OPTIMIZATION OF PAPAYA (*CARICA PAPAYA*) JUICE QUALITY THROUGH ACIDIFIED BLANCHING WATER AND PECTINASE ENZYME PRE-TREATMENTS

By

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A dissertation submitted in partial fulfillment of the requirements for the degree of Bachelor of Technology (B.Tech) in the field of Food Technology
School of Industrial Technology
Universiti Sains Malaysia

June 2021

PUSAT PENGAJIAN TEKNOLOGI INDUSTRI UNIVERSITI SAINS MALAYSIA

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Sekian, terima kasih.

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This dissertation is composed of my original work and contains no material previously published or written by another person except where due reference has been made in the text. The content of my dissertation is the result of work I have carried out since the commencement of my research project and does not include a substantial part of work that has been submitted to qualify for the award of any other degree or diploma in any university or other tertiary institution.

Ong Wen Le

June 2021

ACKNOWLEDGEMENTS

I would like to express my gratitude to everyone who had helped me along this journey. First and foremost, I would like to thank my final year project supervisor, Dr. Maizura Murad for her advice and guidance through this project. She is always attentive, caring and ready to help with any problems I face. Without her dedication, this thesis would not be possible.

I would also like to thank Dr. Maizura's postgraduate student, Ms Rashima for her help and guidance throughout my research study. She is friendly and willing to share with me the knowledge and skills needed for the analysis conducted. Furthermore, I would like to thank the staffs and lab assistants of School of Industrial Technology who assisted me while using the equipment in laboratory. They are patient and helpful to all the final year students carrying out experiment.

Lastly, I am very grateful to have such supportive family members and friends who always encourage and take care of me during my final year project.

Ong Wen Le

June 2021

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LIST OF ABBREVIATIONS

Abbreviation	Caption
ABW	Acidified blanching water
PE	Pectinase enzyme
RSM	Response surface methodology
CCD	Central composite design
TSS	Total soluble solids
TPC	Total phenolic content
TFC	Total flavonoid content
TCC	Total carotenoid content
AAC	Ascorbic acid content
DPPH	2,2-Diphenyl-1-picrylhydrazyl
FRAP	Ferric reducing antioxidant power

PENGOPTIMUMAN KUALITI JUS BETIK (*CARICA PAPAYA*) MELALUI PRA-RAWATAN AIR PENCELURAN BERASID DAN ENZIM PEKTINASE

ABSTRAK

Buah betik (*Carica papaya*) adalah buah yang sangat mudah rosak. Ia boleh diproses menjadi jus betik untuk memanjangkan jangka hayatnya. Namun, kandungan pektin yang tinggi dalam betik menyebabkan pengekstrakan jus menjadi sukar dan memberi hasil yang rendah. Kajian ini bertujuan untuk menentukan kesan rawatan air penceluran berasid dan enzim pektinase terhadap hasil, sifat fizikokimia dan antioksidan jus betik, dan mengoptimumkan kualiti jus betik menggunakan pra-rawatan gabungan dengan menggunakan kaedah permukaan tindak balas (RSM). Kesan individu air penceluran berasid (0-2.5% asid sitrik) dan enzim pektinase (10-30 ppm) dikenal pasti untuk hasil, sifat fizikokimia (jumlah pepejal larut (TSS), kelikatan, kejelasan, warna, pH dan keasidan yang boleh ditetrasi (TA)) dan sifat antioksidan (jumlah kandungan fenolik (TPC), jumlah kandungan flavonoid (TFC), jumlah kandungan karotenoid (TCC), kandungan asid askorbik (AAC), aktiviti pemerangkapan radikal bebas DPPH dan ujian FRAP). Reka bentuk komposit pusat (CCD) digunakan untuk mengkaji kesan air penceluran berasid (0.5-1.5% asid sitrik) dan enzim pektinase (10-30 ppm) terhadap hasil, sifat fizikokimia (TSS, kelikatan, kejelasan, warna dan pH) dan sifat-sifat antioksidan (TPC, TFC, TCC, ujian DPPH dan FRAP). Peningkatan kepekatan air penceluran berasid secara signifikan ($p<0.05$) meningkatkan kejernihan, kecerahan, kekuningan dan TA jus betik dan mengurangkan TSS, kelikatan, kemerahan dan sifat-sifat antioksidan. Peningkatan kepekatan enzim pektinase menyebabkan peningkatan kejernihan dan kecerahan, dan pengurangan TSS, kemerahan, kekuningan, pH, TPC, TCC, AAC, DPPH dan FRAP. Pra-rawatan gabungan air penceluran berasid dan enzim pektinase secara

signifikan ($p<0.05$) mempengaruhi hasil, pH dan TFC jus betik. Selepas pengoptimuman, pra-rawatan 1.05% asid sitrik dalam air penceluran berasid dan 10 ppm enzim pektinase dipilih untuk menghasilkan jus betik dengan hasil maksimum, sifat fizikokimia yang baik dan sifat antioksidan yang tinggi.

OPTIMIZATION OF PAPAYA (*CARICA PAPAYA*) JUICE QUALITY THROUGH ACIDIFIED BLANCHING WATER AND PECTINASE ENZYME PRE-TREATMENTS

ABSTRACT

Papaya (*Carica papaya*) is a highly perishable fruit, it could be processed into papaya juice to prolong its shelf life. However, high pectin content in papaya causes juice extraction difficulty, resulting in low yield. This study aims to determine the effect of acidified blanching water and pectinase enzyme pre-treatments on the yield, physicochemical and antioxidant properties of papaya juice, and to optimize the papaya juice quality using combined pre-treatments with response surface methodology (RSM). Individual effect of acidified blanching water (0-2.5% citric acid) and pectinase enzyme (10-30 ppm) was determined for the yield, physicochemical properties (total soluble solids (TSS), viscosity, clarity, colour, pH and titratable acidity (TA)) and antioxidant properties (total phenolic content (TPC), total flavonoid content (TFC), total carotenoid content (TCC), ascorbic acid content (AAC), DPPH scavenging activity and FRAP assay). Central composite design (CCD) was used to study the effect of acidified blanching water (0.5-1.5% citric acid) and pectinase enzyme (10-30 ppm) on the yield, physicochemical properties (TSS, viscosity, clarity, colour and pH) and antioxidant properties (TPC, TFC, TCC, DPPH and FRAP assay). Increasing concentration of acidified blanching water significantly ($p<0.05$) increases the clarity, lightness, yellowness and TA of papaya juice and decreases the TSS, viscosity, redness and antioxidant properties. Increasing pectinase enzyme concentration cause increase in clarity and lightness, and decrease in TSS, redness, yellowness, pH, TPC, TCC, AAC, DPPH and FRAP. Combined pre-treatments of acidified blanching water and pectinase enzyme significantly ($p<0.05$) affected the yield, pH and TFC of papaya juice. After optimization, 1.05% citric acid in acidified blanching

water and 10 ppm pectinase enzyme pre-treatments were selected to produce papaya juice with maximum yield, good physicochemical properties and high antioxidant properties.

Chapter 1 Introduction

1.1 Research background

Papaya (*Carica papaya*) is a common tropical fruit belong to the *Caricaceae* family and *Carica* genus. It originates from tropical areas of America, and is now mainly cultivated in many tropical and subtropical countries especially Brazil, Mexico, and Nigeria (Ovando-Martínez & González-Aguilar, 2020). According to the Food and Agriculture Organization (FAO) of the United Nations (Medina et al., 2003), papaya fruit is usually made up of approximately 8.5% seed, 12% skin, and 79.5% pulp. Unripe papaya's peel is green, hard and usually produces white latex consisting of a hydrolytic enzyme known as papain, whereas ripe papaya's peel turns into yellow colour. As the papaya ripens, its flesh colour turns yellow-orange or reddish, while the succulent flesh wall thickens. The flavour of a ripe papaya is sweet, the taste is similar to a cantaloupe, and the texture is juicy. In certain types of papaya, the flavour can be slightly musky. A papaya can be consumed at any stage of ripeness. Shredded unripe papaya is used to add flavour to some cuisines, for instance, "som tam" (green papaya salad) is a famous dish in Thailand. Meanwhile, ripe papaya is consumed fresh or processed into jam, jelly and chutney (Saran et al., 2015).

The fruit has a great palatability and high productivity, hence being a useful and favoured fruit to consumers worldwide. According to Saeed et al. (2014), papaya can provide 200 kJ/100 g of energy. The study by Gomez et al. (2002) shows the total soluble solids (TSS) content in a ripe papaya is approximately 48.6 mg/g fresh weight or 9% of the fruit, and is made up mainly of sucrose (61.32%), glucose (26.13%), and fructose (12.55%). The protein content of papaya is about 5%. In the previous decade, papaya is consumed more frequently especially in Europe due to its high content of vitamins, minerals and antioxidants (Karunamoorthi et al., 2014). The papain enzyme in papaya fruit can be beneficial in preventing and improving digestive system disorders, whereas the antioxidant and phenolic compounds found in papaya play a vital role to prevent cardiovascular diseases. Papaya is also proved to have great pharmacological functions such as antioxidant, anti-inflammatory, antimicrobial and anti-hypertensive (Vij & Prashar, 2015). Nevertheless, its nutritional values is affected by the species, growing condition and also the ripeness level (Alara et al., 2020).

Papaya is a highly productive and fast-growing fruit with a fruiting period of 4 to 6 months, depending on the climate of plantation. However, the quality of papaya fruit is often influenced by many conditions such as harvesting timing and practices, diseases, post-harvest treatment, and storage conditions. It is also highly perishable and is prone to post-harvest loss either qualitatively or quantitatively (Sivakumar & Wall, 2013). Therefore, the consumption period of harvested papaya is relatively short, where it can only be stored for 2 weeks even in the optimum temperature of 12 °C (Chan & Sim, 2019). In order to extend the shelf life of papayas, many post-harvest processing is carried out, such as vacuum packing, irradiation, refrigeration, waxing, modified or controlled atmospheric conditions, and many more (Padmanaban et al., 2014; Sidhu, 2007).

Besides the post-harvesting processing mentioned above, one of the processing methods to extend the papaya shelf life is to extract papaya juice from the harvested fruit. Juice extraction is an easier way to preserve fruits and it is more convenient to be consumed (Sharma et al., 2017). Papaya juice can provide a rich source of vitamin A, potassium and carotenoids like beta-carotene (Djokoto et al., 2006). According to Saran et al. (2015), papaya juice is useful in curing warts, tumours, corns and some other skin defects. Papaya juice is sometimes mixed with other fruits such as pineapples or mangoes so that the aftertaste is reduced and the taste acceptability is enhanced (Sidhu, 2007).

However, there is a challenge in the process of extracting papaya juice. The mechanical pressing of papaya fruits with high pectin content causes a low juice yield as the papaya tissues tend to bind to the pulp, forming a jellified texture (Tapre & Jain, 2014). Therefore, the juice extraction is terribly difficult, especially when the extraction is done without an extraction aid (Djokoto et al., 2006). Therefore, in juice processing industry, enzymes are often applied in order to degrade the pectin and to achieve partial or total liquefaction of the papaya flesh. Study by Vishal et al. (2015) shows that enzymatic liquefaction can produce papaya juice with high yield and smooth extraction can occur. Other than that, the papaya juice concentration can reach a higher degree brix. Nevertheless, the addition of enzymes should be done in an optimum amount as too much enzyme can affect the level of antioxidants or the polyphenolic compounds within the papaya juice (Sun et al., 2007). In this study, different concentrations of pectinase enzyme will be used to facilitate the extraction of papaya juice in order to obtain the highest papaya juice yield.

Blanching is another useful way to preserve the quality of the papaya fruit. The benefit of carrying out blanching on the papaya is that it does not affect much of the sensory quality of the products. Blanching can inactivate or stop undesirable enzymatic reactions, soften the texture, and destroy microorganisms in the fruit (Deng et al., 2019). Based on the research done by Yu and Rupasinghe (2012), acidified blanching allows the juice to have higher physicochemical properties stability and a longer shelf life. Guiamba and Svanberg (2016) found that pre-treating with blanching at 90 °C for 4 min, with acidification by citric acid to pH 3.9, can retain nearly 90% of vitamin C in mango puree.

Blanching can also prevent the discolouration of fruits, as pigments such as carotenoids and anthocyanin show high retention level after blanching (Nayak et al., 2015). However, the level of these pigments decreases as the blanching temperature and time increases.

In this project, the effect of two pre-treatments, namely acidified blanching water and pectinase enzyme, on the papaya juice will be studied. Analysis will be carried out particularly on the physicochemical properties and antioxidant properties of the papaya juice. Ideally, an optimum combination of treatment method can be identified such that both the yield and quality of the papaya juice produced can be maintained.

1.2 Problem statement

Papaya is a great and beneficial commodity which is highly perishable and requires processing to extend its shelf life. Papaya juice can be extracted but the process of extraction is difficult due to its high pectin level, causing low yield of the juice which is about 60%. Pectinase enzyme can be added to ease the juice extraction by degrading the pectin, but enzyme application can cause reduction in the micronutrient contents of the product. Therefore, different concentrations of pectinase enzyme and acidified blanching water will be applied. With the suitable treatment, it is hoped that the yield can be increased by 10-20%, and at the same time the antioxidant properties can be retained for the papaya juice product.

1.3 Objectives

Research questions:

1. How does the acidified blanching water and pectinase enzyme influence the yield and physicochemical properties of the papaya juice?
2. How does the acidified blanching water and pectinase enzyme react with the pectin and the antioxidant activities of the papaya juice?
3. What is the optimum concentration of acidified blanching water and pectinase enzyme to produce papaya juice with high yield and antioxidant properties?

General objective:

To develop papaya juice with good physicochemical properties and high antioxidant activities.

Specific objectives:

1. To determine the effects of acidified blanching water and pectinase enzyme pre-treatments on the yield and physicochemical properties of papaya juice.
2. To determine the effects of acidified blanching water and pectinase enzyme on the antioxidant properties of papaya juice.
3. To optimize papaya juice yield, physicochemical and antioxidant properties using acidified blanching water and pectinase enzyme pre-treatments.