



UNIVERSITI PUTRA MALAYSIA

***EFFECTS OF RIPENING AT AMBIENT TEMPERATURE AND
DIFFERENT
DRYING TREATMENTS ON SELECTED ANTIOXIDANTS AND ACTIVITY
OF CHOKANAN MANGO (*Mangifera indica* L.) PEEL AND PULP***

NEDA JAMALI

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EFFECTS OF RIPENING AT AMBIENT TEMPERATURE AND DIFFERENT DRYING TREATMENTS ON SELECTED ANTIOXIDANTS AND ACTIVITY OF CHOKANAN MANGO (*Mangifera indica* L.) PEEL AND PULP

By

NEDA JAMALI

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


February 2014

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The logo of Universiti Putra Malaysia (UPM) is a shield-shaped emblem. It features a red and white color scheme. At the top left, the letters 'UPM' are written in white on a red rectangular background. The central part of the shield contains a stylized white and red design that resembles a book or a flame. The bottom part of the shield has a series of vertical white lines on a red background.

*I dedicate this thesis to my parents, Abdullah Jamali and Tayebah Samavi, your
essence is in everything I accomplish.*

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

EFFECTS OF RIPENING AT AMBIENT TEMPERATURE AND DIFFERENT DRYING TREATMENTS ON SELECTED ANTIOXIDANTS AND ACTIVITY OF CHOKANAN MANGO (*Mangifera indica* L.) PEEL AND PULP

By

NEDA JAMALI

February 2014

Chair: Associated Professor Badlishah Sham Baharin

Faculty: Food Science and Technology

Mango is a seasonal fruit and after the fruit is harvested at commercial maturity stage from the tree for further use in industry or market, in the forms of ripe or raw, fresh or processed it is very important to know what changes the fruit will undergo. Drying is one of the preservative methods to store the fruit for longer time before processing. Thus, the main goals of this study are to evaluate effects of ambient temperature and drying methods on antioxidant properties of mango pulp and peel. In this study, first the pulp and peel of a local variety of mango (Chokanan) was studied for its phytochemical and bioactive components such as mangiferin, gallic acid and quercetin content, total phenolic content (TPC), total antioxidant activity (TAA) and free radical scavenging activity (FRS). Subsequently, proximate analysis including protein content, moisture content, ash content, fat content and dietary fiber content of both pulp and peel of Chokanan mango were studied. The results obtained from this study shows that the peel of mango contains higher amount of mangiferin, antioxidant and phenolic compounds in comparison with mango pulp. In terms of proximate analysis pulp of this fruit tend to have more moisture content than the peel but the other parameters including dietary fiber showed higher content in peel (51%) than pulp (14.1%). Effect of ripening at ambient temperature on the antioxidant properties of pulp and peel of Chokanan mango were determined and based on the results obtained from this chapter ripening has a decreasing influence on the antioxidant activity of the Chokanan peel and flesh. Chokanan peel showed higher antioxidant properties than its pulp in all stages of ripening and as result of ripening TPC of Chokanan peel decreased 3.24% and TPC of Chokanan pulp decreased 12.46%. Due to ripening at ambient temperature FRS and TAA of Chokanan peel and pulp decreased 44.5%, 29%, 8.64% and 17.1%, respectively. Mangiferin and gallic acid content of peel (78.36% and 42.19%, respectively) and gallic acid of pulp (60.5%) tend to decrease throughout ripening but quercetin which was not detected in early stages of ripening

started to increase by the end of ripening process. In a comparison between effect of three different drying techniques including vacuum oven drying, freeze drying and spray drying on the antioxidant activity of both pulp and peel of Chokanan mango it was concluded that freeze drying has the smallest decreasing influence on antioxidant action of peel and pulp of mango by keeping 76% and 54% of their TPC, respectively while spray drying has the most damaging effect on the antioxidant activity of Chokanan peel and pulp by decreasing their TPC 80% and 90%, respectively. Thus, present study identified raw mango peel as a potential source of dietary fiber and antioxidants that future researches would provide a method to convert it from a by-product to a functional food additive.



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

**KESAN KEMASAKAN PADA SUHU AMBIEN SUHU DAN RAWATAN
PENGERINGAN BERBEZA ON ANTIOKSIDAN TERPILIH DAN
PEMEROLEHAN CHOKANAN MANGO (*Mangifera indica* L.) PEEL DAN
PULPA**

Oleh

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Mangga adalah buah-buahan bermusim dan selepas buah dituai pada peringkat kematangan komersil dari pokok itu boleh digunakan lagi dalam industri atau pasaran, dalam bentuk masak atau mentah, segar atau diproses ia adalah sangat penting untuk mengetahui apa perubahan buah akan menjalani. Pengeringan adalah salah satu kaedah pengawet untuk menyimpan buah-buahan untuk masa yang lebih lama sebelum pemprosesan. Oleh itu, matlamat utama kajian ini adalah untuk menilai kesan suhu dan pengeringan kaedah persekitaran pada sifat-sifat antioksidan pulpa mangga dan kulit. Dalam kajian ini, pertama pulpa dan kulit daripada pelbagai tempatan mangga (chokanan) telah dikaji untuk komponen fitokimia dan bioaktif yang seperti mangiferin, asid Gallic dan kandungan quercetin, kandungan jumlah fenol (TPC), jumlah aktiviti antioksidan (TAA) dan aktiviti radikal bebas memerangkap (FRS). Selepas itu, analisis proksimat termasuk kandungan protein, kandungan lembapan, abu, lemak dan serat diet kedua-dua pulpa dan kulit mangga chokanan dikaji. Keputusan yang diperolehi daripada kajian ini menunjukkan bahawa kulit mangga mengandungi jumlah yang lebih tinggi mangiferin, antioksidan dan fenolik sebatian dalam perbandingan dengan pulpa mangga. Dari segi analisis proksimat pulpa buah-buahan ini cenderung mempunyai kandungan lembapan lebih daripada kulit itu tetapi parameter lain termasuk serat pemakanan menunjukkan kandungan yang lebih tinggi pada kulit (51%) daripada pulpa (14.1%). Kesan masak pada suhu persekitaran pada sifat-sifat antioksidan pulpa dan kulit mangga chokanan ditentukan dan berdasarkan keputusan yang diperolehi daripada masak bab ini mempunyai pengaruh yang berkurangan kepada aktiviti antioksidan kulit chokanan dan daging. Chokanan kulit menunjukkan sifat-sifat antioksidan yang lebih tinggi daripada pulpa dalam semua peringkat masak dan hasilnya masak TPC daripada chokanan kulit menurun 3.24% dan TPC pulpa chokanan menurun 12.46%. Oleh kerana masak di FRS suhu ambien dan TAA daripada chokanan kulit dan pulpa menurun 44.5%, 29%, 8.64% dan 17.1%

masing-masing. Mangiferin dan kandungan asid Gallic daripada kulit (78,36% dan 42.19% masing-masing) dan asid Gallic pulpa (60.5%) cenderung untuk mengurangkan seluruh masak tetapi quercetin yang tidak dikesan di peringkat awal masak mula meningkat akhir proses masak. Dalam perbandingan antara kesan tiga teknik pengeringan yang berbeza termasuk vakum pengeringan ketuhar, membekukan pengeringan dan pengeringan semburan aktiviti antioksidan kedua-dua pulpa dan kulit daripada chokanan mempelam ia telah membuat kesimpulan bahawa pembekuan pengeringan mempunyai pengaruh yang paling kecil berkurangan tindakan antioksidan kulit dan pulpa mangga dengan menyimpan 76% dan 54% daripada TPC mereka, manakala semburan mempunyai kesan paling buruk kepada aktiviti antioksidan chokanan kulit dan pulpa dengan mengurangkan TPC mereka 80% dan 90% masing-masing Oleh itu, kajian ini mengenal pasti mangga kulit mentah sebagai sumber yang berpotensi untuk serat dan antioksidan bahawa kajian masa depan akan menyediakan kaedah untuk menukar dari oleh-produk untuk bahan tambahan makanan berfungsi.

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I certify that a Thesis Examination Committee has met on 13 February 2014 to conduct the final examination of Neda Jamali on her thesis entitled "Effects of Ripening at Ambient Temperature and Different Drying Treatments on Selected Antioxidants and Activity of Chokanan Mango (*Mangifera indica* L.) Peel and Pulp" 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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DECLARATION

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LIST OF ABBREVIATIONS

A	Apex
AOAC	Association Of American Chemists
CIE	Mathematically Defined Color Spaces
DPPH	Diphenylpicrylhydrazyl
FRAP	Ferric Reducing Antioxidant Potential
FPEE	Freeze Dried Peel
FPUE	Freeze Dried Pulp
FRS	Free Radical Scavenging
GAE	Gallic Acid Equivalent
HPLC	High Performance Liquid Chromatography
IC ₅₀	Half maximal Inhibition Concentration
N	Newton
S	Stalk
SPEE	Spray Dried Peel
SPUE	Spray Dried Pulp
TAA	Total Antioxidant Activity
TC	Total Carbohydrates
TDF	Total Dietary Fiber
TPTZ	Tri-Pyridyl-s-Triazine
UV-Vis	Ultra Violet Visible
VPEE	Vacuum Oven Dried Peel
VPUE	Vacuum Oven Dried Pulp
PEE	Peel
PUE	Pulp

CHAPTER 1

INTRODUCTION

1.1 General Introduction

Mango (*Mangifera indica L.*) is a popular fruit of tropical region belonging to the family Anacardiaceae. Many studies have been carried out in terms of potent antioxidants in mango plant. Various parts of mango plant, including leaves, pulp and stem bark are known to have various biomedical applications, including anti-inflammatory (Hernandez, Rodriguez, Delgado, & Walczak, 2007), free radical scavenging, antioxidative (Ajila, Bhat, Rao, & Prasada, 2007; Ribeiro, Queiroz, Campos, Pinheiro, & Ribeiro de Queiroz, 2007), and anticancer activities (Percival et al., 2006). The pulp contains fiber, vitamin C, vitamin A and significant amounts of polyphenolic compounds. The composition of mango pulp varies based on many factors such as stage of maturity, variety, locality, and climate (Masibo & He, 2009). Extracts of mango leaves were identified as ideal antioxidants (Ling et al., 2009). The main compound of stem bark and leaves has been introduced as mangiferin which has great medicinal value (Masibo & He, 2009). It has also been reported that the aqueous extract from mango leaves has hypoglycemic activity due to its high content of mangiferin (Aderibigbe, Emudianughe, & Lawal, 2001). The extract from stem bark of mango contains a mixture including compounds such as fatty acids, triterpenes, polyphenols, phytosteroids and microelements that have polyphenolic fraction present in the most part of components (about 50%) and is mainly rich in catechin, epicatechin and mangiferin (Núñez et al., 2002; Scartezzini & Speroni, 2000).

Few scientific investigations have been carried out on mango peels for its anticancer and antioxidant activities (Kim et al., 2010). Peel as a main by-product of mango processing showed significant antioxidant properties (Ajila, Naidu, Bhat, & Rao, 2007). Mango peel is a significant source of phytochemicals, like vitamin C and vitamin E, polyphenols and carotenoids (Ajila & Bhat et al., 2007).

Almost 20% of mangos are processed to produce products like nectar, pickles, leather, puree and canned slices (Ajila & Naidu et al., 2007). Many investigations have been done on postharvest treatments in order to prolong shelf-life of the fruits, which many of them have the potential to change the concentrations of phytochemicals. Ripening and handling conditions that affect color development, quality and disease resistance have been emphasized primarily. Little information is published on factors affecting concentrations of antioxidant phytochemicals. These compounds include ascorbic acid, polyphenolics and carotenoids. The polyphenolics available in mangos are reported to undergo changes during development of fruit, they have been reported to decrease with ripening (Talcott, Moore, Lounds-Singleton, & Percival, 2005).

Drying is a food preservation method which is used widely. The main reason for drying is removing the water and minimizing the microbial growth and deterioration mechanisms. Drying offers longer shelf-life and smaller storage space and less weight for transportation as well (Mohamed Akoy, Von Hörsten, & Luecke, 2008). Sun

drying is a traditional method commonly used to preserve agricultural products in tropical and subtropical countries. During drying process, many factors mostly temperature and time affect the food quality. Fruits are good sources of antioxidants; however these bioactive compounds are very susceptible to heat. Thus, in preserving fruits it is important to minimize the risk of active ingredients becoming denatured or damaged by preservation methods as well (Fernandes, Rodrigues, Law, & Mujumdar, 2011).

Since visual appearance is the first quality parameter of a food which is judged by consumer at the point of sale (Mohamed Akoy et al., 2008), many studies have been done on factors affecting the appearance of food during dehydration. Mango is famous for being seasonal tropical fruit and possible source of dietary fibers and antioxidant compounds. Many dried products available in the market are made from ripe and raw mango pulp in forms of fruit slices or powders to be used as instant beverages or as a food additive to add a sour taste to foods. Since mango contains many bioactive compounds it is very important to produce a dried sort of product from the pulp or peel of this fruit which contains the same amount of bioactive compounds as the fresh mango.

1.2 Problem Statement

Many studies have been done on mango and its antioxidant properties. Mango as a tropical fruit may not be available in most of the countries around the world and being seasonal results in it not being available in market as fresh throughout the year. Thus, numerous products have been developed from this fruit with the purpose of prolonging its shelf life. The composition of mango pulp varies due to many factors such as level of maturity, variety, locality, and climate (Masibo & He, 2009). Despite higher antioxidant content of mango peel in comparison with mango pulp, peel as a major byproduct obtained from mango processing has been discarded as waste for many years (Ajila & Naidu et al., 2007). Regarding high content of bioactive components present in this byproduct which result in high antioxidant properties of this part of mango fruit, many studies have been done to identify the bioactive compounds of peel of some varieties of mango except Chokanan variety.

In processing of mango byproduct, drying can be an essential part in order to inactivate enzymes which degrade several active compounds and also to reduce the degree of microbial spoilage. Time and temperature of drying disturb the stability and activity of bioactive compounds because of chemical and enzymatic degradations (Dorta, Lobo, & González, 2012). It has been reported previously that mango peel powder used in formulation of macaroni and biscuit resulted in products with higher content of dietary fiber and antioxidants (Ajila, Aalami, & Rao, 2008).

Despite general information available about functional properties of mango peel, studies on changes that antioxidant compounds of mango will undergo throughout ripening and drying are few. Thus, to bridge the gap in existing research, this study was conducted on a Malaysian variety of *Mangifera indica* L. (Chokanan) which is the

most popular variety cultivated in Malaysia and it is also a favorite for eating as a raw mango because it is not sour when mature green (Mat Sa'at, Ab. Malik, Maamun, & Sarip, 2008) to evaluate effect of storage at ambient temperature and three different methods of drying on antioxidant properties of its pulp and peel.

1.3 Significance of Study

Mango has been the center of attention of many researchers because of its popularity and high content of bioactive compounds with numerous health benefits. Many researches have been conducted in order to study the postharvest treatments that would help in storage and handling of mango in certain period of time, mostly concentrating either on the structural changes that mango will undergo as result of ripening while stored or on the optimized storage condition or on the effect of different coating materials on its ripening but no information is available about changes of antioxidant properties of peel and pulp of Chokanan cultivar during ripening.

Many dried products made from mango have been introduced to market which are mainly made from ripe and raw mango pulp but the functional properties of these products are still unknown because the main attention has been on the characteristics other than functionality and health benefits.

Therefore, the outcomes of this study should provide useful information about proximate and antioxidant properties of Chokanan mango peel compared to its pulp as well as effects of storage at ambient temperature and different methods of drying mainly on antioxidant characteristics of this Malaysian cultivar.

1.4 Objectives

The main objective of this study was to evaluate the effects of postharvest treatments (storage at ambient temperature and drying) on antioxidant properties of peel and pulp of Chokanan mango.

Thus, the specific objectives of this research are:

- 1) To determine the proximate composition and antioxidant properties of peel and pulp of a Malaysian mango (*Mangifera indica* L.) variety (Chokanan).
- 2) To evaluate the effects of ambient temperature storage on physico-chemical and antioxidative properties of peel and pulp of a Malaysian mango (*Mangifera indica* L.) variety (Chokanan).
- 3) To evaluate the effects of different methods of drying such as freeze drying, vacuum oven drying and spray drying on the antioxidant properties of peel and pulp of a Malaysian mango (*Mangifera indica* L.) variety (Chokanan).

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