UNIVERSITI PUTRA MALAYSIA

NUTRITIONAL COMPOSITION AND ANTIOXIDANT PROPERTIES OF SPRAY PITAYA POWDER (HYLOCEREUS POLYRHIZUS [WEBER] BRITON & ROSE) AND ITS SUPPLEMENTATION EFFECTS ON SELECTED BIOMARKERS IN NORMOCHOLESTROLEMIC SUBJECTS

SITI RAIHANAH BINTI SHAFIE

FPSK(M) 2012 43

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SITI RAIHANAH BINTI SHAFIE

MASTER OF SCIENCE

UNIVERSITI PUTRA MALAYSIA

September 2012

DEDICATION

Special Dedication of This Grateful Feeling to My

Beloved husband;
Ahmad Norfaizal bin Kamaruzaman

Loving parents;
Mr. Shafie bin Mustafa & Mrs. Rusnani binti Haji Awaluddin

Lovely daughter;
Aisy Rania binti Ahmad Norfaizal

Understanding and helpful friends;

For Their Love, Support and Best Wishes.

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

NUTRITIONAL COMPOSITION AND ANTIOXIDANT PROPERTIES OF SPRAY PITAYA POWDER (*Hylocereus polyrhizus* [WEBER] BRITON & ROSE) AND ITS SUPPLEMENTATION EFFECTS ON SELECTED BIOMARKERS IN NORMOCHOLESTEROLEMIC SUBJECTS

By
SITI RAIHANAH BINTI SHAFIE

September 2012

Chairman : Associate Professor Rokiah Mohd Yusof, PhD

Faculty : Medicine and Health Sciences

Red pitaya is a rich source of dietary fibers, vitamins, minerals and antioxidants. Consumption of fruit products have shown to induce beneficial changes in pathways related to cardiovascular health. Therefore, the present study was designed to determine the nutritional composition and antioxidant properties of spray pitaya powder (SPP) and its supplementation effects on biochemical parameters among normocholesterolemic subjects in Mempaga, Pahang. This study comprises of three phases. In phase one of the study, nutritional composition analysis revealed that SPP contains 10.9% moisture, 1.22 g ash, 1.59 g protein, 80.33 g carbohydrate, 0.007 g fat and 17.70 g total dietary fiber per 100 g SPP. SPP also contained potassium, sodium, magnesium, zinc and calcium. In SPP, the vitamin C content was 17 mg/100 g SPP. Meanwhile, other trace elements are very minute. The data demonstrated that antioxidant properties in SPP using FRAP assay, DPPH and total phenolic exhibited 0.396 mM$FeSo_4$/g (FRAP value), 51.1% (radical scavenging effect) and 156.40 mgGAE/100g (total phenolic content) respectively. This finding showed that SPP

contained beneficial nutrients such as dietary fibers, vitamin C, minerals and antioxidants.

Phase two of the study (Chapter 4) involved *in-vivo* experiment to determine the effect of SPP on the liver and kidney function of normal *Sprague Dawley* rats. A total of 32 *Sprague Dawley* rats were divided into a control group and three treatment groups, which were given 0.83 g/kg Body weight (BW)/day, 1.67 g/kg BW/day and 2.5 g/kg BW/day of SPP respectively for 4 weeks. During the experiment, body weight and enzyme markers (liver and kidney enzymes level) were measured. Results showed that the body weight of rats significantly increased throughout the study period. There was no significant difference ($p > 0.05$) in changes of liver enzymes (AST, ALT and ALP) and kidney (BUN and Creatinine) products from both male and female rats in all treatment groups as compared to normal control group throughout the study. On the basis of these results, it demonstrates that daily oral administration of SPP to rats at dose of up 2.5 g/kg BW/day for 4 weeks, which is equivalent to 1500 g fresh red pitaya/60 kg BW/day, was safe as evaluated by the liver and kidney function tests. Data from this study substantiated the use of SPP as a safe food product.

Final phase of the study implied a clinical trial which was conducted among normocholesterolemic subjects. A total of 60 subjects from the residents of Felda Mempaga, Bentong, Pahang participated in this study. The study was a single-blinded, cross-over supplementation trial with two weeks of wash out period. The subjects were allocated into 3 different dosages which are 3 (3S), 4 (4S) or 5 (5S) sachets (20 gram each sachet) of SPP to be consumed daily. Repeated Measures ANOVA analysis had shown a significant decrease ($p < 0.05$) in TC after 4 weeks

supplementation of SPP. All three dosages of SPP showed a decreasing trend of TC. The range of TC dropped in SPP group was 20.75% - 30.1% after 4 weeks supplementation. The higher the dosages given to the subjects, the higher the TC level reduced. Similarly, it was noted that SPP supplementation revealed a significant decreased in LDL-C level ($p < 0.05$). LDL-C decreased by 21.88% (3S), 25.89% (4S) and 27.41% (5S) respectively after 4 weeks of supplementation compared to baseline. Meanwhile, for TG and HDL-C levels, there were only significant difference ($p < 0.05$) found in the group supplemented with 4 sachets of SPP. The present study also showed an improvement in antioxidant status of the subjects. Both 4S and 5S supplementation groups showed an increased percentage in TAS compared to baseline, although only group 5S performed a significant increased ($p < 0.05$) by 12.31% after 4 weeks of consumption. Overall, there was no significant differences were noted in all parameters (TC, TG, LDL-C, HDL-C, GLU and TAS) when compared to different dose of supplementation ($p > 0.05$). This study also found out that the use of this SPP up to the dose of 100g SPP/day showed no adverse effects on liver and kidney functions during 4 weeks supplementation. In conclusion, spray dried pitaya fruit powder gave scientific merits in the area of functional foods for the emerging health food industry in Malaysia. Supplementations of SPP in daily diet would promote the intake of fruit products and the presence of nutritious content in it might have potential benefits to give desired changes in plasma lipid levels and plasma antioxidant status.

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

KOMPOSISI NUTRIEN, CIRI ANTIOKSIDAN SERBUK PITAYA (*Hylocereus polyrhizus* [WEBER] BRITON & ROSE) DAN KESAN PENGAMBILANNYA TERHADAP PARAMETER BIOKIMIA TERPILIH SUBJEK NORMOKOLESTEROLEMIA

Oleh

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Pitaya merah adalah sumber yang kaya dengan fiber, vitamin, mineral dan antioksidan. Penggunaan produk buah-buahan berpotensi memberi perubahan bermanfaat kepada kesihatan kardiovaskular. Oleh itu, kajian ini direka bertujuan untuk menentukan komposisi nutrien dan sifat antioksidan semburan kering serbuk pitaya (SPP), dan kesan pengambilannya pada parameter biokimia di kalangan subjek normokolesterolemik di Mempaga, Pahang. Kajian ini terdiri daripada tiga fasa. Dalam fasa pertama kajian, analisis komposisi nutrien menunujukkan bahawa SPP mengandungi 10.9% kelembapan, 1.22 g abu, 1.59 g protein, 80.33 g karbohidrat, 0.007 g lemak dan 17.70 g jumlah fiber bagi setiap 100 g SPP. SPP juga mengandungi kandungan mineral iaitu kalium, natrium, magnesium, besi, zink, dan kalsium. Kandungan vitamin C adalah sebanyak 17 mg/100 g SPP. Kandungan unsur surih yang lain yang terdapat di dalam SPP adalah sangat rendah. Sifat antioksidan di dalam SPP yang diuji menggunakan asai FRAP, DPPH dan fenolik total mendapati

SPP mengandungi 0.396 mM$FeSo_4$/g (nilai FRAP), 51.1% (kesan penghapusan radikal) dan 156.40 mgGAE/100g (kandungan fenolik total). Penemuan ini menunjukkan bahawa SPP adalah sumber yang kaya dengan fiber, vitamin C, mineral dan antioksidan.

Fasa kedua (Bab 4) melibatkan kajian *in-vivo* bagi menentukan kesan pengambilan SPP pada fungsi hati dan buah pinggang tikus *Sprague Dawley* yang normal. Sebanyak 32 tikus *Sprague Dawley* telah dibahagikan kepada satu kumpulan kawalan dan tiga kumpulan rawatan yang diberikan 0.83 g/kg BW/hari, 1.67 g/kg BW/hari dan 2.5g/kg BW/hari SPP masing-masing selama 4 minggu. Semasa eksperimen, berat badan dan penanda enzim (tahap enzim hati dan buah pinggang) telah diukur. Hasil kajian menunjukkan bahawa berat badan tikus meningkat dan tiada perbezaan yang signifikan ($p > 0.05$) di dapati dalam perubahan enzim hati (AST, ALT dan ALP) dan buah pinggang (BUN dan Kreatinin) dari kedua-dua tikus jantan dan betina dalam semua kumpulan rawatan berbanding dengan kumpulan kawalan yang normal sepanjang kajian ini. Ini menunjukkan bahawa pemberian SPP secara oral kepada tikus sehingga dos 2.5 g/kg BW/hari selama 4 minggu, yang bersamaan dengan 1500 g buah pitaya merah/60 kg BW/hari, adalah selamat seperti yang dinilai oleh analisis kimia plasma. Data daripada kajian ini membuktikan penggunaan SPP sebagai produk makanan yang selamat.

Fasa terakhir kajian melibatkan kajian klinikal telah dijalankan di kalangan subjek normokolesterolemik. Seramai 60 orang subjek daripada penduduk Felda Mempaga, Bentong, Pahang mengambil bahagian dalam kajian ini. Kajian ini dilakukan menggunakan kaedah bias sebelah dan silang suplemen percubaan dengan dua minggu tempoh rehat. Subjek diperuntukkan 3 dos yang berbeza iaitu 3 (3S), 4 (4S)

atau 5 (5S) bungkus (20 gram/bungkus) SPP untuk diambil setiap hari. Analisis *repeated measures ANOVA* telah menunjukkan penurunan signifikan ($p < 0.05$) pada paras TC selepas 4 minggu diberi suplemen SPP. Ketiga-tiga dos SPP menunjukkan tren menurun paras TC. TC bagi kumpulan SPP menurun sebanyak 20.75% - 30.1% selepas 4 minggu suplemen. Semakin tinggi dos yang diberikan, semakin tinggi tahap TC menurun. Tren yang sama juga berlaku kepada LDL-C, di mana suplemen SPP dapat menurunkan paras LDL-C secara signifikan ($p < 0.05$). Paras LDL-C menurun sebanyak 21.88% (3S), 25.89% (4S) dan 27.41% (5S) selepas 4 minggu diberi suplemen berbanding sebelum diberi suplemen. Bagi paras TG dan HDL-C pula, hanya kumpulan 4S yang menunjukkan perbezaan yang signifikan ($p < 0.05$). Kajian juga menunjukkan peningkatan status antioksidan subjek. Kedua-dua kumpulan 4S dan 5S menunjukkan peratusan meningkat TAS berbanding sebelum diberi suplemen, walaupun hanya kumpulan 5S yang menunjukkan prestasi peningkatan signifikan ($p < 0.05$) iaitu sebanyak 12.31% selepas 4 minggu pengambilan suplemen. Secara keseluruhan, tiada perbezaan yang signifikan didapati dalam TC, TG, LDL-C, HDL-C, GLU dan TAS apabila dibandingkan dengan dos suplemen yang berbeza ($p > 0.05$). Kajian ini juga mendapati bahawa penggunaan SPP sehingga dos 100g SPP/hari menunjukkan tiada kesan buruk pada hati dan fungsi buah pinggang selama 4 minggu pengambilan suplemen. Kesimpulannya, semburan kering buah pitaya memberi merit saintifik dalam bidang makanan berfungsi yang semakin mendapat tempat dalam industri makanan kesihatan di Malaysia. Pengambilan SPP dalam diet harian akan menggalakkan pengambilan produk buah-buahan dan kandungan berkhasiat yang terkandung di dalamnya mungkin mempunyai manfaat dan potensi untuk memberi perubahan yang lebih baik dalam tahap lipid plasma dan status antioksidan plasma.

ACKNOWLEDGEMENTS

My utmost sincere praise and gratefulness was giving to Allah S.W.T for His grace in guiding me to complete my study. I wish to express my sincere appreciation to my main supervisor, Associate Professor Dr. Rokiah Mohd Yusof for constantly guiding and encouraging me throughout this study. Thanks a lot for giving me advice and suggestion to bring this thesis to its final form. Without the support and interest, this thesis would not have been the same as presented here. My special thanks to my co-supervisors Professor Asmah Rahmat for good comments and motivation.

I am grateful to all Department of Nutrition and Dietetics staffs for their cheerfulness and professionalism in handling their work especially to Mrs. Rohana Miran and Mr. Syed Hasbullah Syed Kamaruddin.

In preparing this thesis, I was in contact with many people, researches, technicians and academicians. They have contributed towards my understanding and thoughts. In particular, my sincere thankful is also extends to all my colleagues especially Mohd Al-Saufreen Akhiruddin and others who have provided assistance at various occasions. Their views and tips are useful indeed. Unfortunately, it is not possible to list all of them in this limited space. And last, but not least I thank my husband, parents and other family members for their continuous support while completing this thesis.

I certify that a Thesis Examination Committee has met on **21st September 2012** to conduct the final examination of **Siti Raihanah Binti Shafie** on her thesis entitled "**Nutritional composition and antioxidant properties of spray pitaya powder (*Hylocereus polyrhizus* [Weber] Briton & Rose) and its supplementation effects on selected biomarkers in normocholesterolemic subjects**" 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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This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfillment of the requirement for the degree of **Master of Science**. The members of the Supervisory Committee were as follows:

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Date:

DECLARATION

I declare that the thesis is my original research except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously, and is not concurrently, submitted for any other degree at Universiti Putra Malaysia or at any other institutions.

SITI RAIHANAH BINTI SHAFIE

Date: 21 September 2012

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ACUC	Animal care and use committee
ALP	Alkaline phosphate
ALT	Alanine aminotransferase
AOAC	Association of analytical communities
ATP	Adult treatment panel
AST	Aspartate aminotransferase
BMI	Body mass index
BUN	Blood urea nitrogen
BW	Body weight
CAD	Coronary artery disease
CHD	Coronary heart disease
CREA	Creatinine
CVD	Cardiovascular diseases
DALYs	Disability-adjusted life years
DDD	Defined daily dose
DPPH	2,2-Diphenyl-1-picryl-hydrazyl
E.P	Edible portion
EPIC	European prospective investigation of cancer
FAO	Food and agriculture organization
FMHS	Faculty of Medicine and health sciences
FRAP	Ferric reducing ability of plasma
GAE	Gallic acid equivalent
GDP	Gross domestic product
GLU	Glucose
GGT	Gamma-glutamyl transpeptidase
HDL	High density lipoprotein
HPLC	High performance liquid chromatography
ICP-MS	Inductively coupled plasma mass spectrometry
IDF	Insoluble dietary fiber
LDL	Low density lipoprotein
MANS	Malaysian adult nutrition survey

NCEP	National cholesterol education program
NHANES	National health and Nutrition Examination Survey
NHMS	National health morbidity survey
ORAC	Oxygen radical absorbance capacity
RDA	Recommended daily allowance
SDF	Soluble dietary fiber
SPP	Spray pitaya powder
TAS	Total antioxidant status
TC	Total cholesterol
TDF	Total dietary fiber
TEAC	Trolox equivalent antioxidant capacity
TG	Triglyceride
TRAP	Total-radical trapping antioxidant parameter
UK	United kingdom
US	United States
USDA	United states department of agriculture
VLDL	Very low density lipoprotein
WC	Waist circumference
WHO	World health organization

CHAPTER 1

INTRODUCTION

1.1 The background of the study

Development and urbanization happened in many parts of the world that lead to a shift in nutritional transition. Nutritional transition which describes the shift from relatively monotonous diets of varying nutritional qualities and values had shifted towards an industrialized diet that is usually a more varied diet and of a poor quality diet (Popkin, 2001). Industrialize or usually known as 'Westernized' diet includes more preprocessed food, food of animal origin, more added sugar, salt and fat, more alcohol and reduced vegetables and fruits consumption. This shift also followed by the changes in the structure of occupations and leisure activities where it affects the lifestyle behavior of oneself. The occurrences of these changes lead to various types of chronic diseases and a rapid increase in and the numbers of chronic diseases.

Chronic non-communicable diseases are reaching epidemic proportions worldwide. These diseases include cardiovascular disease, cancers, chronic respiratory disease and diabetes mellitus. The factors of chronic diseases are usually attributed by the person dietary intake, physiology, genetics, psychosocial stresses and environment. Over the past years, cardiovascular disease (CVD) still ranked on top from the list. There are multiple risk factors contribute to CVD, which include cigarette smoking, elevated blood pressure, elevated LDL-cholesterol (LDL-C) and triglyceride levels, low HDL-cholesterol level (HDL-C), obesity and type 2 diabetes (Ballantyne *et al*.,

2005). The emergence of these chronic diseases affects people of all ages, nationalities and classes, globally.

Cardiovascular disease entities include coronary artery disease, hypertension, stroke and valvular, muscular and congenital heart disease (Okrainec *et al.*, 2004). From the statistic of year 2006 in United States, it had recorded that 50% from the breakdown of deaths due to cardiovascular disease were significantly attributed by heart disease and approximately it caused 1 of every 6 deaths (Heron *et al*., 2009). Throughout the world, cardiovascular disease kills more people each year, this includes middle income country like Malaysia. In Malaysia, the prevalence of cardiovascular disease risk factors is high even in semirural community (Chin and Pengal, 2009).

High plasma glucose level, elevated blood pressure, high cholesterol level and high smoking rates are among the risk factors for coronary artery disease (Steinberg, 2005). So far, the emphasis has been on the relationship between cholesterol levels and the risk of coronary heart disease (CHD). Indeed, epidemiological, clinical and experimental data found that intervention results with statins as treatment has established hypercholesterolemia as a major causative factor in atherogenesis (Gouni-Berthold *et al*., 2007). Whereas, the protective effects against coronary heart disease are high concentrations of plasma high density lipoprotein cholesterol (HDL-C) and a low ratio of TC to HDL-C (Chen *et al*., 2008). Recently, a study showed that among lipid parameters, the LDL/HDL-cholesterol ratio was found to be a stronger factor associated with atherosclerosis than either LDL-cholesterol or HDL-cholesterol levels alone (Momiyama *et al*., 2012).

Many studies have demonstrated clearly an association between increased concentrations of lipids level and increased rate of premature coronary heart disease (Assman and Schulte, 1992; NCEP II, 1993) . A study by Chen *et al*. (2008) showed a relationship between plasma TC at a concentration above 240 mg/dl and risk of developing CHD. A meta-analysis of 58 randomised trials also quantified the effect of cholesterol lowering on CHD and stroke and it showed a reduction of 11% in coronary death and non-fatal myocardial infarction for a 1.0 mmol/l decrease in LDL-C (Law *et al*., 2003). The study also showed that in order to have a desirable blood lipid profiles, with regards to reduced risk of CHD is to have low concentrations of TC, TG, LDL-C and apolipoprotein-B and high concentrations of HDL-C and apolipoprotein A-I (Law *et al*., 2003).

Nutritional advice and active lifestyle have small but significant role to play in normalizing abnormal lipid profiles in those at high risk of cardiovascular disease. Available evidence indicates that persons who consume more fruits and vegetables often have lower prevalence of important risk factors for CVD, including coronary heart disease. There are also prospective studies showed a direct inverse association between fruit and vegetable intake and the development of CVD incidents such as stroke and CHD (Bazzano *et al*., 2003). In addition, fruit and vegetables also contain nutrients and phytochemicals including dietary fiber, potassium and folate that could be independently or jointly responsible for the apparent result in reduction of the CVD risk (Bazzano *et al*., 2003).

In recent years, there are growing interest in the potential of using alternative way that is natural food components as functional foods to treat hypercholesterolemia,

specifically for patients whose cholesterol level are borderline high (5.2 - 6.2 mmol/l) and does not warrant the prescription of cholesterol-lowering drugs such as statin, resins and fibrates (Chen *et al*., 2008). Using nutritional supplements to control cholesterol levels is a method focused on patients's overall health with the potential of antihypercholesterolemia effect for the prevention of CHD. It is not intended to be a direct treatment of hypercholesterolemia or replacement treatment of hypercholesterolemia. Besides that, nutritional supplement have also been proven to have beneficial aspects to the body system with no known adverse effects.

Pitaya or well known as dragon fruit, has attracted considerable consumer interest because of its micronutrient content and the vibrant color of the fruit itself. Dragon fruit is the fruit of several cactus species that have been classified as white (*Hylocereus undatus)*, red (*H. polyrhizus)*, and yellow (*Selenicereus megalanthus*) (Nerd *et al*., 2002; Hoa *et al*., 2006). Red pitaya was reported to offer many health benefits including anti-inflammatory, chemoprevention of cancer, antidiabetic effects and a reduction in the mortality risk of cardiovascular disease (Stintzing *et al*., 2002; Cos *et al*., 2004). This reports being supported by evidences that showed pitaya fruit is rich in vitamins, minerals and fibers that helps the digestive process, prevent colon cancer and diabetes, neutralize toxic substances such as heavy metals, and helps to reduce cholesterol levels and high blood pressure (Zainoldin and Baba, 2009).

1.2 Problem statements

From year to year, cardiovascular disease remains as the leading global burden of disease. It affected not only to the developed countries but also occurred in developing countries. In 2001 it has been reported by WHO that 7.3 million deaths and 58 million disability-adjusted life years (DALYs) were lost due to CHD worldwide (WHO, 2002). Stunningly, 75% of the global deaths and 82% of the total DALYs were due to CHD occurred in the low and middle income countries (WHO, 2002). In the report by World Health Organization statistics (2007), cardiovascular disease accounted for 33.7% of all death worldwide.

The causes of the diseases have been linked to lifestyle choices, and one of the most important factors is diet itself. All these causes were closely related to the elevation of cholesterol levels, and more particularly low-density lipoprotein cholesterol (LDL-C) that is a primary risk factor for cardiovascular disease. Many studies have clearly shown that a reduction of LDL-C levels and the increase of high-density lipoprotein cholesterol (HDL-C) reduce the risk of cardiovascular events and overall mortality (Schaefer *et al*., 1997). The international guidelines for the prevention of CVD suggested that patients with manifest CVD should control their LDL-C to less than 2.6 mmol/L and blood pressure to less than 140/90 mm Hg (Mancia *et al*., 2007).

All chronic diseases have a big negative impact especially in ones' country economy. In the next 10 years, it was estimated that China, India and the United Kingdom are projected to lose $558, $237 and $33 billion, respectively, in national

income as a result of heart disease, stroke and diabetes, partly as a result of reduced economic productivity (WHO, 2005). Several factors are affected by this increasing burden, including longer average lifespan, tobacco use, decreasing physical activity, and increasing consumption of unhealthy foods. Fortunately, these chronic diseases are largely preventable. Up to 80% of premature deaths from heart disease, stroke and diabetes can be prevented with known behavioural and pharmaceutical interventions (WHO, 2005).

Statins usage is well known among the hypercholesterolemia patients. National Medicines Use survey reported the widely used statins; atorvastatin and simvastatin ranked third and fourth in the list with a 3.9 and 7.9 Defined Daily Dose (DDD)/1000 population/day presented with a total cost of RM 74 million. Out of which the private sector accounted for RM 63 million. This report stated that it is similiar to the Australian Statistics on Medicine wherein the statins are ranked first and second. This is expected in reference to their high utilization for hypercholesterolaemias in both countries (Shanti *et. al*., 2004). In Malaysia, the total health expenditure for the year 2004 was 4.4% of total gross domestic product (GDP), or $62 per capita. Malaysia spends the most per capita on health care with $180 per capita and Myanmar spends the least with $5 per capita (Development Data Group, 2007).

Cardiovascular disease is a global health concern associated with high morbidity and mortality. Therapeutic strategies usually include synthetic drugs, which may entail high costs and serious complications. A modification on our daily eating habit should be the main strategies to be targeted in reducing the risk factors. Inclusion of

fruits and fruit products would be one of the alternative approaches that may provide higher degree of safety and efficacy than medicinal drugs. The situations mentioned showed that there is markedly increase in the need of functional foods or nutritional supplements as an adjunct for prevention and management of CVD. Therefore, the spray pitaya powder nutritional composition, antioxidant properties and its supplementation effects on biochemical parameters in human subjects needs to be clinically examined.

1.3 Significance of the study

Fruits are rich with fiber, vitamins and antioxidants that are found to have potential health benefits. Recommendations for consumption of fruit and vegetables are given as five or more servings per day (Krauss *et al*., 2000). In reality, however, surveys have shown that these guidelines are rarely met (Naska *et al*., 2000) and this being supported by a study in the European countries where it showed the mean intake of fruits and vegetables are 70% below the WHO target which is the intake is less than 275 gram per day (Joffe and Robertson, 2001).

But now, the role of dietary fiber in nutrition and health has stimulated a wide range of research activities and caught public attention (Norziah *et al*., 2008). Efforts to increase dietary fiber in individuals consuming < 25 g/day may help to decrease and improved plasma levels of lipid profiles, blood glucose and blood pressure (Howarth *et al*., 2001). Addition of high fiber foods orfruit products will contribute to the development of nutritional supplements or functional foods that are currently in high demand and had led to a new discovery.

Because of this, many agencies that want to address these growing health concerns have made many campaigns and new products towards contributing to a better health for tomorrow. Coincide with the significant of this study, the purpose is to try to find out new alternative way to prevent and reduce the incidence and mortality of CVD in an effective way such as the development of a better form of fruit products.

People may beliefs that this products are beneficial to health, but there are scarce in the scientific evidences that may strengthen the facts that it really helps. Therefore, it is beneficial if pitaya being utilized to prove that it's really manifest the reduction in cholesterol levels.

Hylocereus polyrhizus or dragon fruit can produce fruits throughout the year, but sometimes it is difficult to be found in the market throughout the year. This is related to the pathogenic bacteria causing disease on dragon fruit in Peninsular Malaysia (Masyahit *et al*., 2009). Because of its high nutritional value (Wu *et al*., 2006) and it can be a potential nutritional supplement, this dragon fruit product can be produced and make available anywhere throughout the year. Spray drying technology can be applied to convert the dragon fruit juice into powder with longer shelf life, cost-effective, easy for storage and is readily available. Thus, in the present research, red pitaya spray dried powder was prepared and evaluated its effect on one's health.

From this study, we hope that all the nutritional values may reveal the potential of pitaya (*Hylocereus polyrhizus* [Weber] Briton & Rose) as one of the fruit products that may help reducing and preventing hypercholesterolemia instead of using drugs.

1.4 Objectives of the study

General Objective:

To investigate the nutritional composition, antioxidant properties of Spray Pitaya (*Hylocereus polyrhizus* [Weber] Briton & Rose) Powder (SPP) and its supplementation effects on selected biochemical parameters in normocholesterolemic subjects.

Specific Objectives:

1. To determine the nutritional composition, vitamin C, minerals, antioxidant properties and heavy metals content in spray pitaya (*Hylocereus polyrhizus* [Weber] Briton & Rose) powder (SPP).
2. To determine the effects of spray pitaya powder (SPP) on the liver (ALT, AST and ALP) and kidney functions (BUN and creatinine) of normal *Sprague Dawley* rats.
3. To determine the effects of SPP supplementation on the biomarkers of plasma lipid profiles (total cholesterol, triglyceride, high density lipoprotein and low density lipoprotein), glucose, total antioxidant status, liver enzymes (GGT, AST, ALT and ALP), kidney functions (BUN and creatinine), blood pressure and body weight changes in normocholesterolemic subjects.

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