



UNIVERSITI PUTRA MALAYSIA

**QUALITY AND ALPHA-GLUCOSIDASE INHIBITORY ACTIVITY OF
FRESH-CUT PINEAPPLE COATED WITH *Neptunia oleracea* Lour. AND
Cosmos candatus Kunth. LEAF EXTRACTS**

YONG YENG YENG

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By

YONG YENG YENG

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

October 2021

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DEDICATION

I would like to dedicate my thesis to my parents, Yong Kim Sang and Lee Kooi Hong for their unconditional love and support in my life.



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

QUALITY AND ALPHA-GLUCOSIDASE INHIBITORY ACTIVITY OF FRESH-CUT PINEAPPLE COATED WITH *Neptunia oleracea* Lour. AND *Cosmos candatus* Kunth. LEAF EXTRACTS

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October 2021

Chair : Associate Professor Noranizan Mohd Adzahan, PhD
Faculty : Food Science and Technology

The MD2 pineapple (*Ananas comosus*) is highly demanded in Malaysia due to its sweet taste and refreshing smell. Wounding of fruit tissues during cutting shortens the shelf life of cut fruits as they are susceptible to deterioration. Besides, taking a large serving size of fresh-cut MD2 pineapple will result in a spike of blood sugar level for diabetic patients. This study aimed to evaluate the storage stability and alpha-glucosidase inhibitory activity of fresh-cut MD2 pineapple coated with an edible coating which was incorporated with either water mimosa (*Neptunia oleracea* Lour.) or Ulam Raja (*Cosmos caudatus* Kunth.) leaf extract. Two types of edible coating were compared in this study, namely *Aloe vera* gel and alginate-based coating. *Aloe vera* gel coating was more effective on retaining the storage stability of fresh-cut MD2 pineapple by maintaining microbiological quality up to 14 days with reduced fluid loss. The water mimosa and Ulam Raja leaf extract coating formulation on fresh-cut MD2 pineapple was optimized by response surface methodology (RSM). The optimised water mimosa leaf extract coating formulation was 71.72% (w/v) *Aloe vera* gel and 1.62% (w/v) water mimosa leaf extract while and the optimised Ulam Raja leaf extract coating formulation was 20% (w/v) *Aloe vera* gel and 1.59% (w/v) Ulam Raja leaf extract. There was no significant ($p > 0.05$) difference between the samples coated with the optimised coating formulation and uncoated samples in term of colour, aroma, taste, texture and the overall acceptability under sensory evaluation. The coated MD2 pineapples were further evaluated for total phenolic content (TPC), DPPH free radical scavenging, alpha-glucosidase inhibitory activity, physicochemical and microbiological properties. Results showed that coated samples with the extracts incorporated have a significantly ($p < 0.05$) higher value of TPC, DPPH free radical scavenging and alpha-glucosidase inhibitory activity than uncoated samples and samples coated

with *Aloe vera* alone. The extract- coated samples also displayed a significant ($p < 0.05$) reduced fluid loss, better retention in pH value and total soluble solid and had longer shelf life extension compared to uncoated samples. In conclusion, incorporation of water mimosa and Ulam Raja leaf extract on *Aloe vera* coated fresh-cut pineapple has the potential to enhance the functional value of fresh-cut pineapples and extend the shelf life up to 8 days, without compromising the physiochemical quality during storage at 5 ± 1 °C.

Keywords: fresh-cut pineapple, edible coating, *Neptunia oleracea* Lour., *Cosmos caudatus* Kunth., storage enhancement, alpha-glucosidase inhibitory activity



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

KUALITI DAN AKTIVITI PERENCATAN ALFA-GLUKOSIDA UNTUK POTONGAN SEGAR NANAS YANG DISALUTI DENGAN *Neptunia oleracea* Lour. AND *Cosmos candatus* Kunth DAUN EKSTRAK

Oleh

Yong Yeng Yeng

Oktober 2021

Pengerusi : Profesor Madya Noranizan Mohd Adzahan, PhD
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Nanas jenis MD2 (*Ananas comosus*) merupakan salah satu jenis buah yang menjadi pilihan utama di Malaysia disebabkan oleh kemanisan dan kesegarannya. Walau bagaimanapun, proses pemotongan akan mengakibatkan kerosakan tisu buah-buahan yang boleh memendekkan jangka hayat buah-buahan. Selain itu, pengambilan buah nanas potong jenis MD2 yang banyak akan menambahkan kebarangkalian peningkatan dalam tahap gula pesakit diabetes. Oleh itu, kajian ini bertujuan untuk menilai kestabilan penyimpanan dan aktiviti perencatan alfa-glukosidase untuk potongan segar. Nanas jenis MD2 melalui proses penyalutan yang menggunakan gabungan salutan yang boleh dimakan di dalam ekstrak daun mimosa air (*Neptunia oleracea* Lour.) dan Ulam Raja (*Cosmos caudatus* Kunth.). Dua jenis salutan yang boleh dimakan akan dibandingkan dalam kajian ini iaitu gel *Aloe vera* dan alginate. Keputusan kajian menunjukkan salutan gel *Aloe vera* adalah lebih berkesan untuk mengekalkan kestabilan penyimpanan buah nanas potong jenis MD2 dapat mengekalkan kualiti mikrobiologi sehingga 14 hari dengan pengurangan kehilangan cecair. Seterusnya, formulasi gabungan salutan gel *Aloe vera* di dalam ekstrak daun mimosa air dan Ulam Raja dioptimumkan dan keputusan kajian memberikan formulasi optimum untuk salutan daun ekstrak mimosa air dan Ulam Raja pada 71.72% (w/v) gel *Aloe vera* dan 1.62% (w/v) mimosa air dan 20% (w/v) gel *Aloe vera* dan 1.59% (w/v) Ulam Raja masing-masing. Ujian statistik menunjukkan tiada perbezaan yang signifikan ($p > 0.05$) bagi sampel formulasi optimum berbanding dengan sampel kawalan dari segi warna, aroma, rasa, tekstur dan kebolehterimaan secara keseluruhan berdasarkan motor deria. Nanas jenis MD2 yang disaluti dikaji selanjutnya untuk kandungan total fenolik (TPC), pemungutan radikal bebas DPPH, aktiviti perencatan alfa-glukosidase, sifat fizikokimia dan mikrobiologi. Keputusan kajian menunjukkan sampel yang disaluti memberikan nilai yang signifikan ($p < 0.05$) dari segi TPC, pemungutan radikal bebas DPPH dan aktiviti perencatan alfa-glukosidase berbanding dengan

sampel kawalan dan sampel Nanas jenis MD2 yang disaluti dengan *Aloe vera* sahaja. Sampel pada formulasi optimum juga menunjukkan berkesan ($p < 0.05$) dari segi pengurangan kehilangan air buah, pengekalan nilai pH, jumlah pepejal larut dan jangka hayat produk yang lebih lama berbanding dengan sampel kawalan. Secara kesimpulan, gabungan mimosa air dan Ulam raja daun ekstrak dengan gel *Aloe vera* di atas nanas jenis MD2 menunjukkan potensi dalam meningkatkan nilai fungsian bagi potongan segar nanas dan melanjutkan jangka hayat produk sehingga 8 hari tanpa menjejaskan kualiti fizikokimia produk dalam penyimpanan suhu 5 ± 1 °C.

Kata Kunci: nanas potong, salutan yang boleh dimakan, *Neptunia oleracea* Lour., *Cosmos caudatus* Kunth., jangka hayat produk, perencatan alfa-glukosidase aktiviti

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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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TABLE OF CONTENTS

	Page
ABSTRACT	i
ABSTRAK	iii
ACKNOWLEDGEMENTS	v
APPROVAL	vi
DECLARATION	viii
LIST OF TABLES	xiv
LIST OF FIGURES	xvi
LIST OF APPENDICES	xviii
LIST OF EQUATIONS	xix
LIST OF ABBREVIATIONS	xxi
CHAPTER	
1 INTRODUCTION	1
2 LITERATURE REVIEW	4
2.1 Pineapple	4
2.1.1 Origin and distribution	4
2.1.2 Botanical description and varieties of pineapple	5
2.1.3 Nutritional components and bioactive compounds	5
2.1.4 Harvesting, storage and handling	6
2.1.5 Fresh-cut pineapple	6
2.2 Fresh-cut fruit	6
2.2.1 Definition and current trends	6
2.2.2 Problems of fresh-cut fruits	7
2.2.3 Ways to overcome the problems of fresh-cut fruits	8
2.3 Diabetes mellitus	10
2.3.1 Definition	10
2.3.2 Issues of diabetes mellitus in Malaysia	11
2.3.3 Remedy of diabetes mellitus	12
2.4 Edible coating	12
2.4.1 Definition and history	12
2.4.2 Classification of edible coating	13
2.4.3 Application and advantages of edible coating on fresh-cut fruits	14
2.4.4 Requirement and challenge of edible coating	16
2.5 Water mimosa	16
2.5.1 Origin and distribution	16
2.5.2 Botanical description	17
2.5.3 Nutritional components and bioactive compounds	17

2.5.4	Pharmacological reports	18
2.6	Ulam Raja	18
2.6.1	Origin and distribution	18
2.6.2	Botanical description	19
2.6.3	Nutritional components and bioactive compounds	19
2.6.4	Pharmacological reports	20
3	EFFECT OG ALGINATE AND <i>ALOE VERA</i> GEL-BASED EDIBLE COATING ON THE STORAGE QUALITY OF FRESH-CUT MD2 PINEAPPLE	22
3.1	Introduction	22
3.2	Materials and methods	23
3.2.1	Materials	23
3.2.2	Fruit sample preparation	23
3.2.3	Alginate-based edible coating formulation	23
3.2.4	<i>Aloe vera</i> gel-based edible coating formulation	24
3.2.5	Storage conditions	24
3.2.6	Headspace gas composition	25
3.2.7	Fluid loss	25
3.2.8	Firmness	25
3.2.9	Colour	25
3.2.10	Microbiological analysis	26
3.2.11	Coating homogeneity and adherence	26
3.2.12	Statistical analysis	26
3.3	Results and discussion	26
3.3.1	Headspace gas composition	26
3.3.2	Fluid loss	28
3.3.3	Firmness	29
3.3.4	Colour	30
3.3.5	Microbiological analysis	31
3.3.6	Coating homogeneity and adherence	34
3.4	Conclusion	35
4	OPTIMISATION OF WATER MIMOSA (<i>Neptunia oleracea</i> Lour.) AND ULAM RAJA (<i>Cosmos caudatus</i> Kunth.) LEAF EXTRACTS COATING FORMULATION ON FRESH-CUT MD2 PINEAPPLE	36
4.1	Introduction	36
4.2	Materials and methods	37
4.2.1	Materials	38
4.2.2	Extraction of Water mimosa	38
4.2.3	Extraction of Ulam Raja	38
4.2.4	Coating optimization	38
4.2.5	Samples preparation and treatment	40

4.2.6	Fluid Loss	40
4.2.7	Firmness	40
4.2.8	Alpha-glucosidase inhibitory activity	40
4.2.9	Total colour difference	41
4.2.10	Sensory Evaluation	41
4.2.11	Statistical analysis	41
4.3	Results and discussion	42
4.3.1	Optimization of Water mimosa leaf extracts coating formulation	42
4.3.2	Optimization of Ulam Raja leaf extracts coating formulation	47
4.3.3	Sensory evaluation	51
4.4	Conclusion	52
5	STORAGE QUALITY OF FRESH-CUT MD2 PINEAPPLE WITH OPTIMISED WATER MIMOSA (<i>Neptunia oleracea</i> Lour.) AND ULAM RAJA (<i>Cosmos caudatus</i> Kunth.) LEAF EXTRACTS COATING	53
5.1	Introduction	53
5.2	Materials and methods	54
5.2.1	Materials	54
5.2.2	Edible coating preparation	55
5.2.3	Fruit sample preparation and treatment	55
5.2.4	Fluid loss	55
5.2.5	Firmness	55
5.2.6	Colour	56
5.2.7	pH, titratable acidity and total soluble solid	56
5.2.8	Total phenolic content	56
5.2.9	DPPH free radical scavenging assay	56
5.2.10	Alpha-glucosidase inhibitory activity	57
5.2.11	Microbiological analysis	57
5.2.12	Statistical analysis	57
5.3	Results and discussion	57
5.3.1	Fluid loss	57
5.3.2	Firmness	58
5.3.3	Colour	60
5.3.4	pH, total soluble solid and titratable acidity	61
5.3.5	Total phenolic content	63
5.3.6	DPPH free radical scavenging assay	64
5.3.7	Alpha-glucosidase inhibitory activity	66
5.3.8	Microbiological analysis	67
5.4	Conclusion	69

6	SUMMARY, CONCLUSION AND RECOMMENDATIONS FOR FUTURE RESEARCH	70
	REFERENCES/BIBLIOGRAPHY	72
	APPENDICES	93
	BIODATA OF STUDENT	98
	LIST OF PUBLICATIONS	99



LIST OF TABLES

Table		Page
2.1	Preservative techniques for fresh-cut fruits	10
3.1	Effect of edible coating on headspace gas composition of fresh-cut pineapple	27
3.2	Effect of edible coating on the firmness of fresh-cut pineapple	30
3.3	Effect of edible coating on the colour of fresh-cut pineapple	31
4.1	Experimental design for water mimosa leaf extracts coating formulation on fresh-cut MD2 pineapple	39
4.2	Experimental design for Ulam Raja leaf extracts coating formulation on fresh-cut MD2 pineapple	39
4.3	Responses for optimization of water mimosa leaf extracts coating formulation on fresh-cut MD2 pineapple	42
4.4	Analysis of variance of final reduced models for water mimosa leaf extracts coating formulation on fresh-cut MD2 pineapple	43
4.5	Regression coefficients of final reduced models for water mimosa leaf extracts coating formulation on fresh-cut MD2 pineapple	43
4.6	Predicted and experimental values of the responses at optimum formulation of water mimosa coating on fresh-cut pineapple	46
4.7	Responses for the optimization of Ulam Raja leaf extracts coating formulation on fresh-cut MD2 pineapple	47
4.8	Analysis of variance of final reduced models for Ulam Raja leaf extracts coating formulation on fresh-cut MD2 pineapple	48
4.9	Regression coefficients of final reduced models for Ulam Raja leaf extracts coating formulation on fresh-cut MD2 pineapple	48

4.10	Predicted and experimental values of the responses at optimum formulation of Ulam Raja coating on fresh-cut pineapple	51
5.1	Effect of edible coating on the firmness of fresh-cut pineapple	59
5.2	Effect of edible coating on the colour of fresh-cut pineapple	61
5.3	Effect of edible coating on pH, titratable acid and total soluble solids of fresh-cut pineapple	63
5.4	Effect of edible coating on total phenolic content of fresh-cut pineapple	64
5.5	Effect of edible coating on DPPH scavenging activity of fresh-cut pineapple	65
5.6	Effect of edible coating on α -glucosidase inhibitory activity of fresh-cut pineapple	66

LIST OF FIGURES

Figure		Page
2.1	MD2 pineapple	4
2.2	Water mimosa	17
2.3	Ulam Raja	19
3.1	Effect of edible coating on the fluid loss of fresh-cut pineapple	29
3.2	Effect of edible coating on the microbiological analysis (A: total plate count; B: yeast and mould count) of fresh-cut pineapple.	33
3.3	Micrograph (magnification 20x) of cross section of uncoated and edible coated fresh-cut pineapple. (A) without coating (control), (B) <i>Aloe vera</i> coating and (C) alginate coating	34
4.1	Response surface plot for fluid loss (%) as a function of <i>Aloe vera</i> and water mimosa leaf extracts concentration	44
4.2	Response contour plot for α -glucosidase inhibitory activity (%) as a function of <i>Aloe vera</i> and water mimosa leaf extracts concentration	45
4.3	Response contour plot for total colour difference as a function of <i>Aloe vera</i> and water mimosa leaf extracts concentration	46
4.4	Response contour plot for firmness as a function of <i>Aloe vera</i> and Ulam Raja leaf extracts concentration	49
4.5	Response surface plot for total colour change as a function of <i>Aloe vera</i> and Ulam Raja leaf extracts concentration	50
4.6	Sensory attributes of coated and uncoated fresh-cut pineapple on 0 th day.	52
5.1	Effect of edible coating on the fluid loss of fresh-cut pineapple	58

- 5.2 Effect of edible coating on the microbiological analysis (A: total plate count; B: yeast and mould count) of fresh-cut pineapple. 68



LIST OF APPENDICES

Appendix		Page
A	Different varieties of pineapple in Malaysia	93
B	Proximate composition of pineapple	94
C	Maturity stage of MD2 pineapple	95
D	Fluid loss of uncoated and edible coated fresh-cut pineapple on the 16 th storage day. (A) without coating (control), (B) alginate coating and (C) <i>Aloe vera</i> coating	96
E	Preliminary study for the effect <i>Aloe vera</i> coating incorporated with water mimosa leaf extract on α -glucosidase inhibitory activity of fresh-cut pineapple	97

LIST OF EQUATIONS

Equation		Page
1	Percentage of fluid loss	25
2	Whiteness index	25
3	Chromaticity	25
4	Hue angle	25
5	Percentage of α -glucosidase inhibition	40
6	Total colour difference	41
7	General polynomial equation for evaluation of relationship between response and independent variables	41
8	Equation of fluid loss prediction for optimization of water mimosa incorporated <i>Aloe vera</i> coating on fresh-cut pineapple	42
9	Equation of firmness prediction for optimization of water mimosa incorporated <i>Aloe vera</i> coating on fresh-cut pineapple	42
10	Equation of α -glucosidase inhibitory activity prediction for optimization of water mimosa incorporated <i>Aloe vera</i> coating on fresh-cut pineapple	42
11	Equation of total colour difference prediction for optimization of water mimosa incorporated <i>Aloe vera</i> coating on fresh-cut pineapple	42
12	Equation of fluid loss prediction for optimization of Ulam Raja incorporated <i>Aloe vera</i> coating on fresh-cut pineapple	47
13	Equation of firmness prediction for optimization of Ulam Raja incorporated <i>Aloe vera</i> coating on fresh-cut pineapple	47
14	Equation of α -glucosidase inhibitory activity prediction for optimization of Ulam Raja incorporated <i>Aloe vera</i> coating on fresh-cut pineapple	47

15	Equation of total colour difference prediction for optimization of Ulam Raja incorporated <i>Aloe vera</i> coating on fresh-cut pineapple	47
16	DPPH free radical scavenging activity	57



LIST OF ABBREVIATIONS

CaCl ₂	Calcium chloride
CFU	Colony Forming Unit
CO ₂	Carbon dioxide
DM	Diabetes mellitus
DPPH	2,2-diphenyl-1-picrylhydrazyl
FA	Fatty acids
FAMA	Federal Agriculture Marketing Authority
GA	Gallic acid
GC-MS	Gas Chromatographic-Mass Spectrometric
IDF	International Diabetes Federation
IFST	Institute of Food Science and Technology
MAFI	Ministry of Agriculture and Food Industry
MAP	Modified atmosphere packaging
MARDI	Malaysian Agriculture Research and Development Institute
MPIB	Malaysian Pineapple Industry Board
Na ₂ CO ₃	Sodium carbonate
NaOH	Sodium hydroxide
NHMS	Malaysia National Health and Morbidity Survey
NKEA	National Key Economic Area
O ₂	Oxygen
PCA	Plate Count Agar
PE	Pectin exterase
PG	Polygalacturonase
PNPG	<i>p</i> -nitrophenyl- α -D-glucopyranose

PPO	Polyphenol oxidase
PRI	Pineapple Research Institute
RSM	Response surface methodology
TA	Titrateable Acidity
TPC	Total plate count
TPU	University Agricultural Park
TSS	Total Soluble Solids
WHO	World Health Organisation



CHAPTER 1

INTRODUCTION

Pineapple (*Ananas comosus* L.) ranks as the third most important tropical and subtropical fruit crops production in the international trade, next to banana and citrus (Valleser, 2019). Malaysia is one of the major pineapple producers in Asia, where 70% of fresh pineapple was distributed to domestic market and 30% for export market including Singapore, Saudi Arabia, Brunei and Hong Kong (Malaysia Pineapple Industry Board, 2020). MD2 pineapple is considered as the top breed among the nine pineapple cultivars in Malaysia. It has been recognized as one of the target products in Economic Transformation Program (Ministry of Agriculture and Food Industry, 2020). MD2 pineapple is smaller in size, however it has an attractive golden yellow flesh, tastes sweeter, less acidic, more aromatic, higher vitamin C content and longer shelf life than other pineapple cultivars (Ding and Syazwani, 2016). Hence, MD2 pineapple is highly demanded in international market particularly from China (Malaysia Pineapple Industry Board, 2020).

The demand of fresh-cut fruits have grown rapidly over the years because of their convenience as ready to eat products as well as the desirable nutritional and sensory quality associated with their consumption (Yousuf et al., 2018). Pineapple is suitable for processing into fresh-cut fruits because the thick and hard peels of pineapple are difficult to remove for direct consumption. Besides, consumers can buy any quantity they desire if fresh-cut pineapple can come in variety form of package sizes (James and Ngarmsak, 2010). However, production of fresh-cut fruits involves process of washing, peeling, slicing and cutting that induce wounding stress and speed up metabolic activities on fruit tissue (Yousuf and Qadri, 2020). This accelerates microbial spoilage and resulted physical quality deterioration on fresh-cut fruits (Singh et al., 2018).

In addition, taking a large serving size of fresh-cut MD2 pineapple might cause a spike of blood sugar level, especially for diabetic patients (Guevarra and Panlasigui, 2000). Diabetes mellitus (DM) is a major public health challenge in most parts of the world due to the increasing mortality and morbidity outcomes associated with this disease (Chukwuma et al., 2019). According to International Diabetes Federation (2019), diabetes affected 463 million people worldwide, with the number expected to rise to 700 million by 2045. In Malaysia, one in five adults which is about 3.9 million people aged 18 years and above is suffering from diabetes (Institute for Public Health, 2020). People with diabetes are at higher risk of developing life-threatening complications such as heart disease, stroke, end-stage renal failure, blindness and amputation (Hussein et al., 2015). Although there are several commercial drugs available in the market for the treatment of diabetes such as acarbose, voglibose and miglitol, they may usually

lead to hepatic disorders and other negative gastrointestinal symptoms in diabetic patients (Murai et al., 2002). Traditional medicinal plants with the natural sources of antioxidant and alpha- glucosidase inhibitors that can significantly lower the postprandial blood glucose level is a more preferred choice for the treatment of diabetes (Lee et al., 2014).

Therefore, an appropriate technique that can enhance the storage quality and functionality of fresh- cut pineapple is required to overcome these challenges. Edible coating is recognized as a safe and promising technique that preserves fresh-cut fruits by creating a dried and thin edible layer on their surface to serve as a selective barrier against gases and water, control the growth of microorganism and improve textural properties (Otoni et al., 2017; Zhao, 2018).

Alginate is a natural polysaccharides obtained from brown seaweed (Nair et al., 2018). It has been proven to be an excellent coating material with good tensile strength, resistance to tearing and impermeable to oils (Brownlee et al., 2009). Alginate-based coating was reported to extend shelf life of fresh-cut fruits such as papaya, mango, pineapple and cantaloupe (Koh et al., 2017; Azarakhsh et al., 2014; Robles-Sanchez et al., 2013; Tapia et al., 2008).

Aloe vera gel is a colourless and odourless polysaccharide matrix that rich in active compounds and comprised antibacterial and antifungal properties (Misir et al., 2014). Application of *Aloe vera* gel as edible coating had been reported to control maturation development, delay ripening and reduce microorganism proliferation on table grapes, kiwifruit, plum and strawberry (Martínez-Romero et al., 2017; Ali et al., 2016; Sogvar et al., 2016; Benítez et al., 2015). Effectiveness of edible coatings can be enhanced by introducing antimicrobial and antioxidants agents, essential oil or natural plant extract as active ingredients (Rojas-Graü et al., 2009). Incorporation of plant extracts into edible coatings was reported to successfully improve the storage quality and functionality of fresh-cut orange (Radi et al., 2017), avocado (Tsfay and Magwaza, 2017) and guava (Nair et al., 2018).

Malaysia is blessed with diverse species of medicinal plants that serve as the primary healthcare for locals. Water mimosa (*Neptunia oleracea* Lour.) is consumed as local salad in Southeast Asia. It also used as a medical plant for jaundice, sores on the tongue, diarrhea with bleeding, epileptic convulsion (Wahab et al., 2014). Lee et al. (2016) reported that freeze dried leaves extract preserve high amount of phenolic compound such as vitexin-2-O-rhamnoside, catechin, quercetin derivatives, kaempferol derivatives, myricetin derivatives, gallic acid and caffeic acid. It showed a high DPPH free radical scavenging and alpha-glucosidase inhibitory activities with an IC₅₀ value of 6.42ug/ml and 0.34ug/ml respectively. Hence, the leaves extract was suggested to have persuasive antioxidant and α-glucosidase inhibitory properties that is good for

diabetes treatment.

Ulam Raja (*Cosmos caudatus* Kunth.) is often consumed as fresh salad in Malaysia due to its health beneficial effects. It contains variety of bioactive compounds such as phenolics, flavonoids, glycosides and amino acids that can improve blood circulation, cleanse blood plasma, stimulate bone formation and improve respiratory health (Bodekar et al., 2009; Shui et al., 2005). Ulam Raja leave extracts shown high alpha-glucosidase inhibitory activities (IC₅₀ value of 13.7ug/ml) that give compelling impact on retarding glucose absorption in the intestine. Incorporation of Ulam Raja extract revealed significant reduced number of microflora in osyter mushroom. This demonstrated its potential to be developed as natural preservative in processing raw food materials (Yusoff et al., 2015).

Therefore, the storage quality and alpha-glucosidase inhibitory activities of fresh-cut MD2 pineapple coated with an edible coating material and incorporated with either water mimosa or Ulam Raja leaf extract were evaluated in this study. The specific objectives of this study were:

1. To compare the effect of alginate and *Aloe vera* gel coating on the quality of fresh-cut MD2 pineapple.
2. To optimize the pineapple coating formulation when incorporated with either the water mimosa or Ulam Raja leaf extracts
3. To evaluate the storage quality and alpha-glucosidase inhibitory activities of fresh-cut MD2 pineapple with the optimised coating.

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