UNIVERSITI PUTRA MALAYSIA

EFFECTS OF CUTTING SIZE AND ORGANIC ACID ON QUALITY AND ENZYME ACTIVITIES OF FRESH-CUT WAX APPLE (Syzygium samarangense (BLUME) MERILL & PERRY)

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By

NUR IZZAH BINTI KADIR

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

May 2015

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

EFFECTS OF CUTTING SIZE AND ORGANIC ACID ON QUALITY AND ENZYME ACTIVITIES OF FRESH-CUT WAX APPLE (*Syzygium samarangense* (BLUME) MERILL & PERRY)

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Chair: Associate Professor Yahya Awang, PhD

Faculty: Agriculture

Wax apple seems to be one of the potential fruits for fresh-cut market. The knowledge on fresh-cut wax apple is still lacking especially on their enzymes activity with respect to cell wall softening and tissue browning and how these enzymes could contribute in maintaining products' quality. Thus, the study was conducted in order to gain more knowledge on the changes that occurred during the processing of fresh-cut wax apples that might be affected by cutting sizes and dipping treatment while remaining or maintaining the quality almost as good as intact fruits.

In the first experiment, wax apples were stored as whole (control), halves, quartered, and wedged in domestic refrigerator (~5^0C) for nine (9) days and observed at 0, 3, 6, and 9 day. Water loss was observed to be increasing from day zero to day nine and also significantly related with the cutting sizes in which the whole wax apples lost the least amount of water compared to other cutting sizes. Firmness, total soluble solid, and ascorbic acid of wax apples were reduced significantly throughout the nine days of storage meanwhile the titratable acidity and pH value was observed to increase throughout the storage period. Since cutting sizes did not showed much significant differences on post-harvest qualities except for weight loss and titratable acidity, it is recommended to process wax apple into wedged (1/8) since they have the ability to retain their moisture by absorbing back more water from the condensation that could prevent weight loss. In conclusion, it is possible to use *Syzygium samarangense* as fresh-cut products as the changes in the qualities of fresh-cut wax apples was not critical in a way that they could reduce the market value of wax apples.

For the second experiment, the wedged fresh-cut wax apples were dipped into three types of organic acids; ascorbic acid (AA), citric acid (CA), and oxalic acid (OA) at five different concentrations (0, 0.5, 1.0, 1.5 and 2.0%) and stored for nine days. The type of acids did not significantly affect water loss of the samples but the parameter was markedly varied under varying levels of acid concentration ($P \leq 0.01$) and storage period ($P \leq 0.0001$). The effect of acid concentration was apparently interacted significantly with period of storage ($P \leq 0.01$). The titratable acidity of fresh-cut wax apples was significantly affected by different type of acids but their effects on TA varied depending on their concentration. At a lower concentration of organic acids, the TA measured were similar to each other for AA, CA, and OA but the TA in the OA-dipped fresh-cut wax apples started to increase significantly as the concentration of organic acids increased from 1.0 to 2.0%. In comparison to CA and OA, the concentration of AA dipping treatment caused the increased of the ascorbic acid content in fresh-cut wax apples without decreasing the pH that indicates sourness which can be an added value to fresh-cut wax apple in terms of nutrition. OA treated wax apples was recorded with the highest antioxidant activity which is 90.64% followed by CA (86.15%) and AA (81.17%) with the significant increased throughout nine days of storage period. Fresh-cut wax apples treated with OA (33.84 mg/100g) and CA (33.64 mg/100g) resulted in a significantly higher TPC in comparison to those dipped in AA (30.43 mg/100g) with the increased in TPC over nine days of storage period. As for enzyme activities, only pectin methylesterase and polyphenol oxidase activities were only affected by storage period whereas polygalacturonase activity was not affected by the treatment given.

Overall, it can be concluded that the treatment with the 2.0% of ascorbic acid was proven to be beneficial for fresh-cut wax stored up to 9 days since it was recorded with the highest amount of ascorbic acid content or better known as vitamin C compared to other concentrations but at the same time, the pH remains similar to others that may suggest the retention of the flavours for the fresh-cut wax apples.

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

KESAN SAIZ POTONGAN DAN ASID ORGANIK KE ATAS KUALITI DAN AKTIVITI ENZIM BUAH JAMBU AIR (*Syzygium samarangense* (BLUME) MERILL & PERRY)

Oleh

NUR IZZAH BINTI KADIR

Mei 2015

Pengerusi : Professor Madya Yahya Awang, PhD

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Jambu air merupakan salah satu buah yang berpotensi untuk menjadi produk potongan segar. Pengetahuan tentang jambu air potong ini masih lagi kurang terutamanya berkaitan rawatan celupan serta enzim yang mempengaruhi kekerasan serta pemerangan sel tisu jambu serta bagaimana enzim boleh memberi kesan dalam usaha mengekalkan kualiti produk. Oleh itu, kajian ini dilakukan untuk medapatkan lebih pengetahuan tentang perubahan yang berlaku semasa pemprosesan buah jambu air potong yang mungkin dipengaruhi oleh saiz potongan dan rawatan celupan dalam mengekalkan kualitinya sebaik buah yang tidak diproses.

Untuk eskperimen pertama, jambu air telah disimpan secara keseluruhan, potongan separuh, potongan 4, dan potongan 8 disimpan di dalam bekas dan diletakkan ke dalam peti ais (~5^0C) untuk 9 hari dan dianalisis pada hari 0, 3, 6, dan 9. Kehilangan air diperhatikan meningkat daripada hari kosong kepada hari ke sembilan dan berkaitan secara signifikan dengan saiz potongan di mana jambu air yang tidak diproses kehilangan sedikit air berbanding dengan saiz potongan yang lain. Kekerasan, jumlah pepejal larut dan asid askorbik berkurang dengan ketara sepanjang 9 hari penyimpanan sementara itu keasidan tertitrat dan nilai pH diperhatikan meningkat sepanjang tempoh penyimpanan. Memandangkan saiz potongan tidak menunjukkan banyak perbezaan dalam kualiti pasca tuai kecuali untuk kehilangan berat dan keasidan tertitrat, ianya dicadangkan untuk memproses buah jambu air pada potongan 1/8 memandangkan mereka mempunyai kebolehan untuk mengekalkan kelembapan dengan menyerap kembali lebih banyak air yang terhasil daripada proses kondensasi yang boleh mengurangkan kehilangan berat. Kesimpulannya, jambu air mempunyai potensi sebagai produk potongan segar kerana perubahan kualiti buah jambu air potong tidak kritikal sehingga mampu mengurankan nilai pasaran jambu air.

Di dalam eksperimen kedua, jambu air potong 1/8 telah dicelup ke dalam tiga jenis asid organik termasuk asid askorbik (AA), asid sitrik (CA), dan asid oksalik (OA) pada 5 kepekatan yang berbeza (0, 0.5, 1.0,1.5, dan 2.0%). Hasil menunjukkan jenis asid tidak mempengaruhi kehilangan air secara signifikan tetapi berbeza di bawah kepekatan asid yang berbeza ($P \leq 0.01$) dan juga tempoh simpanan ($P \leq 0.0001$) yang juga dikesan berinteraksi antara satu sama lain ($P \leq 0.01$). Keasidan tertitrat dipengaruhi secara signifikan oleh jenis asid tetapi berbeza bergantung kepada kepekatannya. Pada kepekatan asid yang rendah, keasidan tertitrat untuk jambu air untuk celupan ke dalam AA, CA, dan OA adalah hampir sama tetapi untuk OA meningkat sebaik sahaja kepekatannya meningkat daripada 1.0% ke 2.0%. Berbanding dengan celupan ke dalam CA dan OA, kepekatan celupan AA telah meningkatkan kandungan asid askorbik di dalam jambu air potong tanpa merendahkan pH yang menunjukkan tahap kemasaman yang boleh dijadikan nilai tambah untuk jambu air potong dari segi nutrisi. Jambu air potong yang dicelup dengan OA juga merekodkan kadar antioksida yang paling tinggi iaitu 90.64% diikuti dengan CA (86.15%) dan AA (81.17%) dengan peningkatan yang signifikan sepanjang sembilan hari penyimpanan. Kandungan fenolik untuk jambu air yang dicelup dengan OA (33.84 mg/100g) dan CA (33.64 mg/100g) adalah lebih tinggi daripada AA (30.43 mg/100g) yang menunjukkan peningkatan sepanjang tempoh penyimpanan. Untuk enzim aktiviti pula, hanya aktiviti pektin metilesterase dan polifenol oksida hanya dipengaruhi oleh jangka waktu simpanan sementara aktiviti polygalakturonase tidak berubah oleh rawatan yang diberikan.

Secara keseluruhannya, rawatan (celupan) ke dalam 2.0% asid askorbik dikenalpasti dapat memberi kelebihan untuk jambu air potong untuk penyimpanan sehigga sembilan hari memandangkan ianya direkodkan dengan jumlah asid askorbik atau lebih dikenali dengan vitamin C berbanding kepekatan yang lain tetapi pada masa yang sama dapat mengekalkan nilai pH sama dengan yang lain.

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I certify that a Thesis Examination Committee has met on 28 May 2015 to conduct the final examination of Nur Izzah binti Kadir on her thesis entitled "Effects of Cutting Size and Organic Acid on Quality and Enzyme Activities of Fresh-Cut Wax Apple (*Syzygium samarangense* (Blume) Merrill & Perry)" 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.

Members of the Thesis Examination Committee were as follows:

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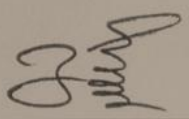

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This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfilment of the requirement for the degree of Master of Science. The members of the Supervisory Committee were as follows:

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%	percent
^{0}C	degree celcius
AA	ascorbic acid
AAS	atomic absorption spectrophotometer
ANOVA	analysis of variance
CA	citric acid
CRD	completely randomized design
FW	fresh weight
LSD	least significant difference
OA	oxalic acid
FAO	Food and Agriculture Organization
TA	titratable acidity
TSS	total soluble solid
TPC	total phenolic content
GRAS	generally recognized as safe
PPO	polyphenol oxidase
PG	Polygalacturonase
PME	pectin methylesterase

CHAPTER 1

INTRODUCTION

Syzygium samarangense or commonly known as wax apple is a species from the Myrtaceae family. The plants of Myrtaceae family can be found abundantly around South East Asia, South America, and Australia (Reynertson et al., 2008). Wax apple, a non-climacteric fruits, is presumed to be native to Philippines, Indonesia, and Malaysia (Rosnah et al., 2012). Khandaker et al., (2011) stated that wax apple is widely cultivated in Malaysia, Thailand, Taiwan, and Indonesia. The tree of wax apple is used to be popular as backyard trees before being cultivated for commercial purposes.

A number of cultivars have been developed and grown all over the tropical and subtropical region of the world (Simirgiotis et al., 2008). Wax apple is glossy and can be found in green to dark red colour depending on the variety (Nakasone and Paull, 1998). As for the shape there are pear-shaped and bell-shaped wax apple according to its variety (Simirgiotis et al., 2008; Rosnah et al., 2012). The length of the fruits may be found within the range of 4 to 5 cm and 5 to 8 cm wide (Rosnah et al., 2012). The fruit is fibrous with white-flesh pulp and sometimes contain 1 to 4 seeds (around 1 to 2 cm in diameter) (Simirgiotis et al., 2008), but can also be seedless (Morton, 1987).

Wax apple's pulp is rich in water and crispy at the same time. Wax apple also produce subtle sweet and low acidic taste that becomes one of the special characteristics of this fruit. According to Food and Agriculture Organization (FAO) (2005), the combinations of the characteristics mentioned above has made wax apple to be favoured in Western countries.

Nowadays, fresh-cut fruits and vegetables has become a trend in order to encourage the consumption of healthy food for a healthier lifestyle. For example, the consumption of fresh-cut produces has been increasing in Asia, Australia, Western countries, and also Europe (Kim, 2007). Fresh-cut or minimally processed fruits and vegetables are defined as fruits and vegetables that are ready for consumption without further processing. In other words, the fruits and vegetables must have been trimmed or peeled or cut, washed, packaged, and maintained with refrigeration as 100% usable products before being sold to consumers.

Another common problem that arises in the fresh-cut industry is the occurrence of enzymatic browning. Enzymatic browning mostly occurs due to the presence of polyphenol oxidase (PPO) on phenolic compounds with the presence of activated enzyme, oxygen, and fibre (Kim and Jung, 2011). Generally, browning in fresh-cut products could reduce the appearance and nutritional values. Ascorbic acid (AA), citric acid (CA), and oxalic acid (OA), the three anti-browning agents that are generally recognized as safe (GRAS), being used as anti-browning agents due to its properties as weak organic acids and widely found in plant tissues. The effectiveness of AA, CA,

and OA on fresh-cut products varied depending on the types of organic acid, concentration being used and type of produces. This is due to the different PPO isozymes and/or phenolic substrates among products types (Suttirak and Manurakchinakorn, 2010).

At the same time, enzymes reactions could also resulted in the reduction of firmness of the fresh-cut products during storage and ripening. This is due to the modifications of the polymers' network causing the loss of the firmness and change the texture of the produces (Brummel et al., 1999). Polygalacaturonase (PG) and pectin methylesterase (PME) are enzymes that play roles in softening of cell wall. In the effort of reducing the firmness loss in fresh-cut produces, it is crucial for us to understand the behavior of cell wall degrading enzymes so that their activities could be controlled in order to lengthen the economical values of the fresh-cut products.

Due to the changes in the qualities of fresh-cut fruits in general, wax apple is not an exception. Hence, it is important to conduct this study so that researchers will be able to gain more knowledge on the changes that might occurred during the processing of fresh-cut wax apples and to figure out the most cutting sizes that allows the trading of fresh-cut wax apples while remaining or maintaining the quality almost as good as intact fruits. Additionally, the treatment with well known anti-browning agents such as AA, CA, and OA that is known to reduce or retard the degradation of the fresh-cut products was might also be beneficial in reducing the quality losses of fresh-cut wax apple as researchers in the fresh-cut field had been working extensively on how to reduce and/or retard the browning problem in fresh-cut products that might also be associated with the enzyme activities revolving inside the wax apple. The appropriate anti-browning agents dipping treatment could effectively delay the browning in fresh-cut wax apples can be determined through this study.

With the justification stated in the paragraph before, hence the objectives of this study were

(1) To evaluate the retention of wax apple qualities throughout storage as whole and also potentially as fresh-cut fruits.
(2) To evaluate the potential use of organic acids such as ascorbic acid, citric acid, and also oxalic acid as they are known to have the potential in retaining or reducing the qualities losses throughout the storage.
(3) To investigate the activities of the cell wall enzymes such as polygalacturonase (PG), pectin methylesterase (PME), and also browning enzyme, polyphenol oxidase activities in affecting the qualities of fresh-cut wax apples.

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