UNIVERSITI PUTRA MALAYSIA

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

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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

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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 OHMIC-HEATED PASTEURIZER COMPARED TO CONTACT-HEATED PASTEURIZER

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NURUL FAEZAWATY JAMALUDIN

May 2008

Chairman: **Hishamuddin Jamaludin**

Faculty: **Engineering**

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

NURUL FAEZAWATY JAMALUDIN

May 2008

Pengerusi: **Hishamuddin Jamaludin**

Fakulti: **Kejuruteraan**

Pempasteuran makanan cecair menggunakan kaedah konvesional 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 menyumbnagkan 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 <10cfu/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.

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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. Budiatman Satiawihardja* for their constant guidance and advice as well as constructive criticism in the preparation of this project.

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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.

Members of the Examination Committee were as follows:

Johari Endan, PhD
Associate Professor
Faculty of Engineering
Universiti Putra Malaysia
(Chairman)

Ling Tau Chuan, PhD
Lecturer
Faculty of Engineering
Universiti Putra Malaysia
(Internal Examiner)

Rimfiel Janius, PhD
Lecturer
Faculty of Engineering
Universiti Putra Malaysia
(Internal Examiner)

Ir. Hj. Wan Ramli Wan Daud, PhD
Professor
Institute of Fuel Cell Technology
Universiti Kebangsaan Malaysia
Malaysia
(External Examiner)

_____
HASANAH MOHD GHAZALI, PhD
Professor and Deputy Dean
School of Graduate Studies
Universiti Putra Malaysia

Date: 25 September 2008

This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfilment of the requirement for the degree of Master of Science. The members of the Supervisory Committee were as follows:

Hishamuddin Jamaludin
Faculty of Engineering
Universiti Putra Malaysia
(Chairman)

Coskan Ilicali, PhD
Professor
Faculty of Engineering
Universiti Putra Malaysia
(Member)

Chin Nyuk Ling, PhD
Faculty of Engineering
Universiti Putra Malaysia
(Member)

AINI IDERIS, PhD
Professor and Dean
School of Graduate Studies
Universiti Putra Malaysia

Date: 16 October 2008

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.

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NURUL FAEZAWATY JAMALUDIN

Date: 18 August 2008

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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 ºC)
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)