APPLICATION OF THERMAL TREATMENT FOR VARIOUS COCOS NUCIFERA SAMPLES TO THE SUCROSE CONTENT ANALYSIS

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A thesis submitted in fulfillment of the requirements for the award of the degree of Bachelor Chemical Engineering

Faculty of Chemical and Natural Resources Engineering
Universiti Malaysia Pahang

APRIL 2009
DECLARATION

I declare that this thesis entitled “Application of Thermal Treatment for Various Cocos Nucifera Samples to the Sucrose Content Analysis” is the result of my own research except as cited in the references. The thesis has not been accepted for and degree and is not concurrently submitted in candidature of any other degree.

Signature : ............................................................

Name of Candidate : Siti Noreyani Binti Abdul Rahman

Date : 21 APRIL 2009
To Beloved Dad and Mom, Haji Abdul Rahman Bin Jusoh and Hajjah
Shamsiah Bt Mamat, My Lovely Fiance, Abdul Halim Bin Abdul Razik and
siblings.
ACKNOWLEDGEMENT

I would like to express my deep gratitude to my supervisor, Dr. Mimi Sakinah Bt Abdul Munaim, for her guidance and support throughout my work and study.

I am also grateful to all my colleagues in the Bachelor of Chemical Engineering for their help whenever I need. I should also to thank for any considerable assistance from those who have contributed into this work, directly and indirectly.

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ABSTRACT

The percentage of diabetics has shown unwelcomed increment recently and one of the methods to mitigate this situation is by increasing the production of Fructo-Oligosaccarides (FOS) in the market. FOS is very useful product for diabetics as it can reduce the amount of sugar in their blood. Sucrose which can be found in coconut samples is the raw material to produce FOS. Through thermal treatment of the coconut samples, the percentages of sucrose production can be determined. In this research, three types of coconut samples being used which are coconut water (22.41% sucrose content), coconut sugar A (17.88% sucrose content) and coconut sugar B (14.95% sucrose content). The thermal treatment involves specific procedures of heating and cooling which can give effects to the microstructures of each sample. Two parameters has been analyzed in this study which are temperature and exposure time. The changes of sucrose concentration in each sample have been analyzed using UV-Vis Spectrometer. The experimental results show that increased in temperature and exposure time resulted in increased of sucrose concentration. Optimal conditions for coconut water are 181.64 minutes exposure time and 70°C with the concentration of sucrose produced is 343.53 g/L. Without the thermal treatment, the concentration of sucrose is only 224.05 g/L or 34.78% lower than with thermal treatment. Meanwhile, optimal conditions for coconut sugar A and coconut sugar B are 199.24 minutes and 202.08 minutes respectively, both at temperature of 70°C. At these optimal conditions, coconut sugar A produced 398.06 g/L of sucrose (55.08% higher than without thermal treatment) and coconut sugar B produced 305.37 g/L of sucrose (51.04% higher than without thermal treatment). In conclusion, after performing the thermal treatment for the three types of coconut samples, coconut sugar A is the best sample where the production percentage of sucrose has been increased up to 55.08% after 199.24 minutes exposure time at 70°C.
ABSTRAK

Pada masa kini, peratusan pesakit diabetes semakin meningkat disebabkan oleh peningkatan kandungan gula di dalam darah. Salah satu kaedah bagi mengurangkan risiko menghidap penyakit ini adalah dengan menggunakan frukto-Oligosakarida (FOS) sebagai penggantian kepada gula tebu kerana FOS dapat mengawal kandungan gula di dalam darah. Sukrosa merupakan bahan mentah dalam penghasilan FOS. Dalam kajian ini, kaedah rawatan haba djalankan ke atas beberapa jenis sampel kelapa bagi mengenal pasti peningkatan peratusan penghasilan sukrosa. Tiga jenis sampel kelapa digunakan iaitu air kelapa (22.41% sukrosa), gula kelapa A (17.88% sukrosa) dan gula kelapa B (14.95% sukrosa). Kaedah pemanasan dan penyejukuan yang djalankan memberikan kesan terhadap mikrostruktur dan seterusnya memberikan kesan terhadap sifat-sifat sampel tersebut. Dua parameter dijaki iaitu suhu (40°C, 50°C, 60°C, 70°C dan masa (setiap 30 minit, 0 minit hingga 300 minit) terhadap sampel-sampel kelapa dan seterusnya perubahan kepekatan sukrosa dianalisa menggunakan Spektrometer UV-Vis. Hasil daripada eksperimen yang djalankan, didapati semakin meningkat suhu dan masa yang dikenakan, semakin banyak penghasilan sukrosa di dalam sampel-sampel. Tempoh optima untuk sampel air kelapa ialah pada 181.64 minit pada suhu 70°C dengan kepekatan sukrosa 343.53 g/L. Berbanding dengan kepekatan sukrosa sebelum rawatan, 224.05 g/L menunjukkan peningkatan peratusan sebanyak 34.78%. Manakala untuk gula kelapa A dan gula kelapa B, tempoh optima pada 199.24 minit dan 202.08 minit, pada suhu 70°C dengan kepekatan sukrosa, 398.06 g/L dan 305.37 g/L. Berbanding sebelum rawatan, kandungan sukrosa, 178.794 g/L dan 149.507 g/L, peratusan meningkat kepada 55.08% dan 51.04%. Kesimpulannya, gula kelapa A adalah sampel terbaik kerana menghasilkan kandungan sukrosa yang tertinggi (55.08%) pada suhu 70°C dan masa 199.25 minit berbanding dengan sampel air kelapa dan gula kelapa B selepas menggunakan kaedah rawatan haba.
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LIST OF SYMBOLS

°C  Degree Celcius
Min  Minute
g/L  Gram per Litre
yr  Year
C=O  Free Carbonyl Group
COOH  Carboxylate Anion
OH  Oxidation radical
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CHAPTER 1

INTRODUCTION

1.0 Introduction

1.1 Background of Study

The scientific name for the coconut is *Cocos nucifera*. It is perhaps one of the most widely spread fruit through natural means in the world, and because of this and the many utilitarian uses of this plant it has become an extremely important plant for indigenous populations. But the coconut now is facing the effects of globalization. From indigenous crop, to disappearing resource, the coconut is a threatened crop. The ever increasing use of monocrops being forced upon the developing world is destroying the traditional methods of agriculture in indigenous populations all in the name of profit for the Western world.

The sucrose, fructose and glucose containing in natural sources such as barley malt syrup, date sugar, white grape juice, honey, maple syrup, banana and coconut sugar is also one of them. Sucrose is usually made from sugar beets or sugar cane that gives you quick energy. However too much consumption of sucrose can cause the excess carbohydrates to be stored in fat cells just like the consumption of others high-glycemic carbohydrates. Another disadvantage of sucrose is that it encourages acid production in the mouth and in turn this promotes dental caries. In this study, the sucrose produced will be raw material in order to convert it become Fructo-Oligosaccharide (FOS). Fructo-oligosaccharide ,(FOS) can be used as a curing agent for colon diseases and diabetic. Fructo-oligosaccharide (FOS) as a prebiotic and also as a sweetener.
1.2 Problem Statement

The incidence of diabetes has risen from almost nothing a century ago to a level of major concern today. It is now the sixth biggest killer in America. Diabetes not only can cause death but can lead to kidney disease, heart disease, high blood pressure, stroke, cataracts, nerve damage, hearing loss, and blindness. It is estimated that 65% percent of the population is at risk of developing diabetes. With diabetes, heart attacks occur earlier in life and often result in death. By managing diabetes, high blood pressure and cholesterol, people with diabetes can reduce their risk. One of the ways reducing the sugar in blood is by using synthetic sugar. Synthetic sugar having no sucrose, low of calories and do not effecting blood sugar level but synthetic sugar are still chemicals whereas food additives that could cause side effects.

There are so many foods and beverages on the market today that that contain aspartame. Some on the list are diet soft drinks, yogurt, instant breakfasts, candy, breath mints, sugar free gum, cocoa mixes, coffee beverages, frozen desserts, juice, laxatives, milk drinks, shakes, tea beverages, topping mixes, wine coolers, and the list goes on. Many people make the mistake of not checking labels, and continue to poison themselves and their children, unknowingly. So, by using nutritious natural sugar, it will add benefiting nutrients to consumer.

The coconut industry is also facing the problem of decreasing prices in all coconut-based products. A main cause of this situation is oversupply of global output especially in Thailand which is one of the major suppliers of coconut based. The uses of this product at the moment are limited to food industry. Hence, too much production with lower demand can cause the value of coconut to decrease.
1.3 Objectives

Objective can be defined as the main target that needs to be achieved in this proposal. It is also as guidance to make sure that the problem is solved with an appropriate solution. The objectives for this proposal are:

i. To determine the effect of temperature during production of sucrose by using thermal treatment.

ii. To determine the effect of exposure time during production of sucrose by using thermal treatment.

iii. To identify the optimal condition of glucose production, during thermal treatment method.

1.4 Scopes of Study

To make this project a success, some boundary need to be specify so that the objective of this project can be achieve without questionable problem. The boundary is called scope of study. This scope will be use to get a clear view on which element that need to be study or which component that will be use.

First, this study will be focusing on determination of the maximum amount of sucrose produce by using thermal treatment method. There are three types of sample which are coconut water (22.41% sucrose), coconut sugar A (17.88% sucrose) dan coconut sugar B (14.95% sucrose).

The parameters that will be study are the optimal temperature and exposure time. The temperatures used for this treatment are 40, 50°C, 60°C and 70°C and for exposure time at range 300 minutes with 30 minutes interval time. The pH set for this pre-treatment is pH 5.5 by using acetate buffer. The Dinitrosalicylic Calorimetric Method (DNS Method) was used to determine the amount of sucrose produced by using UV-Visible Spectrophotometer.
1.5 Significant of Study

Diabetes is a chronic condition in which the body cannot properly convert food into energy. Coconut sugar is the best product for diabetic patient comparing with the synthetic sugar. Nowadays, diabetic patients use synthetic sugar to replace sugar in their foods and drinks in controlling their insulin surges. The synthetic sugar and natural sugar contains the sucrose, fructose and glucose which are helping the patient to control their blood sugar. However the natural sugar is better since there is no presence of chemicals compared to the synthesis ones.

For the health conscious consumers and diabetics, coconut sugar can be considered to be the best sweetener substitute once it is available in the market because of the many benefits that it has to offer. Tests done by the Food and Nutrition Research Institute (FNRI) and Department of Science Technology (DOST) of the Philippines has revealed a low glycemic index (GI) of 35 compared to that of cane sugar’s glycemic index of 50. That's mean coconut sugar is good for proper control of diabetes mellitus. The coconut sugar consist 0.64% bonded glucose, 1.43% bonded fructose and 89.33% bonded sucrose. With amount of 89.33% of sucrose in coconut sugar, the amount FOS being converted can be produced more.

Fructo-oligosaccharide (FOS) also known as oligofructose, a dietary sugar, which the human body does not metabolize, hence its potential use for diabetics and in body weight control. Coconut was one of the best raw material with high sucrose content to produce Fructo-oligosaccharide (FOS). Fructo-oligosaccharide (FOS) can actually help bring down high blood sugar levels in diabetics. In addition, it cuts down elevated cholesterol levels and normalizes blood fat content. Moreover, increased intake of oligofructose has been associated with improved gut health because of the stimulation of (beneficial) bifidus bacteria in the colon.
From this study, at optimal temperature and time of exposure, maximum amount of could be collected and converted to Fructo-oligosaccharide (FOS). Fructo-oligosaccharide (FOS) is known from natural resource that is free from chemical which is can be used as a dietary sugar and prebiotic also as a synthetic sugar. With these advantages, demand for coconut sugar will rapidly increase as the price also.
CHAPTER 2

LITERATURE REVIEW

2.0 Introduction

2.1 Coconut Fruit (Cocos Nucifera)

Coconut (Cocos nucifera L.), one of the key plantation crops of the tropics, is a member of the monocotyledonous family Aracacea (Palmacea) (Daniel et al., 2005). It is the only species of the genus Cocos belonging to the subfamily Cacoidea which includes 27 genera and 600 species (Perera et al., 2003). Now, coconut is divided into two main types which are tall coconuts, fast growing and predominantly allogamous (cross-fertilizing), and dwarf ones, slow growing and mainly autogamous (self-fertilizing) (Teulat et al., 2000).

Recently, the coconut palm also occupies an important position in the international vegetable oil market (Baudouin et al., 2006). In addition, coconut can also be used as food diet and other purposes. For example, lauric acid, the major fatty acid from the fat of the coconut, has long been recognized for its unique properties that it lends to nonfood uses in the soaps and cosmetics industry (Ashburner et al., 1997). At the same time, in some regions, the coconut is, with few exceptions, exclusively a tropical ornamental plant, much in demand as a signature tropical landscape element (Meerow et al., 2003).
Base on Figure 2.1, Dignan et al. (2004) have studied that the coconut products differ in their nutrient content. Coconut oil is almost 100% fat with no carbohydrate, whereas boiled coconut toddy is almost half carbohydrate with almost no fat. As it matures, the flesh of the coconut becomes higher in fat and energy. Coconut oil, mature coconut meat and coconut cream are all high in energy (calories). A small amount of coconut cream added to local root crops and starchy fruits makes a good energy food for young infants after six months of age. The soft flesh of a young drinking coconut is also a suitable food for infants and children.

![Coconut fruits](image.png)

**Figure 2.1** : Species Coconut fruits for Pacific Island Agroforestry (Bourdeix, 2005)

Coconut toddy is an excellent source of vitamin C, which is important for fighting infection and also helps the body absorb some forms of iron. One cup of fresh toddy provides more than the estimated daily requirement of vitamin C for most adults (45 milligrams). Coconut juice, sprouted coconut, and the flesh of immature and mature nuts are also good sources of vitamin C.
From Murai et al. (1958) previous studies, some coconut products are also a good source of iron, which is needed for building strong blood. Many coconut products contain niacin, riboflavin, and thiamine (essential B vitamins), which are important for body metabolism. The drinking coconut contains a refreshing nutrient rich liquid. The juice can also be given to people with diarrhoea to replace lost fluids and minerals. Soft drinks contain few nutrients (Table 2.1) and may be harmful to health because they often contain a large amount of refined sugar.

**Table 2.1** : Comparison of 100gm edible of coconut products, processed baby food and soft drink.

<table>
<thead>
<tr>
<th>Food item</th>
<th>Kcal*</th>
<th>Protein (g)</th>
<th>Fat (g)</th>
<th>CHO (g)</th>
<th>Fibre (g)</th>
<th>Calcium (mg)</th>
<th>Iron (mg)</th>
<th>Niacin (mg)</th>
<th>Vitamin C (mg)</th>
</tr>
</thead>
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<tr>
<td>Sprouting coconut</td>
<td>74</td>
<td>1.3</td>
<td>3.6</td>
<td>6.5</td>
<td>1.6</td>
<td>19</td>
<td>0.7</td>
<td>0.9</td>
<td>6</td>
</tr>
<tr>
<td>Coconut flesh, mature</td>
<td>283</td>
<td>3.0</td>
<td>27.4</td>
<td>3.6</td>
<td>7.6</td>
<td>10</td>
<td>1.0</td>
<td>0.6</td>
<td>7</td>
</tr>
<tr>
<td>Coconut flesh, immature</td>
<td>81</td>
<td>1.8</td>
<td>5.9</td>
<td>3.8</td>
<td>3.2</td>
<td>2</td>
<td>1.3</td>
<td>3.6</td>
<td>3.8</td>
</tr>
<tr>
<td>Coconut cream, fresh, no water</td>
<td>325</td>
<td>4.4</td>
<td>32.3</td>
<td>4.7</td>
<td>1.7</td>
<td>15</td>
<td>1.8</td>
<td>0.5</td>
<td>1.0</td>
</tr>
<tr>
<td>Coconut water/juice, immature nut</td>
<td>16</td>
<td>0.1</td>
<td>0</td>
<td>3.9</td>
<td>0</td>
<td>12</td>
<td>trace</td>
<td>2.8</td>
<td>1.4</td>
</tr>
<tr>
<td>Coconut water, mature nut</td>
<td>22</td>
<td>0.3</td>
<td>0.2</td>
<td>4.0</td>
<td>0</td>
<td>29</td>
<td>0.1</td>
<td>0.1</td>
<td>2</td>
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<tr>
<td>Coconut toddy, fresh</td>
<td>42</td>
<td>0.2</td>
<td>0.4</td>
<td>9.6</td>
<td>0</td>
<td>trace</td>
<td>trace</td>
<td>0.2</td>
<td>20</td>
</tr>
<tr>
<td>Coconut toddy, boiled</td>
<td>217</td>
<td>0.9</td>
<td>2.1</td>
<td>49.4</td>
<td>0</td>
<td>trace</td>
<td>trace</td>
<td>trace</td>
<td>**</td>
</tr>
<tr>
<td>Coconut oil</td>
<td>883</td>
<td>trace</td>
<td>99.9</td>
<td>0</td>
<td>2</td>
<td>trace</td>
<td>trace</td>
<td>0</td>
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<td>Baby food, apple and apricot</td>
<td>45</td>
<td>0.2</td>
<td>0.2</td>
<td>9.8</td>
<td>1.8</td>
<td>6</td>
<td>0.3</td>
<td>0.1</td>
<td>18.0</td>
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<td>0</td>
<td>0</td>
<td>10.9</td>
<td>0</td>
<td>trace</td>
<td>0</td>
<td>0</td>
<td>0</td>
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2.1.1 **Coconut Sugar**

Recently, PCA Administrator Oscar G. Garinbared in a press conference the result of Glycemic Index (GI) test done by Dr. T. P. Trinidad of the Food and Nutrition Research Institute-DOST on coconut sugar produced at Linabu, Balingasag, Misamis, Oriental. According to this test, the glycemic index of
coconut sap sugar is only 35, hence classified as Low GI food which is good for proper control & management of deadly diabetes.

The Glycemic Index (GI) is a ranking system for carbohydrates based on the immediate effect on blood glucose level, the higher the number, the greater the blood sugar response. A low GI food will cause a small rise in blood glucose level while a high GI food will trigger a dramatic rise in blood glucose level. Low GI food is good for proper control and management of the deadly diabetes mellitus, a local and global major human disease. Coconut sugar is also capable of lowering the total cholesterol and low density lipoprotein (LDL).

A disease in which the blood glucose levels are above normal or the body does not produce or properly use insulin. Insulin are hormone needed to convert sugar, starches and other food into energy needed for daily life. Currently, more than 240 million people worldwide living with diabetes. The rate of diabetes among adults in countries as Asian giants such as China and India, others like South Korea, Indonesia and Thailand are contributing to this increase. In the Philippines, there are 3.5million who are diabetics, roughly 4.6% of our population, another 4.6% unaware that they are diabetic; 8% will become diabetic.. These figures are expected to double in the next 20 years, by then the Philippines were expected to be among top 10 countries with highest incidence of diabetes.

Asian countries rich in coconut resources such as Philippines, Thailand, Indonesia, Vietnam and others should encourage coconut farmers and processors to produce sugar because a healthy natural sweetener also for people of all walks of life, particularly, the diabetics. This can be one measure to prevent or minimize the incidence of this disease especially in children. Young people are now prone to Type 2 diabetes due to current lifestyle because of the fast foods and junk foods and lesser physical activities which leads to obesity. In Thailand, public health officials are encouraging government to consider increase in taxes of food high in sugar and consequently promote healthy diet.
2.1.2 Coconut Water

Coconut water is a refreshing beverage that comes from coconuts. It is a powerhouse of nutrition containing a complex blend of vitamins, minerals, amino acids, carbohydrates, antioxidants, enzymes, health enhancing growth hormones, and other phytonutrients. Because its electrolyte or known as ionic mineral content is similar to human plasma, it has gained international acclaim as natural sports drink for oral rehydration. As such, it has proven superior to commercial sports drinks. Unlike other beverages, it is completely compatible with the human body, in so much that it can be infused directly into the bloodstream. In fact, doctors have used coconut water successfully as an intravenous fluid for over 60 years (Fife., 2008).

Coconut water’s unique nutritional profile gives it the power to balance body chemistry, ward off disease, fight cancer, and retard aging. History and folklore credit coconut water with remarkable healing powers, which medical science is now confirming. Published medical research and clinical observation have shown that coconut water makes an excellent oral rehydration sports beverage, aids in exercise performance, kidney function and dissolves kidney stones. Coconut water also can reduces swelling in hands, feet and risk of heart disease, protects against cancer, provides a source of ionic trace minerals, improves blood circulation, blood cholesterol levels and digestion which are contains nutrients that feed friendly gut bacteria. Besides that, this fruit can helps balance blood sugar and relieve constipation, lowers high blood pressure, prevent atherosclerosis and abnormal blood clotting, possesses anti-aging properties and enhances immune function (Fife., 2008).

Young tender coconut water contains ascorbic acid. The concentration of ascorbic acid ranges between 2.2 to 3.7 mg per ml. This ascorbic acid content gradually diminishes as the kernel surrounding the water begins to harden up. The coconut water also contains vitamins of the B group.