UNIVERSITI PUTRA MALAYSIA

EFFECTS OF ULTRAVIOLET IRRADIATION ON PHYSICOCHEMICAL, MICROBIOLOGICAL, AND RHEOLOGICAL PROPERTIES OF PINEAPPLE (Ananas comosus L. VAR. YANKEE) JUICE

CHIA SU LING

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By

CHIA SU LING

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

December 2011

Specially thanks to….

My parents….

My siblings….

My friends….

For their support and encouragements….

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

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December 2011

Chairman: Rosnah Binti Haji Shamsudin, PhD

Faculty: Engineering

Unpasteurised or fresh juice may be contaminated with pathogens or microorganisms that are harmful to human health. Presently, thermal pasteurisation is the most common technology used in the fruit juice industry to inactivate enzymes or microorganisms, but the application of heat adversely affect the nutritional and sensory qualities of the juice. Ultraviolet (UV) irradiation is a promising disinfection technology. This nonthermal technology minimizes the loss of flavour and nutritional qualities of fruit juice. There is no literature available about the application of UV to pineapple juice. The present study aims to investigate the effect of UV irradiation on the quality of pineapple juice based on physicochemical, microbiological and rheological analyses. A UV dosage of 53.42 mJ/ cm^2 administered to the pineapple juice was chosen based on germicidal effectiveness. The UV-irradiated pineapple juice was similar to the untreated juice in total soluble solids (TSS), pH, titratable acidity, ascorbic acid, L*, hue angle and chroma parameters, but was significantly different ($p<0.05$) compared to the thermally pasteurised pineapple juice. Turbidity

of pineapple juice was significantly decreased ($p<0.05$) after UV treatment and significant increased ($p<0.05$) after the thermal treatment. A large and significant reduction ($p<0.05$) in the total phenolic content was seen in the thermal treatment group (34.83%) as compared to the UV-irradiated group (16.55%). There was a significant decrease ($p<0.05$) in the total plate counts (TPC) and the yeast and mould counts (YM) in the UV and the thermally treated pineapple juice, although the thermally treated group was statistically more variable than the UV treatment group. During the 13 weeks of storage, TSS and titratable acidity of UV-irradiated juice were significantly decreased ($p<0.05$) whereas pH and turbidity were significantly increased ($p<0.05$). However, these parameters remained stable in thermally pasteurised juice throughout the storage time. There were no significant changes in total phenolic for both treatments throughout the storage period. Other quality parameters (ascorbic acid, L*, hue angle and chroma) were significantly affected by the storage time in the UV-irradiated and thermally pasteurised juice. Regarding the microbiological analysis, the TPC and YM of the UV-irradiated juice increased gradually throughout the 13 weeks of storage while these parameters remained unchanged in the thermally pasteurised juice with almost no microorganism growth. A rheological test was performed on untreated, UV-irradiated and thermally pasteurised juice at temperatures ranging from 5°C to 25°C throughout the 13 weeks of storage. The Bingham model described adequately the rheological behaviour of he juices. There was no significant variation between the plastic viscosities of the untreated and UV-irradiated juice at all temperatures. A significant ($p<0.05$) increase of plastic viscosity was however observed in the thermal pasteurised juice at temperature 5°C and 10°C. Throughout the 13 weeks of storage, plastic viscosities of untreated and UV-irradiated juice in the temperature range of 5°C to 25°C

significantly decreased while no significant change was found in thermally pasteurised juice. The effect of temperature on plastic viscosity was adequately described by the Arrhenius equation. The results of this study demonstrate the effectiveness of UV irradiation in preserving the nutritional quality attributes of fruit juice compared to thermal pasteurisation.

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

KESAN IRRADIASI ULTRAUNGU KE ATAS SIFAT-SIFAT FIZIKAL-KIMIA, MIKROBIOLOGI, DAN REOLOGI JUS NANAS (*Ananas comosus* L. VAR. YANKEE)

Oleh

CHIA SU LING

Disember 2011

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Jus segar yang tidak dibasmikan kuman menyebabkan kewujudan bakteria dan mikroorganisma yang berbahaya kepada kesihatan manusia. Kini, pempasteuran terma merupakan teknologi yang paling umum digunakan dalam industri jus buah-buahan untuk mematikan enzim atau mikroorganisma, tetapi aplikasi terma menjejaskan kualiti nutrisi dan sensori jus. Irradiasi ultraungu (UV) adalah teknologi pembasmian kuman atau bakteria yang berpotensi. Teknologi bukan terma ini meminimumkan kehilangan nutrisi dan rasa jus buah-buahan. Tiada kajian tentang aplikasi irradiasi UV dalam pemprosesan jus buah-buahan. Penyelidikan ini adalah bertujuan untuk mengetahui kesan irradiasi UV terhadap kualiti jus nanas berdasarkan analisis fizikal-kimia, mikrobiologi dan reologi. Irradiasi UV pada dos 53.42 mJ/ cm^2 dipancarkan ke atas jus nanas dipilih berdasarkan keberkesanan dalam pembunuhan bakteria dan mikroorganisma. Sifat-sifat fizikal-kimia seperti jumlah pepejal larut (TSS), pH, keasidan, vitamin C, L*, warna “hue” dan“chroma” bagi jus nanas yang diiradiasi dengan UV didapati sama dengan jus tanpa rawat.

Walaubagaimanapun, terdapat perubahan signifikan ($p<0.05$) dilaporkan bagi jus pempasteuran terma. Kekeruhan bagi jus nanas yang diirradiasi dengan UV dan dipasteuri terma masing-masing dilaporkan menurun dan meningkat secara signifikan ($p<0.05$). Terdapat penurunan besar dan signifikan ($p<0.05$) untuk jumlah fenolik dalam jus pempasteuran terma (34.83%) berbanding dengan jus irradiasi UV (16.55%). Walaupun pempasteuran terma lebih berkesan dalam pembunuhan mikroorganisma, tetapi penurunan signifikan ($p<0.05$) bagi jumlah bilangan plat (TPC) dan yis serta kulat (YM) didapati juga dalam jus irradiasi UV dan pempasteuran terma. Bagi jus irradiasi UV, TSS dan keasidan menurun secara signifikan ($p<0.05$) manakala pH dan kekeruhan meningkat secara signifikan ($p<0.05$) sepanjang 13 minggu penyimpanan. Namun begitu, sifat-sifat fizikal-kimia ini stabil dalam jus pempasteuran terma sepanjang masa penyimpanan. Tiada perubahan signifikan jumlah fenolik untuk kedua-dua jenis rawatan sepanjang penyimpanan. Vitamin C, L*, warna "hue" dan "chroma" untuk jus irradiasi UV dan pempasteuran terma ada perubahan signifikan semasa penyimpanan. Keputusan analisis mikrobiologi pula didapati TPC dan YM untuk jus irradiasi UV meningkat tetapi tiada perubahan dalam jus pempasteuran terma dengan hampir tiada pertumbuhan mikroorganisma sepanjang masa penyimpanan. Perubahan reologi semasa penyimpanan bagi jus tanpa rawat, irradiasi UV dan pempasteuran terma dilakukan pada suhu 5-25 $^{\circ}$C. Dalam semua kes, sifat-sifat reologi jus nanas berpadanan dengan model Bingham. Tiada perubahan signifikan untuk kelikatan plastik jus nanas tanpa rawat dan irradiasi UV pada semua suhu. Namun, kelikatan plastik jus pempasteuran terma didapati meningkat secara signifikan ($p<0.05$) pada suhu 5 $^{\circ}$C dan 10 $^{\circ}$C. Selain itu, kelikatan plastik jus tanpa rawat dan irradiasi UV pada suhu 5-25 $^{\circ}$C menurun secara signifikan ($p<0.05$) semasa penyimpanan

manakala tiada perubahan signifikan bagi jus pempasteuran terma. Kesan suhu ke atas kelikatan plastik jus nanas diterangkan oleh persamaan Arrhenius. Secara keseluruhan didapati keputusan menunjukkan keberkesanan irradiasi UV dalam pengekalan kualiti nutrisi jus buaha-buahan berbanding dengan pempasteuran terma.

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I certify that a Thesis Examination Committee has met on 8 December 2011 to conduct the final examination of Chia Su Ling on her thesis entitled "Effects of Ultraviolet Irradiation on Physicochemical, Microbiological, and Rheological Properties of Pineapple (*Ananas comosus* L. Var. Yankee) Juice" in accordance with the Universities and University Colleges Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U.(A) 106] 15 March 1998. The Committee recommends that the student be awarded the Master of Science.

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

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DECLARATION

I declare that the thesis is my original work except for quotations and citations which have been duly acknowledged. 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 instituition.

CHIA SU LING

Date: 8 December 2011

TABLE OF CONTENTS