61

**Figure 2.** The mean cooling rates of various cones exposed to different  
durations in the microwave ..... 63

## LIST OF PLATES

	Page
<b>Plate 1.</b> Seedlings of <i>Pinus radiata</i> after a germination test period of 28 days . . . .	36
<b>Plate 2.</b> <i>Pinus radiata</i> cones after various degrees of heating . . . . .	39

## LIST OF APPENDICES

	Page
<b>Appendix 1.</b> Means for different durations (seconds) of microwave oven heating for the weight of seed extracted, percentage seed extracted, germination performance and seed value for the initial treatment screening. . . . .	88