

TABLE OF CONTENTS

TITLE PAGE	i
ENDORSEMENT LETTER	ii
AUTHOR’S DECLARATION OF ORIGINALITY	iii
ACKNOWLEDGEMENTS	iv
TABLE OF CONTENTS	vii
LIST OF TABLES	ix
LIST OF FIGURES	x
LIST OF APPENDIXES	xi
ABSTRACT	xii
INTISARI	xiii
CHAPTER I INTRODUCTION	1
1.1 Background	1
1.2 Problem Statement	6
1.3 Limitations of the Study	7
1.4 Objective	8
1.5 Benefits of Study	8
1.6 Outputs of the Study	8
CHAPTER II LITERATURE REVIEW	9
2.1 Tomato Plants	9
2.2 Greenhouse Management System	12
2.3 Water Stress Treatment	14
2.4 Carotenoids	15
2.5 Lycopene	16
2.6 Storage Effects to Lycopene Content in Tomato Fruit	19
2.7 Spectroscopy	20
2.8 Multivariate Analysis	22
CHAPTER III MATERIALS AND METHOD	27
3.1 Materials	27
3.1.1 Samples	27

3.1.2 Reagents	28
3.2 Equipment	28
3.2.1 Water Stress Tomato	28
3.2.1 Storage Experiment	28
3.2.1 Non-destructive Measurements	28
3.2.2 Vis/NIR Analysis	29
3.3 Location	30
3.4 Methods	30
3.5 Research Flowchart	37
CHAPTER IV RESULTS AND DISCUSSION	38
4.1 Tomato Plants	38
4.2 Water Stress Measurement	41
4.3 Tomato Fruit Qualities	49
4.4 Tomato Fruit Qualities After Storage	51
4.5 Spectra Acquisition	56
4.6 Statistical Analysis	60
CHAPTER V CONCLUSION AND FUTURE WORKS	68
5.1 Conclusion	68
5.2 Suggestions and Future Works	68
SUBMITTED PAPER	70
REFERENCES	72
APPENDIXES	80

LIST OF TABLES

Table 2.1. The Contribution of Carotenoid Species in Tomato Fruits.....	17
Table 2.2. Physical Properties of Lycopene.....	18
Table 4.1. Water Stress and Control Treatment in Tomato Plants.....	46
Table 4.2. Tomato Fruit Quality for Water Stress and Control	50
Table 4.3. Tomato Appearance Before and After Storage.....	53
Table 4.4. Tomato Fruit Quality After Storage.....	54
Table 4.5. Multiple Linear Regression for Lycopene Estimation.....	62
Table 4.6. Summary of Statistical Analysis	66

LIST OF FIGURES

Figure 2.1. Molecular Structure of Lycopene	18
Figure 2.2. The Electromagnetic Spectrum.....	20
Figure 2.3. Transmission and Colour	21
Figure 2.4. Absorbance and Complementary Colours	22
Figure 3.1. Analytical Diagram Using Visible/Near-infrared Spectroscopy	33
Figure 3.2. Research Flowchart	37
Figure 4.1. High Technology Greenhouse in Ehime University (a) and Inside High Technology Greenhouse in Ehime University (b)	39
Figure 4.2. Panel Box to Control the Environment Inside Greenhouse.....	39
Figure 4.3. Nutrient Supplying Tanks.....	40
Figure 4.4. Water Content Measurement in The Rockwool Slab using Water Content Meter (a) Result for Control, (b) Result for Water Stress, (c) Plunge/sensor	42
Figure 4.5. Automatically Controlled Nutrient Supplying System.....	43
Figure 4.6. Original Image When the Projected Area Ratio (a) 100% (b) 85% and Binarized Image When Projected Area Ratio (c) 100% and (d) 85%.....	45
(Shikoku Research Institute INC. database)	45
Figure 4.8. Incubators Used for Storing the Tomato Fruits (a) Thermo Recorder Used as Data Logger (b)	52
Figure 4.9. Spectra Measurement Top Part (a), and Side Part (b) of Tomato	57
Figure 4.10. Fruit Selector Spectroscopy Scheme	57
Figure 4.11. Original Spectra (a) and Second Derivative Spectra (b) for Top and Side Tomato	60
Figure 4.12. Tomato Spectra Obtained From Preliminary Experiments	61
Figure 4.13. Tomato Original and Second Derivative Spectra Obtained From Preliminary Experiments.....	62
Figure 4.14. Estimated and Observed Lycopene Content for Top and Side Part of Tomato Using MLR (a) and (b), PCR (c) and (d), PLS (e) and (f).....	65

LIST OF APPENDIXES

Appendix 1. Nutrient Solution Dose for Tomato Plants Grown Under Water Stress Treatment	80
Appendix 2. Measurement Methods	84
Appendix 3. Spectra Analysis Using The Unscrambler Method	93