# DEVELOPMENT OF PECTIN JELLY CONFECTIONERY USING RED PITAYA, *HYLOCEREUS POLYRHIZUS*

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DISSERTATION SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF BACHELOR OF AGRICULTURE SCIENCE WITH HONOURS

HORTICULTURE AND LANDSCAPING PROGRAMME
SCHOOL OF SUSTAINABLE AGRICULTURE
UNIVERSITI MALAYSIA SABAH
2014

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JUDUL : DEVELOPMENT OF PECTIN JELLY CONFECTIONERY USING RED PITAYA, HYLOCEREUS POLYRHIZUS.

IJAZAH : BACHELOR DEGREE IN AGRICULTURE SCIENCE WITH HONOURS (HORTICULTURE AND LANDSCAPING)

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## ACKNOWLEDGEMENT

I would like to take this opportunity to express my appreciation to my beloved family especially my parent, who had always unconditionally given me invaluable love, moral support and encouragement in my academic life.

I would also like to express my sincere gratitude to my supervisor, Mr. Sim Kheng Yuen for his support, advice and guidance throughout my final year project. I am grateful for his kindness to listen to my problems and gave me invaluable advices all the time. Besides that, I am also appreciating the insightful advices and comments from the examiners in my dissertation writing and the presentation.

Special appreciation is also goes to all the lab assistants in SSA especially Mr. Panjiman for always giving his assistance, technical support and advices during laboratory analyses.

Not forgetting also want to thank all the sensory panels that given me a very good cooperation during sensory evaluation of my products. Last but not least, thanks also my friends who always help me, share their thoughts and moral support.

## ABSTRACT

This research was carried out to develop a new jelly confectionery product by utilizing local commercial fruit, red pitaya, *Hylocereus polyrhizus*. A total of 12 formulations have been produced based on modifications of the percentage red pitaya puree (30%, 35% and 40%), sugar (17.5% and 20%), glucose syrup (17.5% and 20%), and citric acid (0.6% and 0.8%). Out of 12 formulations, 6 best formulations were selected based on better mean scores through 2 sessions ranking test separately for sensory evaluation. According to seven points hedonic scale test, formulation 10 with 40% red pitaya puree, 17.5% for both sugar and glucose syrup respectively, and 0.8% of citric acid was selected as the best formulation with highest mean score value for colour (6.39±0.76), aroma (4.71±1.58), texture (5.16±1.29), sweetness (5.45±1.00), and sourness (5.32±1.30). The physicochemical analysis showed that the end product have pH value 3.27 ± 0.01, total dissolve solid 53.1±0.01°Brix, acidity percentage 0.07±0.01%, vitamin C 1.28±0.01 mg/100g, reducing sugar 9.78±0.39, and non-reducing sugar 13.5±1.24. The proximate analysis showed that the best formulation sample contains 21.11±0.98% of moisture, and have very low content in ash (0.54 ± 0.01 %), protein (0.08±0.01%), fat (0.12±0.01%), crude fibre (1.91±0.54%), but its high in carbohydrate content which is 69.41±0.29%. Storage study of the end product was carried out by packaged in glass jars for 8 weeks in 3 different temperatures include 21°C ambient temperature, 37°C (accelerated storage test), and 6.5°C cool room temperature. Physicochemical analysis after 8 weeks of storage showed that there were no significant difference ($p>0.05$) between the fresh sample and the cool room stored sample, but there were significant difference ($p<0.05$) between the fresh sample with the samples stored at ambient temperature and accelerated storage test samples. The end product was also free from microorganism growth although after 8 weeks of storage. For market survey, 54% of respondents liked to consume the red pitaya pectin jelly compared with another two types of marketed jelly confectionery products.

**PEMBANGUNAN PRODUK PEKTIN JELI KONFEKDIONERI BERASASKAN BUAH PITAYA MERAH, *HYLOCEREUS POLYRHIZUS***

## ABSTRAK

Kajian ini telah dijalankan bagi menghasilkan produk jeli konfeksioneri baru yang menggunakan buah-buahan tempatan bersifat komersial iaitu buah pitaya merah, *Hylocereus polyrhizus*. Sebanyak 12 formulasi telah dihasilkan berdasarkan pengubahsuaian peratusan puri buah pitaya merah (30%, 35% dan 40%), gula (17.5% dan 20%), sirap glukosa (17.5% dan 20%), dan asid sitrik (0.6% dan 0.8%). Daripada 12 formulasi, 6 formulasi yang paling baik telah dipilih berdasarkan jumlah skor purata melalui 2 sesi ujian pemeringkatan dalam penilaian sensori. Menurut ujian skala hedonic, formulasi 10 dengan kandungan puri buah pitaya merah 40%, gula dan sirap glukosa masing-masing 17.5%, dan asid sitrik 0.8% telah dipilih sebagai formulasi yang terbaik dengan nilai skor purata yang tertinggi dalam atribut warna (6.39±0.76), aroma (4.71±1.58), tekstur (5.16±1.29), kemanisan (5.45±1.00), dan kemasaman (5.32±1.30). Analisis fizikokimia menunjukkan bahawa produk akhir mempunyai nilai pH 3.27±0.01, jumlah pepejal larut 53.1±0.01°Briks, peratusan keasidan 0.07±0.01%, vitamin C 1.28±0.01 mg/100g, gula *reducing* 9.78±0.39% dan gula *non-reducing* 13.5±1.24%. Analisis proksimat menunjukkan bahawa sampel formulasi terbaik mengandungi kelembapan 21.11±0.98%, dan mempunyai kandungan abu (0.54±0.01%), protein (0.08±0.01%), lemak (0.12±0.01%), serat mentah (1.91±0.54%) yang sangat rendah, tetapi kandungan karbohidrat tinggi iaitu sebanyak 69.41±0.29%. Kajian penyimpanan produk akhir telah dijalankan dengan membungkuskan sampel dalam bekas kaca selama 8 minggu dalam 3 suhu yang berbeza termasuk 21°C suhu ambien, 37°C (ujian penyimpanan yang dipercepatkan), dan 6.5°C suhu bilik sejuk. Analisis fizikokimia selepas 8 minggu penyimpanan menunjukkan tiada perbezaan yang signifikan ($p>0.05$) antara sampel segar dengan sampel yang disimpan di bilik sejuk, tetapi mempunyai perbezaan yang signifikan ($p<0.05$) Antara sampel segar dengan sampel yang disimpan di suhu 21°C dan 37°C. Produk akhir ini juga tidak mempunyai pertumbuhan mikroorganisma walaupun selepas 8 minggu penyimpanan. Ujian pasaran yang telah dijalankan mendapati 54% responden suka makan jeli pektin pitaya merah berbanding dengan dua jenis produk jeli yang sedia ada di pasaran.

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| | |
|---|---|
| % | percentage |
| °Brix | Degrees Brix |
| °C | Degrees Celcius |
| °F | Degrees Fahrenheit |
| cm | centimeter |
| cfu | colony forming unit |
| g | gram |
| kg | Kilogram |
| mg | milligram |
| min | minit |
| ml | millilitre |
| M | molarity |
| Σ | summation |
| ANOVA | Analysis of Variance |
| AOAC | The Association of Official Analytical Chemists |
| CFU | Colony Forming Unit |
| DOA | Department of Agriculture |
| FAO | Food and Agriculture Organization |
| MARDI | Malaysian Agricultural Research & Development Institute |
| PCA | Plate Count Agar |
| PDA | Potato Detrose Agar |
| PET | Polyethylene Terephthalate |
| RM | Ringgit Malaysia |
| SPSS | Statistical Package of Social Sciences |
| SSA | School of Sustainable Agriculture |
| TPC | Total Plate Count |
| UMS | Universiti Malaysia Sabah |
| USDA | United State Department of Agriculture |

## LIST OF FORMULAE

3.7 Non-reducing sugar content of the sample, 30

Non-reducing sugar content (%) = Total sugar content – reducing sugar content

3.8 Moisture content of the sample, 31

$$\text{Moisture content (\%)} = \frac{(b - c)}{(b - a)} \times 100$$

a = tare weight of crucible in grams
b= weight of crucible and sample in grams
c = weight of crucible and the dried sample in grams

3.9 Ash content of the sample, 31

$$\text{Ash content (\%)} = \frac{(c - a)}{(b - a)} \times 100$$

a = weight of crucible in grams
b = weight of crucible and sample in grams
c = weight of crucible and ash in grams

3.10 Protein content of the sample, 32

$$\text{Protein content (\%)} = \frac{\text{acid (ml)}[\ V_s - V_b\ ] \times N \times 14.0 \times 6\ .25 \times 100}{W \times 1000}$$

$V_s$ = the volume of HCl used for sample
$V_b$ = the volume of HCl used for evacuation
N = the normality of acid
W = the weight of sample

3.11 Fat content of the sample, 33

$$\text{Fat content (\%)} = \frac{(b - a)}{c} \times 100$$

a = weight of empty flask in grams
b = weight of flask + fat in grams
c = weight of sample in grams

3.12 Crude fiber content of the sample, 34

$$\text{Crude fiber content (\%)} = \frac{(a - b)}{c} \times 100$$

a = weight of sample + Gooch crucible in grams (before dried)
b = weight of sample + Gooch crucible in grams (after dried)
c = weight of sample in grams

3.13 Carbohydrate content of the sample, 35

Carbohydrate content (%) = 100 - $\Sigma$%(moisture+ash+protein+fat)

# CHAPTER 1

# INTRODUCTION

## 1. 1 Background

The sugar confectionery industry is widely extent which covered jelly products. The global market for this industry has increased gradually for many years probably because of the deliciousness as well as its consumer-friendly storage for longer period of time (Edwards, 2007). However, the jelly confectionery products are generally perceived as having too much sugar for regular consumption. This product normally contains high sugar and calories level; some are even prepared by using artificial colourings, flavourings and gelatine-based gelling agents. The increase of health conscious among Malaysian consumers has led to the switch in demand of healthier jelly confectionery product (Euromonitor International, 2013). Current consumer trends reveal that majority of the consumers are looking for functional, herbal, fruits and sugar-free jelly products.

There are many types of jellies available in the market and their differences are depends on its food preservation on perishable fruits consistency, which from soft and chewy to hard texture. Jelly confectioneries that made from fruit have a soft texture with a refreshing fruit taste and aroma. It also considered as a mean to preserve the perishable fruits for longer period. The characteristics of the soft texture of a jelly are very much depends on the type of gelling agent being used during the making process. In addition, the ratio of sugar to glucose syrup, quantity and type of gelation agent, as well as the level of total soluble solids also play significant role in the texture development of jelly confectionery products.

The making of jelly is simple and do not require sophisticated machineries to produce it. However, it do need proper processing methods as it consist of several unit of properties such as mixing, heating, moulding, forming, and other relevant steps. According to Edwards (2007), the procedure for making jellies can be generalised as starting with dissolving of raw materials, concentrated by boiling, deposited into moulds, and last undergo drying the product to the final moisture content process. The main ingredients for jelly production are sugar, glucose syrup, acids, and gelling agent. The preservation principles behind the jelly production can be very critical; this is because the correct combination of acidity, sugar level and pectin content are crucial for jelly formation and also to ensure the jelly will have low water activity content. Hence, these three proportions must be adoptable in order to obtain a satisfactory end product which is safe for consumption other than with good sensory attributes.

Pectin is a natural component of the cell wall and the middle lamella of all higher terrestrial plants, which is also a common gelling agent for jellies. The general uses of pectin are functioned as gelling agent, thickener, stabilizer, and emulsifier (FAO, 2009). Pectin jellies are one of the commercial varieties of the jelly confectionery category (Greweling, 2007). Pectin is added to jelly confectionery in order to produce a superior jelly product with tender, soft texture, relatively short gel, and provide an excellent base for fruit-flavoured products (Booth, 1990). The scientific merits of the pectin are their ability to convert liquid into a solid-like structure via bonding and forming a fine meshed network that holds the liquid in its cavities.

Pitaya (various *Hylocereus* spp.), or commonly known as dragon fruit is among the most nutritious exotic fruits. White and red fleshed pitaya were commercially cultivated in Malaysia and also other Asian countries such as Vietnam, Thailand, Southern China and many more. However, the red fleshed pitaya fetches higher price compared to the white fleshed pitaya. This is because the red pitaya is more nutritious and the content of nutrients and vitamins are more complete than white fleshed pitaya, according to nutrition experts. Besides that, the attractive colour in the red pitaya encourages people to buy. This exotic fruit is important as a commercial fruits in local as well as for ornamental purposes. It can be consumed directly or to processed into various value-added products including fruit juice, jam, jelly, ice-cream, and wine as well. A fresh pitaya fruit contains a lot of juice, with soft and smooth texture, and rich in vital nutrients. Basically, pitaya fruits are highly concentrated with Vitamin C,

antioxidants, minerals and boasts of high water soluble fiber content which enhances the digestion in human bodies. It has the ability to regulate diabetics, cancer, high cholesterol as well as high blood pressure in human body (DOASL, 2006).

Due to its short shelf life after harvesting, postharvest treatments as well as food processing have become the only alternative to preserve its essential nutritional components or nutrients as much as possible for a longer period (Arthey and Ashurst, 1996). In this study, red pitaya have been chosen as the raw material for making the confectionery jelly products due to its high nutritional value (antioxidants, vitamin C, low calories and high fiber) and the easy availability from the local market at affordable price.

As one of the important ingredients in making the jelly confectionery product, the plant-based pectin powder has been used as the gelling agent in jelly confectionery processing. In addition, pectin based jellies can be produced efficiently and specifically tailored to formulations and production parameters. In contrast to other hydrocolloids, pectin is standardized to constant gelling strength, they dissolve rapidly and they are heat-resistant even with low pH value. Pectin allows sufficient time for depositing but at the same time set relatively quickly. After a relatively short standing time, the products can be formed quickly at optimum quality.



## 1.2 Justification

This study aims to produce a novel jelly confectionery from red pitaya with health benefits which has a potential to march into local sugar confectionery market. This study utilizes the local fruits to convert them into value-added confectionery product and to produce a fruit-based jelly confectionery product using natural ingredient. Furthermore, this study can provide an alternative processing method to overcome the short shelf life problem generally faced by dragon fruit. Besides from prolonging the shelf-life of dragon fruit, this process can produce value-added products that would be financially feasible for production.

## 1.3 Objectives

The objectives of this study are:

1. To develop and determine the best formulation for the production of a new pectin jelly confectionery from red pitaya, *Hylocereus polyrhizus.*

2. To determine the nutritional quality, sensory attributes and storage stability of the newly developed pectin jelly.

3. To test the consumer's acceptance on the pectin jelly confectionery made from red pitaya, *Hylocereus polyrhizus*.

## 1.4 Research Hypothesis

$H_0$: The newly developed pectin jelly confectionery from red pitaya, *Hylocereus polyrhizus* is accepted by consumers.

$H_A$: The newly developed pectin jelly confectionery from red pitaya, *Hylocereus polyrhizus* is not accepted by consumers.

# CHAPTER 2

# LITERATURE REVIEW

## 2.1 Global Industry Trend of Confectionery

In developing countries, the industry of confectionery was forecasted to experience modest growth. The increase in demand for confectionery food might be due to the urbanization and busy lifestyles of the community. The rise in income levels, increased availability of innovative products focusing on the specific health needs of consumers and other macroeconomic factors also contributed to the growth of confectionery market. As per the study, introduction of confectionery categories and new product variants of different tastes are ensuring higher acceptability of these confectionery products. However, as what had been proposed by Lucintel (2013), health and nutritional awareness is one of the biggest obstacles of confectionery industry.

Fondness for healthier confectionery is being recognized as an upcoming inclination in confectionery industry (GIA, 2012). Due to this trend, the confectionery industry has responded continuously to market demands by establishing hundreds of portion-controlled, calorie-controlled, reduced-fat, sugar-free as well as fortified products. Development of new confectionery product will be strongly influenced by the health-related issues according to experts in confectionery industry (NCA, 2009).

As one of the developing countries, Malaysia are likewise switching to healthier, sugar free and mints sugar confectionery as a result of increasing health awareness (Euromonitor International, 2013). The sugar confectionery products that are perceived to be unhealthy is expected to slowly obsolete, gradually replaced by the products that offer health benefits or functionality such as fruits, medicated confectionery and mints.

In most of the developing countries, the recent growth of confectionery market can be attributed to the introduction of successful confectionery products with characteristic like low-fat, low-sugar, organic and fair-traded products. The spread of confectionery products marketed on a health platform continues to grow (Research and Market, 2006). New product innovation and development remain critical to future success within the confectionery industry, with many of the world's leading suppliers investing profoundly in this area.

### 2.1.1 Jelly Confectionery

The confectionery industry had been divided into three categories, which include the chocolate confectionery, flour confectionery and sugar confectionery (Edwards, 2000). According to Bernard (1990), sugar confectionery covers hard candy, fudge, toffees, fondants, jellies, pastilles, and others which do not include chocolate, cookies or cakes. As a sub category of sugar confectionery, jellies products include commercial varieties like jelly beans, gumdrops, pectin jellies, jujubes, Turkish delight and gummy candies (Peter, 2007).

Generally, jelly can be considered as a type of preserved food with semi-solid colloidal solution formed or solidified depending on gelling agent used. Jelly confectionery had been widely used to refer to a class of confectionery that made from a bulk sweetener such as sugar, a sugar-substitute, glucose or a mixture of these, with a hydrocolloid gelling system which imparts setting property on the confection. As stated by Bates (2011), typical hydrocolloids include pectin, gelatine, gum, agar-agar, starch and the combinations thereof.

Jelly confectionery is usually prepared by cooking the ingredients (except for acids, colouring and flavouring) to the required temperature or the required solids content, follow with the cooling of the hot fluid mixture to a deposition temperature and the adding of edible acid, colour and flavour. The mixture is then deposited into moulds, cooling and conditioning into the moulded product.

## 2.2 Red Pitaya (*Hylocereus polyrhizus*)

Red pitaya, or scientifically known as *Hylocereus polyrhizus* (F.A.C.Weber) Britton & Rose, is an exotic fruit which belongs to the vine cacti from the Cactaceae family from the subfamily Cactoidea of the tribe of Cactea (Raveh *et al.*, 1993). According to Esquivel *et al.* (2007), this exotic fruit is native to the tropical regions of North, Central and South America. Red pitaya is a small fruiting climbing cactus that has already received worldwide recognition as an ornamental plant for its large, scented, night-blooming flower. This exotic fruit has obtained high popularity in many Asian counties and had been commercially cultivated in Vietnam, Taiwan, Philippines and Malaysia (Mizrahi *et al.*, 1997). Among Chinese community, red pitaya fruit is famously named as dragon fruit as resembled by the shape of the fruits. In Malaysia, about 927.4 ha have been established for the planting of pitaya for local and export markets (Cheah and Zulkarnain, 2008). The red-flesh pitaya farm's size is increasing substantially due to a high demand from the market. Red pitaya has becoming very popular nowadays not only due to its attractive red-purple coloration and economic value as an exotic fruit product, but also because of its health benefits (Wybraniec and Mizrahi, 2002).

### 2.2.1 Morphology

Red pitaya is a perennial, segmented, epiphytic crawling cactus with aerial roots. Being an epiphyte, it clings to its support and can obtain nutrients from cracks where organic material concentrates. The fleshy succulent stems are three sided (occasionally four or five) and lobed along the ridges, which have small swellings equipped with short spines.

From these swellings, large, perfumed and ivory white flowers appear with yellow centres containing a large number of stamens. The flowers open in the evening and are finished in the early morning, lasting only one night. This spectacular feature has earned them the name of moonflower or Queen of the night.

The red pitaya has red exocarp covered with bracts or scales, with the mesocarp consists of a red-purple pulp which contains numerous small digestible seeds (Zee *et al.*, 2004). The red pitaya weighed up to 1 kg with mildly sweet taste in its translucent red flesh.

Figure 2.1 The red colour exocarp of red pitaya which covered with bracts or scales

Figure 2.2 The mesocarp of the red-fleshed pitaya, *Hylocereus polyrhizus,* that contains numerous of small digestible seeds

### 2.2.2 Nutrition Components

Red pitaya has reported as a rich source of many nutrients and minerals which include vitamin B1, vitamin B2, vitamin B3, vitamin C, protein, fat, carbohydrate, crude fiber, flavonoid, thiamin, niacin, pyridoxine, kobalamin, glucose, phenolic, betacyanins, polyphenol, carotene, phosphorus, iron, lycopene and phytoalbumin (Le Bellec *et al.*, 2006). Hylocereus polyrhizus is rich in fibers, vitamin C, minerals and phytoalbumins which are highly valued for their antioxidant properties. Apart from that, red pitaya is also rich with potassium, protein, fiber, sodium and calcium (Khalili *et al.*, 2006).

The red colour of the red-fleshed pitaya is contributed by a set of pigments called betalains which are nitrogen-containing pigments (Wyler and Dreiding, 1957; Harivaindaran *et al.*, 2008), which comprised of the red-violet betacyanins and yellow betaxanthins (Herbach *et al.*, 2006). The structure activity relationships of various betacyanins and betaxanthins exhibited free radical scavenging capacities which further contribute to the capability of *H. polyrhizus* to be a source of antioxidant (Cai *et al.*, 2003). In a previous study, red pitaya (*H. polyrhizus*) varieties were found to have higher antioxidant activity, as compared to white-fleshed pitaya (*Hylocereus undatus*) varieties (Chemah *et al.*, 2010; Choo and Yong, 2011).

Asides from these, studies had revealed that a mature red pitaya contains considerable amount of total soluble solids and rich in organic acids (Stintzing *et al.*, 2003). The seeds of *H. polyrhizus* contain high levels of essential fatty acids, namely linoleic and linolenic acids (Ariffin *et al.*, 2009) which are essential in human diet. The dietary fiber found in red pitaya can be divided into two types, which are the soluble dietary fiber like mucilage and pectin and the insoluble dietary fiber (Phebe *et al.*, 2009; Stintzing and Carle, 2007).

Apparently, red pitaya has a great potential for use as a source of functional ingredients to provide nutrients that may alleviate nutrition-related problems and improve physical wellness of the consumers.

### 2.2.3 Health Benefits

Red pitaya was reported to offer many health benefits including cancer chemoprevention, anti-inflammatory, anti-diabetic and cardiovascular mortality risk reducing properties (Cos *et al.*, 2004; Herbach *et al.*, 2006; Stintzing *et al.*, 2002). The red pitaya helps in the digestive process, prevent colon cancer and diabetes, neutralize toxic substances such as heavy metal, and reduce cholesterol levels and high blood pressure. Furthermore, red pitaya is known to be a natural laxative. Regular consumption of red pitaya can help against asthma and cough (Khalili *et. al.*, 2006).

Incidence of degenerative diseases such as arthritis, arteriosclerosis, cancer, heart disease, and inflammation and brain dysfunction can be reduced with the consumption of red pitaya with its high antioxidants property. In addition, antioxidants

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