



UNIVERSITI PUTRA MALAYSIA

**NUTRIENT RETENTIVITY AND THERMAL PROCESS CAPABILITY OF
OHMIC-HEATED PASTEURIZER COMPARED TO CONTACTHEATED
PASTEURIZER**

NURUL FAEZAWATY JAMALUDIN

FK 2008 52



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**MASTER OF SCIENCE
UNIVERSITI PUTRA MALAYSIA**

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By

NURUL FAEZAWATY JAMALUDIN

**Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in
Fulfilment of the Requirements for the Degree of Master of Science**

May 2008

Dearest Mak, Abah, Akak, Nuar, Lea; Adik love you all.....
My lovely husband; thank you for your love, sacrifices and encouragements... ..
Friends; without you all, who am I.....
Lecturers; thank you for the encouragements and support.....

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Master of Science

**NUTRIENT RETENTIVITY AND THERMAL PROCESS CAPABILITY OF
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NURUL FAEZAWATY JAMALUDIN

May 2008

Chairman: Hishamuddin Jamaludin

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Pasteurization of liquid foods using conventional heating is inefficient. The inefficiency as for example the excessive usage of energy, non-uniform and localized heating that contribute to nutrient losses and food poisoning. This study tries to overcome the stated problems by introducing a simple and unique design of an ohmic heating system. The unit consist of the ohmic heating cell and the fluid handling system, and the ohmic heater control panel. The performance of the ohmic heating unit was compared with a plate heat exchanger and evaluated based on three major parameters namely nutrient retentivity; determined by using High Performance Liquid Chromatography (HPLC), destruction of bacteria; based on the plate count method and iron content determination using Atomic Absorption Spectrophotometer (AAS).

From this study it was found that the ascorbic acid (vitamin C) in pineapple juice drink degrades by 26.67% in conventional heating and 1.27% in ohmic heating, whereas in

pink guava juice it degrades up to 75% and 44% respectively. The time to heat the product to pasteurization temperature is one of the factors in contributing nutrient degradation. In conventional heating especially with heat regeneration, the product heating time is almost 28 minutes compared to 15 seconds in ohmic heating. The destruction of bacteria for both methods gave the same results, which is <10 cfu/ml. The iron content in samples increased significantly in conventional heating up to 70% as compared to ohmic heating 31%. Iron increment in conventional heating method may be due to corrosion on the of process stream whereas in ohmic heating method, the increment is due to electrolytic effect of the electrodes.

The performance of the ohmic heated pasteurizer system developed is able to control temperature and meet the pasteurization parameters as set, electrically safe to operate, hygienic in design and lower in cost.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Master Sains

**PENYIMPANAN NUTRIEN DAN KEBOLEHAN PROSES PEMANASAN
PEMPASTEUR PEMANAS OHMIK BERBANDING PEMPASTEUR PEMANAS
SENTUHAN**

Oleh

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Pempasteuran makanan cecair menggunakan kaedah konvensional adalah kurang efisien. Sebagai contoh ianya kurang efisien adalah seperti pembaziran penggunaan tenaga, pemanasan setempat dan tidak sekata yang boleh mengakibatkan kehilangan nutrisi dan keracunan makanan. Kajian ini adalah untuk mencuba menangani masalah yang ditimbulkan dari penggunaan kaedah pempasteuran konvensional dengan memperkenalkan sistem pemanasan ohmik yang lebih ringkas dan mudah untuk digunakan. Ianya terdiri daripada dua komponen utama iaitu kerangka kawalan bendalir beserta sel pemanas ohmik dan panel kawalan. Keupayaan dan keberkesanan pemanas ohmik ini telah dibandingkan dengan penukar haba kepingan (*plate heat exchanger*) dan dinilai berpandukan tiga faktor utama iaitu pengekalan nutrien di dalam produk, menggunakan *High Performance Liquid Chromatography* (HPLC), pembasmian bakteria berpandukan kaedah kiraan kepingan (*plate count method*) dan kandungan Ferum menggunakan *Atomic Absorption Spectrophotometer* (AAS).

Daripada kajian ini, didapati bahawa asid askorbik (vitamin C) di dalam minuman jus nenas menyusut sebanyak 26.67% yang dipasteur menggunakan kaedah pemanasan konvensional dan 1.27% menggunakan pemanasan ohmik, manakala ianya menyusut sehingga 75% dan 44% masing-masing di dalam jus jambu batu merah. Salah satu faktor yang menyumbangkan kepada kehilangan nutrien ialah masa yang diperlukan untuk memanaskan bahan kepada suhu pempasteuran. Dengan kaedah pemanasan konvensional, terutamanya melibatkan haba yang dijana semula, produk dipanaskan sehingga hampir 28 minit berbanding dengan 15 saat menggunakan pemanas ohmik. Pembasmian bakteria bagi kedua-dua kaedah menghasilkan keputusan yang sama di mana kandungan bakteria di dalam sampel adalah $<10\text{cfu/ml}$. Kandungan Ferum di dalam sampel meningkat dengan ketara menggunakan pemanasan konvensional sehingga 70% berbanding pemanasan ohmik 31%. Peningkatan kandungan Ferum di dalam kaedah pemanasan konvensional yang ketara ini adalah berkemungkinan disebabkan oleh penghakisan di dalam proses saluran, manakala dengan pemanasan ohmik berlakunya kesan elektrolitik pada elektrod yang digunakan.

Keupayaan sistem pempaspasteur pemanasan ohmik yang dibangunkan ini berupaya mengawal suhu dan memenuhi piawaian pempasteuran yang telah ditetapkan. Ianya selamat untuk dikendalikan, rekabentuk yang bersih dan modal permulaan yang agak rendah.

ACKNOWLEDGEMENTS

بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

In the name of Allah The Most Gracious and The Most Merciful

Alhamdulillah, God be Praised that our project and report with the title “Nutrient Retentivity and Thermal Process Capability of Ohmic Heated Pasteurizer Versus Contact Heated Pasteurizer” has been completed successfully. In order to finished this project and report, I have faced a lot of challenges in psychology and physically.

Because of this, I would like to express my heartiest appreciation and gratitude to my honourable, patient and understanding supervisor committee, *Mr. Hishamuddin Jamaludin, Dr. Chin Nyuk Ling, Prof. Dr. Coskan Ilicali and Dr. Budiartman Satiawihardja* for their constant guidance and advice as well as constructive criticism in the preparation of this project.

I would like to expand my heartiest and deepest gratitude to my charming husband (*Affendy Shamsuddin*), beloved parents (*Jamaludin Ahmad and Hamidah Ramli*) and family, truly friends (*Rashid, Asyraf, Mariam, and others*) for being so loving, patient and supportive throughout the years of my study in UPM. Without you all, I couldn't have gone this far. Thank you.

Last but not least, to my helpful colleagues, supportive laboratory assistance, Mr. Mansor, Mr. Kamaruzzaman, Mrs. Siti Hajar, Mr. Mohd Noh, Mr. Zainal Abidin, Mr.

Azman, Mr. Razali, Hidayah, Mr. Abdul Hamed, MARDI and all others directly and indirectly aiding the project. Thank you for your encouragement and support.

Thank you will not be enough to express my gratitude to all of you, for all your help and support. After all, I'd like to say *thank you very much*, couldn't reach this place without taking all the winding routes to success.

I certify that an Examination Committee met on 30 May 2008 to conduct the final examination of Nurul Faezawaty binti Jamaludin on her Master of Science thesis entitled “Nutrient Retentivity and Thermal Process Capability of Ohmic-Heated Pasteurizer Compared to Contact-Heated Pasteurizer” in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher degree) Regulations 1981. The Committee recommends that the student be awarded the Master of Science.

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DECLARATION

I declare that the thesis is my original work except for quotations and citations which have been duly acknowledge. I also declare that it has not been previously, and is not concurrently, submitted for any other degree at Universiti Putra Malaysia or at any other institution.

NURUL FAEZAWATY JAMALUDIN

Date: 18 August 2008

TABLE OF CONTENTS

		Page
	ABSTRACT	iii
	ABSTRAK	v
	ACKNOWLEDGEMENTS	vii
	APPROVAL	ix
	DECLARATION	xi
	LIST OF TABLES	xvi
	LIST OF FIGURES	xix
	LIST OF APPENDICES	xxii
	LIST OF ABBREVIATIONS	xxiii
CHAPTER		
1	INTRODUCTION	1
	1.1 General Overview	1
	1.2 Problem Statement	3
	1.3 Background of the Project	4
	1.4 Objectives of the Study	5
2	LITERATURE REVIEW	6
	2.1 Thermal Processing	6
	2.1.1 Thermal Processing System	6
	2.1.2 Thermal Processing Option	7
	2.1.3 Thermal Process Calculation	8
	2.2 Kinetics of Thermal Inactivation	8
	2.2.1 Inactivation of Micro Organisms	9
	2.2.2 Inactivation of Enzymes	10
	2.2.3 Effect of Temperature	11
	2.2.4 Thermal Destruction Data	12
	2.2.5 Quality Degradation of Ascorbic Acid	15
	2.3 Pasteurization	15
	2.3.1 Definition of Pasteurization	15
	2.3.2 Batch Pasteurization	17
	2.3.3 Continuous Pasteurization	17
	2.4 Ohmic Heating	20
	2.4.1 History of Ohmic Heating	20
	2.4.2 Theory and Principles of Ohmic Heating	20
	2.4.3 Application of Ohmic Heating	21

2.4.4	Ohmic Heating Process	21
2.4.5	Design Consideration of Ohmic Heating	22
2.4.6	Parameters Affecting Factor in Ohmic Heating	23
2.4.7	Heating Rates in Ohmic Heating	26
2.4.8	Power Temperature Relationship in Ohmic Heating	28
2.4.9	Power Generated in Ohmic Heating	29
2.4.10	Advantages of Ohmic Heating	30
2.4.11	Effects of Corrosion in Ohmic Heating	31
2.5	Conventional Heating	31
2.5.1	Continuous Heat Processing	31
2.6	Pineapple Juice	33
2.6.1	Nutritional Values of Pineapple Juice	35
2.6.2	Properties of Pineapple Juice	36
2.7	Pink Guava Juice	36
2.7.1	Nutritional Values of Pink Guava Juice	37
2.7.2	Properties of Pink Guava Juice	38
3	METHODOLOGY	39
3.1	General	39
3.2	Construction of Ohmic Heated Pasteurizer	40
3.2.1	Ohmic Heater Bench	41
3.2.2	Ohmic Heater Control Panel	48
3.3	Instruments Calibration	54
3.3.1	Temperature Sensor Calibration	55
3.3.2	Pump Calibration	56
3.4	Continuous Ohmic Heated Pasteurizer	57
3.5	Process Parameters Determination	58
3.5.1	Determination of Solution Proportionality Constant, m	58
3.5.2	Relationship of Electrical Conductivity and Flow Rate with Temperature	59
3.6	Power Model Verification of Continuous Ohmic Heated Pasteurizer	60
3.7	Plate Heat Exchanger	61

3.8	Sample Preparation	63
3.8.1	Trial Run Solution	63
3.8.2	Pineapple Juice Drink Process	64
3.8.3	Pink Guava Juice Process	64
3.9	Sample Quality Analysis	65
3.9.1	Nutrient Retainable Testing	66
3.9.2	Bacterial Destruction Testing	66
3.9.3	Iron Content Testing	67
4	RESULTS AND DISCUSSION	68
4.1	Constructed Continuous Ohmic Heated Pasteurizer	68
4.2	Instruments Calibration	72
4.2.1	Temperature Sensor Calibration	72
4.2.2	Pump Calibration	74
4.3	Process Parameters Determination and Relationship	74
4.3.1	Proportionality Constant of Solutions, m	75
4.3.2	Relationship of Electrical Conductivity and Flow Rate with Temperature	77
4.3.3	Temperature, Current and Cell Diameter Relationship	80
4.4	Time Temperature Data for Continuous Ohmic Heated Pasteurizer	82
4.5	Power Model Verification of Continuous Ohmic Heated Pasteurizer	89
4.5.1	Sensitivity Analysis of Power Model Verification	93
4.5.2	Power versus Initial Electrical Conductivity	95
4.6	Time Temperature Data for Plate Heat Exchanger	97
4.7	Quality Analysis of Sample	101
4.7.1	Nutrient Content	101
4.7.2	Bacterial Destruction	103
4.7.3	Iron Content Determination	104
4.7.4	Effect of Pasteurization Method on Quality Factor	106

4.8	Comparison of Continuous Ohmic Heated Pasteurizer with Plate Heat Exchanger	108
4.8.1	The Advantages and Disadvantages of Ohmic Heating	108
4.9	Comparison of Continuous Ohmic Heated Pasteurizer with Other Design	109
5	CONCLUSION AND RECOMMENDATIONS	112
	REFERENCES	114
	APPENDICES	119
	BIODATA OF STUDENT	166

LIST OF TABLES

Table		Page
2.1	Thermal destruction data of spoilage micro organisms (Maroulis and Saravacos,2003)	12
2.2	D-values and kinetic reaction rate constants (k) for <i>Bacillus subtilis</i> spores under conventional and ohmic heating, (Cho et al, 1999)	14
2.3	D-values and reaction rate constants for inactivation of <i>Bacillus subtilis</i> spores during single and double stage conventional and ohmic heating at 90°C, (Cho et al, 1999)	14
2.4	Kinetic reaction rate constants (k) for <i>Zygosaccharomyces bailii</i> under conventional and ohmic heating (Palaniappan et al, 1992)	14
2.5	Time-temperature combinations for HTST pasteurization (International Dairy Federation, IDF)	19
2.6	Comparison time-temperature combinations between pasteurization methods (International Dairy Foods Association, IDFA)	19
2.7	Nutritional composition of pineapple (MTFIS)	35
2.8	Nutritional composition of ripe guava (USDA Nutrient Database)	37
3.1	Ohmic heating cell dimensions	44
3.2	Electrodes dimension	46
4.1	Temperature sensor calibration values	73
4.2	The differences of the calibration value compared with standard condition	73
4.3	Proportionality constant of lime solution	77
4.4	Proportionality constant of samples solution	78
4.5	Results for ohmic heated pasteurizer	83

4.6	Differences between power and K value	91
4.7	t-test value	92
4.8	z-test value	93
4.9	Time temperature data for pineapple juice drink in plate heat exchanger	99
4.10	Results of conventional heating method	100
4.11	Losses of Vitamin C in juices with different heating method	102
4.12	Comparison of cook value and quality degradation for pineapple juice drink	103
4.13	Results on bacterial destruction in samples	104
4.14	Iron content in sample	105
4.15	Comparison of sample quality between ohmic heating and conventional heating method with standard	107
4.16	The advantages and disadvantages of ohmic heating	109
A2.1 (a)	Build specification of hose pump	122
A2.1 (b)	Operating specification of hose pump	122
A2.2	General specification of Unimeter	123
A2.3	The technical data of thyristor	125
A2.4 (a)	Standard specification of chart recorder	126
A2.4 (b)	Operating specification of chart recorder	126
A2.4 (c)	Specification for power supply of chart recorder	127
A2.5 (a)	General specification of frequency inverter	128
A2.5 (b)	The specifications for the optional, circuit breaker (CB) and wire	128

A2.6	General specification of temperature transmitter	129
A2.8	General specification of conductivity meter	132
A2.9	General specification of digital thermometer	133
A2.10	Standard specification of clamp meter	134
A4.1 (a)	Delrin cell with internal diameter 60 mm	142
A4.1 (b)	Glass cell with internal diameter 60 mm	142
A4.1 (c)	Glass cell with internal diameter 83 mm	142
A4.1 (d)	Glass cell with internal diameter 100 mm	143
A4.2 (a)	Delrin cell with internal diameter 60 mm	143
A4.2 (b)	Glass cell with internal diameter 60 mm	143
A4.2 (c)	Glass cell with internal diameter 83 mm	144
A4.2 (d)	Glass cell with internal diameter 100 mm	144
A4.3 (a)	Delrin cell with internal diameter 60 mm	144
A4.3 (b)	Glass cell with internal diameter 60 mm	145
A4.3 (c)	Glass cell with internal diameter 83 mm	145
A4.3 (d)	Glass cell with internal diameter 100 mm	145

LIST OF FIGURES

Figure		Page
1.1	Proposed ohmic heater with negative feedback process control scheme	4
2.1	Thermal destruction data of spoilage micro organisms (Maroulis and Saravacos, 2003)	13
2.2	Simplified process in HTST pasteurization	18
2.3	Schematic of a continuous flow ohmic heating process (Zoltai and Swearingen, 1996)	22
2.4	Plate heat exchanger (Adapted from Alfa Laval Inc.)	33
2.5	Morris pineapple (MTFIS)	34
2.6	Pink guava	36
3.1	Overall methodology	39
3.2	Schematic continuous ohmic heated pasteurizer	41
3.3	Hose pump model CZ27	43
3.4	Ohmic heating cell of various sizes	45
3.5	Stainless steel electrodes SS316 for 60 mm cell	45
3.6	Electrodes arrangement in ohmic cell (Adapted from Hishamuddin J., 2002)	46
3.7	Three phase delta connected balance load	46
3.8	Plexisteel hose	47
3.9	Feed and product tank	47
3.10	The thyristor coding	49
3.11	Thyristor TC3001	49
3.12	Unimeter XQL as a process controller	50

3.13	Paperless chart recorder	51
3.14	AS built in Multistranded wire	52
3.15	Pump inverter	53
3.16	Panel board	54
3.17	Plate heat exchanger	63
4.1	Continuous ohmic heated pasteurizer bench	69
4.2 (a)	Continuous ohmic heated pasteurizer control panel (front view)	69
4.2 (b)	Continuous ohmic heated pasteurizer control panel (inside view)	70
4.3	Speed of response of RTD	74
4.4	Pump 1 and 2 calibration	75
4.5	Graph electrical conductivity versus temperature of lime solution	76
4.6	Graph electrical conductivity versus temperature for pineapple juice drink	77
4.7	Relationship of outlet temperature increment and flow rate with different initial electrical conductivity	79
4.8	Relationship of flow rate and electrical conductivity at 75°C	80
4.9	Graph temperature versus ohmic heating cell diameter	81
4.10	Graph current versus ohmic heating cell diameter	82
4.11	Temperature profiles in continuous ohmic heating of lime solution at 0.2S/m	84
4.12	Temperature profiles of pineapple juice drink at 0.25 S/m	85
4.13	Temperature profile of pineapple juice drink at 0.254 S/m	86
4.14	Temperature profile of pink guava juice at 0.204 S/m	87
4.15	Power input, power output and power generated for ohmic heating system.	88

4.16	Calculated power for Delrin cell	90
4.17	Graph power generated versus power input	94
4.18	Power input at different initial electrical conductivity	95
4.19	Power generated at different initial electrical conductivity	96
4.20	Power output at different initial electrical conductivity	97
4.21	Plate heat exchanger typical flow sheet	98
4.22	Temperature profile of pineapple juice drink at 0.8 GPM	100
4.23	Vitamin C retentivity in samples	102
4.24	The APV 10kW ohmic heater and position of hall effect sensor	110
4.25	Continuous flow ohmic heater (Sastry, 1992)	111
A2.2	Programming flowchart for Unimeter	124
A3.1	Standard operating procedure for continuous ohmic heated pasteurizer	135
A4.1 (a)	Temperature profile for lime solution at $\sigma_0 = 0.3S/m$	146
A4.1 (b)	Temperature profile for pineapple juice drink	147
A4.1 (c)	Temperature profile for pink guava juice with varies in flow rate	148
A4.2 (a)	Power for Glass cell with internal diameter of 60mm	149
A4.2 (b)	Power for Glass cell with internal diameter of 83mm	149
A4.2 (c)	Power for Glass cell with internal diameter of 100mm	150
A4.3	Power circuit diagram for continuous ohmic heated pasteurizer	151
A4.4	Control circuit diagram for continuous ohmic heated pasteurizer	152

LIST OF APPENDICES

Appendix		Page
A1	Process parameters	120
A2	Specifications of instruments and equipment	122
A3	Methodology and procedure	135
A4	Result tables and figures	142
A5	Calculations	153

LIST OF ABBREVIATIONS

A	cross sectional area of the cell (m^2)
A_e	electrode area (m^2)
C	concentration
C	cook value
C_c	cook value at the coldest spot
C_0	initial concentration
c_p	specific heat of the material (J/kg °C)
C_s	average quality degradation
D	decimal reduction time
d	distance between electrodes (m)
E	activation energy (kJ)
E_s	supplied voltage (V)
F	lethality
F_s	product flow rate (m^3/s)
I	current (A)
I_d	current density (Acm^{-2})
I_L	line current (A)
k	reaction rate constant
k_0	Arrhenius constant
K	power generated constant (shape factor)
L	length of the cell (m)