



UNIVERSITI PUTRA MALAYSIA

***OSMOTIC DEHYDRATION OF PINEAPPLE (*Ananas comosus* L. Merr.)
USING SUCROSE-SORBITOL MIXTURES AND MICROBIAL STABILITY
DURING STORAGE***

LIM CHEE HUI

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By

LIM CHEE HUI

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

April 2017

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

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April 2017

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Osmotic dehydration (OD) is an effective preservation technique to remove water from fruits and produce high quality products with minimal nutrients loss. Sorbitol is a low-glycemic carbohydrate with complementary sugar's functionality with lower glycemic index compared to sucrose. The osmotic dehydration kinetic and microbial stability of the osmodehydrated pineapple of sorbitol-sucrose mixtures during storage were determined in this study. OD were conducted using 65 °Brix sucrose-sorbitol mixture ranging from 0 to 100 % concentration at 40 °C for 240 minutes and subjected to hot air drying at 50 °C to approximately 30 % moisture content. Samples were vacuum-packed and stored at 4 °C for storage study. Textural, moisture content, a_w , pH, colour, flavonoids, vitamin C and bromelain were determined using texture analyzer, moisture analyzer, water activity meter, pH meter, Hunter LAB calorimeter, spectrophotometer, standard Vitamin C AOAC 967.21 and casein digestion unit (CDU) method, respectively. The results showed that in general all formulations studied gave decreasing trend for weight reduction (WR) and water loss (WL) and increasing trend for solutes gain (SG). Sorbitol substitution at 75 % and 100 % were recommended for osmodehydrated pineapple because both formulations gave the lowest WR, highest WL and SG values, which fulfilled the requirement as a high quality osmodehydrated fruits. In addition, both formulations had the lowest water activity, low pH values, medium firmness and no obvious browning. Results on microbial stability showed that osmodehydrated pineapple with sorbitol can be stored at 4°C for more than 2 months at bacteria count $< 10^6$ CFU/g and yeast and mould $\leq 10^4$ CFU/g. However, there were no significant effects of different osmotic solutions used on the retention of vitamin C content and total flavonoid content because all showed degradation throughout storage and firmness of osmodehydrated pineapple decreased with storage. However, for bromelain activity, sorbitol treated pineapple is significant in retaining the bromelain activity.

In conclusion, sorbitol treated osmodehydrated pineapple have a better extended shelf life and better retention of bromelain activity which showed that sorbitol can be used as an alternative osmotic solution in osmotic dehydration of pineapple.

Keywords: Osmotic dehydration kinetic, pineapple, sucrose-sorbitol, bromelain, flavonoids, vitamin C, shelf life



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

**DIHIDRASI OSMOSIS BAGI BUAH NENAS (*Ananas comosus* L. Merr.)
DENGAN MENGGUNAKAN CAMPURAN SUKROSA-SORBITOL DAN
KESTABILAN MIKROBIOLOGI SEMASA PENYIMPANAN**

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Dehidrasi osmosis (OD) adalah teknik pengawetan yang berkesan untuk menyingkirkan air daripada buah-buahan dan menghasilkan produk yang berkualiti tinggi dengan kehilangan nutrien yang minimum. Sorbitol adalah karbohidrat berglisemik rendah berbanding sukrosa yang mempunyai fungsi yang sama dengan gula. Kinetik dihidrasi osmosis dan kestabilan mikrob buah nenas osmodehidrasi semasa tempoh penyimpanan telah dikaji dalam kajian ini. OD telah dijalankan menggunakan campuran 65 °Brix sukrosa - sorbitol dari kepekatan 0 sehingga 100 % pada suhu 40 °C selama 240 minit dan pengeringan pada 50 °C sehingga kandungan kelembapan mencecah 30 %. Sampel telah dibungkus dalam keadaan vakum dan disimpan pada 4 °C untuk kajian penyimpanan. Tekstur, kandungan kelembapan, a_w , pH, warna, flavonoid, vitamin C dan bromelain telah ditentukan dengan menggunakan analyzer tekstur, kelembapan analyzer, meter aktiviti air, meter pH, Hunter LAB kalorimeter, spektrofotometer, vitamin C standard AOAC 967,21 dan casein digestion unit (CDU), masing-masing. Hasil analisis menunjukkan bahawa secara umumnya semua formulasi yang dikaji memberi tren berkurang untuk pengurangan berat (WR) dan kehilangan air (WL), manakala tren peningkatan untuk peningkatan bahan larut (SG). Penggantian sorbitol pada 75 % dan 100 % telah disyorkan untuk nenas osmodehidrasi kerana kedua-duanya memberikan nilai WR paling rendah, WL dan SG tinggi, yang memenuhi syarat sebagai buah-buahan osmodehidrasi yang berkualiti tinggi. Di samping itu, kedua formulasi tersebut mempunyai aktiviti air yang paling rendah, nilai pH yang rendah, keteguhan sederhana dan tiada perubahan warna yang jelas. Analisis mikrob menunjukkan nenas osmodehidrasi dengan sorbitol boleh disimpan pada suhu 4 °C untuk tempoh melebihi dua bulan dengan kiraan bakteria $< 10^6$ CFU/g dan kiraan kulat $\leq 10^4$ CFU/g. Walau bagaimanapun, penggunaan larutan osmosis yang berlainan tidak memberikan perbezaan pada pengekalan kandungan vitamin C dan jumlah

kandungan flavonoid serta tekstur keteguhan nenas osmodihidrasi menurun semasa tempoh penyimpanan. Bagaimanapun, nenas dihidrasi dengan sorbitol boleh mengekalkan aktiviti bromelain lebih signifikan kalau berbanding dengan nenas dihidrasi dengan sukrosa sahaja. Pada kesimpulan, nenas osmodihidrasi dengan sorbitol mempunyai jangka hayat yang lebih baik dan boleh mengekalkan aktiviti bromelain. Ini menunjukkan bahawa sorbitol boleh digunakan sebagai alternatif dalam dehidrasi osmosis buah nenas.

Kata Kunci : kinetik osmotik dehidrasi , nenas , sukrosa - sorbitol , bromelain , flavonoid , vitamin C , jangka hayat

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I certify that a Thesis Examination Committee has met on 18 April 2017 to conduct the final examination of Lim Chee Hui on his thesis entitled "Osmotic Dehydration of Pineapple (*Ananas comosus* L. Merr) using Sucrose-Sorbitol Mixtures and Microbial Stability During Storage" 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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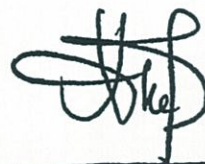
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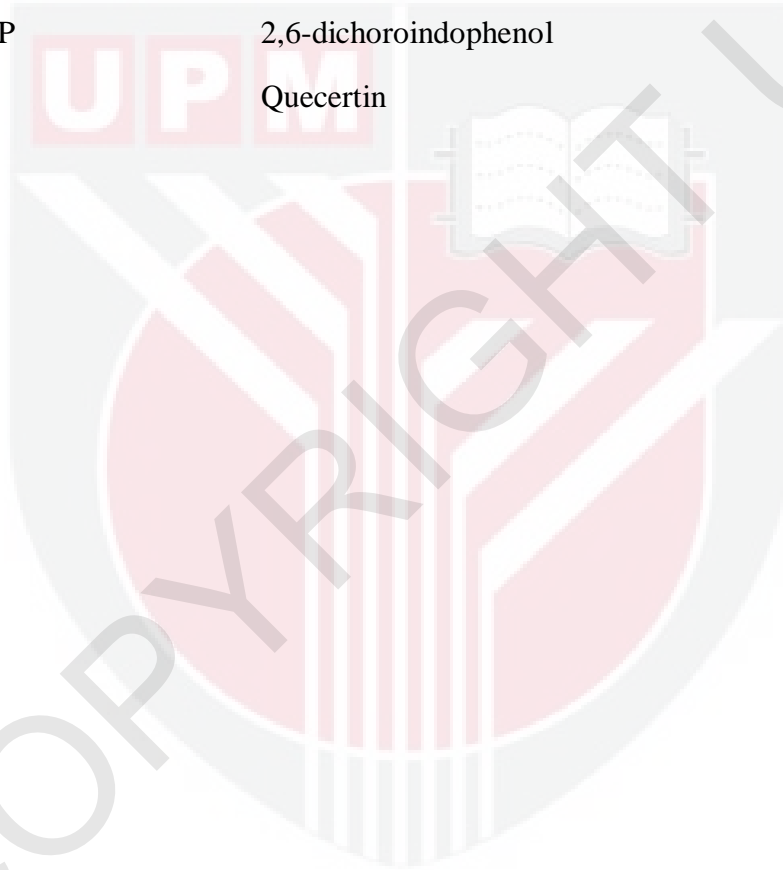
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LIST OF ABBREVIATIONS

OD	Osmotic Dehydration
CDU	Casein Digestion Unit
WR	Weight Reduction
WL	Water Loss
SG	Solute Gains
CFU	Colony Forming Unit
DCPIP	2,6-dichoroindophenol
QE	Quecertin



CHAPTER 1

INTRODUCTION

1.1 Background

Osmotic dehydration (OD) is known as a process of removing water from water-containing solid by using osmotic pressure in the osmotic solution (Rastogi & Raghavarao, 2004a). Osmotic pressure is the driving force for OD and this driving force will cause the natural osmosis of water from the fruits into the osmotic solution through cell membrane (Rastogi, Raghavarao, & Niranjana, 2005). OD is becoming more popular in recent years as an effective method in preserving fruits due to the ability to preserve the natural characteristics of the fruits (Chavan & Amarowicz, 2012). OD process is conducted by immersing the fruits in a hypertonic solution to induce removal of water from the fruits cell through the cell membrane without changing of phase and at low or ambient temperature (García-Martínez et al., 2002; Igual, Contreras, & Martínez-Navarrete, 2010). There are several advantages of OD such as minimum effect on the natural characteristics of the fruits after processed because the temperature used in process is at low or ambient temperature (Chavan & Amarowicz, 2012). OD also used less energy due to the low temperature treatment (Igual et al., 2010). OD combined with other drying method can produce higher fruit quality products for local and international market (Rastogi et al., 2005). Many types of osmodehydrated fruits using sucrose have been produced such as pineapple, apple, guava, strawberry, grapefruits and kiwi (Panadés-Ambrosio et al., 1996; Silveira, Rahman, & Buckle, 1996; Saputra, 2001; García-Martínez et al., 2002; Lombard et al., 2008; Nuñez-Mancilla et al., 2013).

Pineapple (*Ananas comosus*) fruits are widely grown in Johor located in the southern area of peninsular Malaysia and Malaysia is known as one of the largest producers in the world (MPIB, 2012d). Statistic data shows that there is a total export of 13653 tonnes worth RM 37.2 million (MPIB, 2012a). Pineapple is rich in vitamin C, vitamin B (B1 and B3), potassium content, sodium and contain enzyme Bromelain which used in medical applications. There is a wide opportunity to expand pineapple based products with better health benefits and nutraceutical properties in order to introduce Malaysia pineapple cultivar to international markets and increase the annual total export of pineapple products in Malaysia.

The conventional preservations of pineapple are done using high thermal processing which will affect the natural characteristics of fruits that the natural colour of the fruits, flavour and specific nutrients such as vitamin C will degrade (García-Martínez et al., 2002). Also, the common pineapple based products are usually produced in high glycemic and calorie indexes such as pineapple jam and candied pineapple which will affect the human health particularly in diabetes (Basu, et al., 2011). The problem statement for this research is the preservation of pineapple using osmotic dehydration with minimal temperature to prevent losses of natural characteristics and

using low calorie sugar substitute to minimize the calorie and glycemic index in the osmodehydrated pineapple.

In the previous researches, there is lacking of information on substitution of sucrose with sorbitol in the osmotic dehydration process and physical and microbial stability of osmodehydrated pineapple during storage. The focus of this research is on preparing the osmodehydrated pineapple for further process application in pineapple base products.

1.2 Objectives

Overall, the research is undertaken with the aim to produce healthier osmodehydrated pineapple and extend the shelf life. The specific objectives of this research were:

- i) To determine the osmotic dehydration kinetic, textural and physicochemical properties of pineapple at different concentration of sucrose and sorbitol mixtures
- ii) To determine physicochemical properties, microbial stability and kinetic of quality changes of osmodehydrated pineapple during storage

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