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Identification of Macro Elements (Sucrose, Glucose and Fructose) and Micro Elements (Metal Minerals) in the Products of Palm Sugar, Coconut Sugar and Sugar Cane

*Yeyen Maryani
Department of Chemical Engineering, Faculty of Engineering
Universitas Sultan Ageng Tirtayasa
Serang – Banten, Indonesia
Indonesia Center of Execelenc for Food Security (I-CEFORY), UNTIRTA (Local Food Innovation)
*yeyen.maryani@untirta.ac.id

Rida Oktorida Khastini
Department of Biology Education, Faculty of Teacher Training and Education
Universitas Sultan Ageng Tirtayasa
Serang – Banten, Indonesia
rida.khastini@untirta.ac.id

Irma Saraswati
Department of Electrical Engineering
Faculty of Engineering
Universitas Sultan Ageng Tirtayasa
Serang – Banten, Indonesia
irma.saraswati@untirta.ac.id

Agus Rochmat
Department of Chemical Engineering, Faculty of Engineering
Universitas Sultan Ageng Tirtayasa
Serang – Banten, Indonesia
agusrochmat@yahoo.co.id

Teguh Kurniawan
Department of Chemical Engineering, Faculty of Engineering
Universitas Sultan Ageng Tirtayasa
Serang – Banten, Indonesia
teguh_khr@yahoo.com

***Abstract*—Nowadays, there are many kinds of sweetener commonly found in foods and beverages available on the market such as sugar cane, brown sugar (coconut sugar) and palm sugar. Those types of sugar have different nutritional content. Palm sugar is widely consumed as a natural sweetener since it is quite safe for the body, because the palm sugar contains several macro and micronutrient elements. It is estimated that the nutrient content on palm sugar is higher compare than those in sugar cane and coconut sugar. In this study it was found that the water content for palm sugar, sugar cane and coconut sugar respectively 1.49%, 0.01% and 0.78%, ash content: 0.8%, 1.5% and 1.5 %, fat content: 4.67%, 18.69%, 12.28%. The simple sugars found in palm and coconut sugar were sucrose, glucose and fructose respectively 89.94%, 3.61%, 3.50% and 86.86%, 4.64%, 3.70% while sugar cane only contained sucrose at 94.75%. The complete mineral content was found in coconut sugar. Most of these were minerals Fe, Zn, Cu and Mn respectively 14.40%, 1.56%, 0.90% and 0.96%. Palm and sugar cane contained 3 minerals of Fe, Zn and Cu respectively 9.66%, 1.56%, 1.51% and 6.52%, 1.21%, 0.98%. This study provides the information the values of palm sugar that could be employed as a healthy and the natural sweetener.**

Keywords: sugar cane, coconut sugar palm sugar, simple sugar, minerals

I. INTRODUCTION

Palm sugar is widely consumed as one of the natural sweetener, contains several important nutrients that is safe to provide body's nutritional needs. The palm sugar has several macro and micronutrient elements. It is estimated, the content of both in palm sugar is higher than sugar cane [1]. The health benefits of palm sugar are worthy due to the high contained of iron. High iron content in palm sugar making who will consume them avoid anemia. Antioxidant properties in palm sugar are intimately involved in the prevention of damage from radical attacks and lower on the glycemic index than common sugar [2]. The results of the analysis by HPLC, showed total phenolic content of 26.5, 31.5, 372 and 3837 lg GAE / g for smooth, white, chocolate and jaggery, respectively. HPLC analysis revealed that different phenolic acids content present in brown sugar and jaggery [3]. The content of sucrose in palm sugar is 70-79% as well as 35% of glucose and fructose content which is sugar cane with 99.9-100% sucrose. Followed by 50% glucose and 50% fructose [4]. The area of palm sugar plantations in Banten Province in 2005 reached 1,633 ha. Production of printed palm sugar in Banten Province is concentrated in Lebak Regency. The concentration of palm sugar production is due to the growth of printed palm sugar agro-industry which is very dependent on the availability of fresh neera sap poduced from palm trees. The biggest producer of brown sugar in 2005 was Cijaku District with 346.20 kg, with 1,752 people for the labour, and 876 business units [5].

Research on palm sugar cultivation and utilization in Banten society has been widely carried out. The related topic were the efficiency and business of printed palm sugar [6,7], effect of palm sugar industry on household welfare Levels [8], increased palm sugar production [6], diversification of palm sugar with advanced crystalization technology [9], phenolic analysis and characterization of palm sugar [10]. The research and information related to nutritional content of palm sugar originated from Banten province is still limited. Therefore it is necessary to provide information for the public health about nutritional content and characterization of palm sugar. Thun the result will be compared with the

nutritional content on coconut sugar and sugar cane. The analysis of nutritional characteristics carried out include ash, fat and water content, macro element content such as sucrose, glucose and fructose content and micro element such as mineral metal.

II. METHODS

A. *Ash content*

About 2-3 g of each sample were weighed into a porcelain (or platinum) cup. Then the ash was put in the incinerating furnace at a temperature of 550 ºC until complete graying (once the furnace door is opened slightly, so that oxygen can enter). Then it was inserted and cooled in a desiccator, then was weighed until the weight remains.

B. *Fat content*

About 1-2 g of sample were put on the cotton which was reposed on filter paper and then it was rolled up to be a thimble. Wrapped samples were inserted into Soxhlet. Then hexane were added into the 400 ml fat flask, stirred then extracted for approximately 6 hours. During distillation process, the solvent will be accommodated in an extractor chamber, and then it was discarded so it reenter into the fat flask. Afterward, fat flask was dried in an oven at temperature of 105 ° C. Subsquently, fat flask was put in a desiccator until reached constant weigh

C. *Moisture Test*

Weigh approximately 2g each sample carefully, input into the moisture analyzer. Heated with a red indicator on the device lights up (the process has been completed marked with a dim indicator light. Next the moisture content listed on the device screen were recorded

D. *Sugar content analysis*

Standard Sugar Preparation

Standard sugar solutions were prepared separately by dissolving ±0.5 g in 50 mL volumetric flask ten homogenized. About 1 µL these solutions were subjected to the For HPLC analysis.

Samples Preparation

About 10 g of the sample test were blended into smaller finest pieces, then transferred to a 125 mL erlenmeyer and dissolved with 50 mL of distilled water. The sample was extracted using ultrasonic for 10 minutes, filtered and subjected into rotavavor. The concentrated extract was dissolved volumetrically with distilled water into a 10 mL measuring flask. The test sample was ready for injection into HPLC

E. *Mineral content analysis*

About 2-5 grams of sample were added 10 mL of HNO_3 (1: 1) then stirred gently and cover using a watch glass. The sample was heated in 95 ° C, refluxed for 10-15 minutes without boiling temperature then were placed into cool condition. About 5 mL of concentrated HNO_3 were added then refluxed for 30 minutes with a little heat. Then the sample was covered in a watch glass and evaporated to 5 mL without boiling temperature. After that the sample was cooled and proceed by adding 2 mL of deionized free water and 3 mL of 30% H_2O_2. The sample beaker is covered with a watch glass and then heated to warm the sample to form a bubble. Then 1 ml per H2O2 $H_2O_2$30% were added until it formed bubbles slightly. The addition of H_2O_2 should not be more than 10 mL of total. Sample cooled. Then added 5 mL of HCl and 10 mL of ion free water. Cover the sample with a watch glass then heat it on a hot plate, then continued with reflux for 15 minutes without boiling temperature. The sample were cooled, then pitched the sample to a 100 mL measuring flask with ion free water, filtered using Whatman filter paper then the sample was ready to be measured with AAS.

III. RESULT AND DISCUSSION

A. *Results of Analysis of Water Content, Ash Content and Fat Content in Palm Sugar, Coconut Sugar and Sugar Cane.*

Water is contained in almost all foods, and it is important to dissolve a number of chemicals.The capability of dissolving more substances is higher than any other liquid. Determination of water and moisture content is one of the most common tests in food because it has an important relationship on chemical, physical and microbiological changes during storage. Determination of ash content has to do with mineral content in an ingredient and is used as a parameter of nutritional value in food, while determination of fat content will show total fat content which will affect health [11]. In this study, moisture content, the ash content and fat content were carried out on palm sugar, coconut sugar and white sugar. Table 1.

TABLE I. THE RESULTS OF THE ANALYSIS OF WATER CONTENT, ASH CONTENT AND FAT CONTENT IN THREE TYPES OF SUGAR.

No	Types of Sugar	Water content (%)	Ash Content (%)	Fat Content (%)
1	palm sugar	1,49	0,8	4,67
2	white sugar	0,01	1,5	18,69
3	coconut sugar	0,78	1,5	12,28

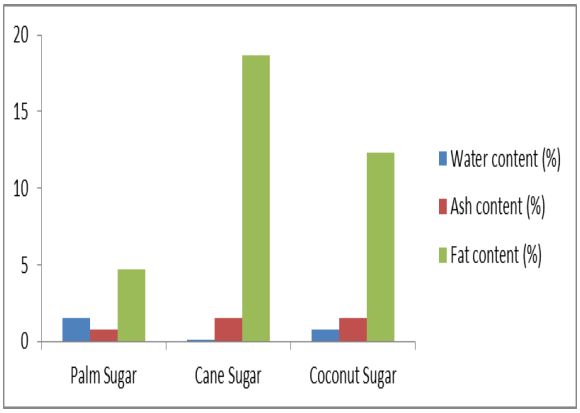

Fig 1. Water content, ash content and fat content in palm sugar, sugar cane and coconut sugar

Figure 1 showed that the water content in palm sugar is higher compared to coconut sugar and sugar cane so that palm sugar is more soluble in food additives. The ash content is less than sugar cane and coconut sugar. Even though the palm sugar have less mineral content, but the fat content is also smaller. Therefore when people consume palm sugar, it

will be healthier compared to that of coconut sugar and sugar cane.

B. Analysis of Sucrose, Glucose and Fructose Content with High Performance Liquid Chromatography (HPLC).

Many foods that contain high sugar content, produce energy but has less nutrition. The condition will affected on the nutrient intake balance such as minerals, vitamins and protein [12]. In this study, the content of sucrose, glucose and fructose on palm sugar, coconut sugar and white sugar was analyzed using HPLC and the result can bee seen by the spectrum below

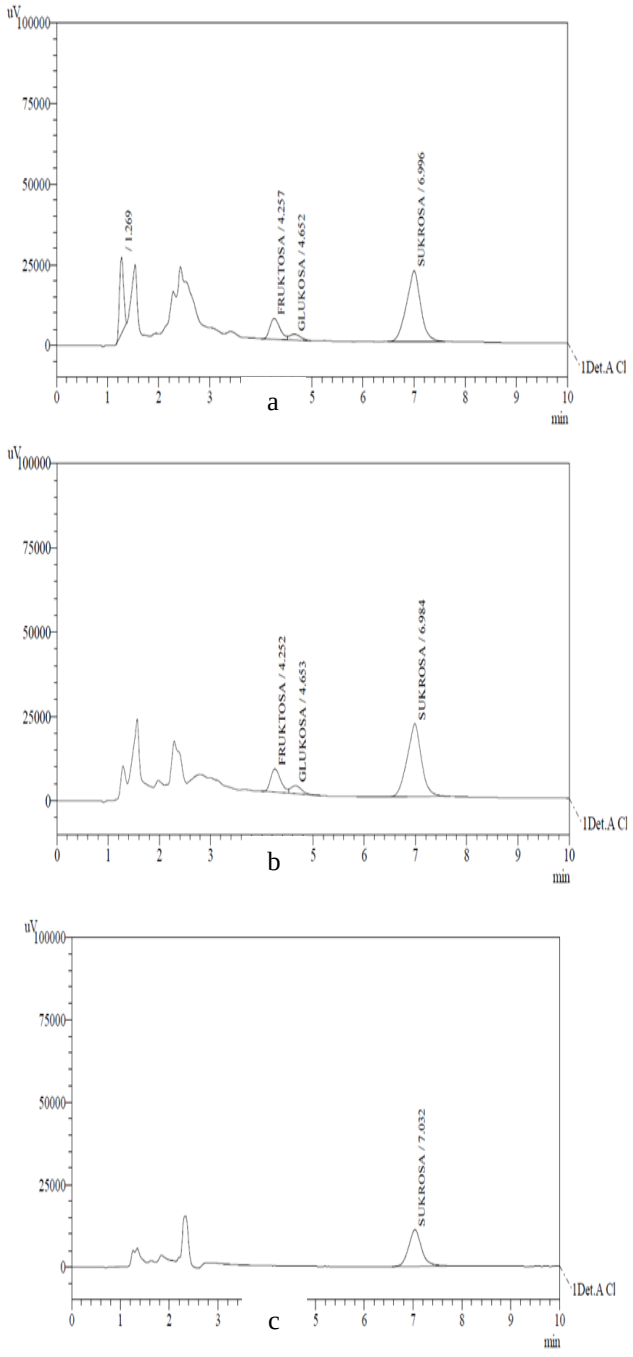

Fig 2. Simple sugar content chromatogram on a. Palm Sugar, b. Coconut Sugar, c. Sugar Cane

Figure 2 showed that palm sugar and coconut sugar contained sucrose, fructose and glucose. Whereas in sugar cane appears that only contains sucrose. The percentage of simple sugar content is shown in the following table.

TABLE 2. RESULTS OF SIMPLE SUGAR CONTENT ANALYSIS IN THREE TYPES OF SUGAR.

No	Types of Sugar	Sucrosa (%)	Glucosa (%)	Fructosa (%)
1	Palm sugar	89,94	3,61	3,50
2	Coconut sugar	86,86	4,64	3,70
3	Sugar Cane	94,75	Nd	Nd

Sucrose is a disaccharide while glucose and fructose are monosaccharides. Monosaccharides are absorbed immediately in the intestine. Glucose is absorbed in the intestinal villi through transportation along with sodium ions then enters capillary blood to be finally transported to the liver. Glucose is the main source of fuel for cellular metabolism in the body. The complex carbohydrates such as polysaccharides, oligosaccharides and disaccharides need to be broken down by various enzymes before they are absorbed in the intestine. Sucrose present in sweet soft drinks and foods can increase the risk of type 2 diabetes since it is easily absorbed [12], sugar cane contain sucrose, has been used as natural sweetener in the food and household industries since the end 1880s. But there are many other sources of natural sugar, such as honey, maple syrup, agave syrup, grapes, and other fruit juices / concentrated syrups, and date palm sugar. In addition, sugar and chocolate molasses, as a special product for processing sugar, as well as palm sugar, have a sizeable place in the market gaining popularity due to reduced calorific value, low glycemic index, and non caryogenic properties [13]. The results showed in table 2 indicated that sugar cane only contains sucrose which is a disaccharide that cannot be directly absorbed by the body, and coconut sugar and brown sugar is better because besides containing sucrose it also contains glucose and fructose which are monosaccharides which can be directly absorbed by the body and produce energy.

C. Mineral content analysis (Fe, Zn, Cu and Mn metals) in three types of sugar

Determination of mineral nutrients and inorganic contaminants has an important role in improving data on nutritional quality and food safety [14]. In this study the determination of minerals in palm sugar, coconut sugar and sugar cane is conducted by analyzing the metal con

TABLE 3. RESULTS OF ANALYSIS OF MINERAL CONTENT IN THREE TYPES OF SUGAR.TENT OF FE, ZN, CU AND MN.

mineral content	Fe (mg/Kg)	Zn (mg/Kg)	Cu (mg/Kg)	Mn (mg/Kg)
palm sugar	9,66	1,22	1.51	Nd
coconut sugar	14,40	1,56	0,90	0,96
sugar cane	6,52	1,21	0,98	Nd

Nd = Not detected

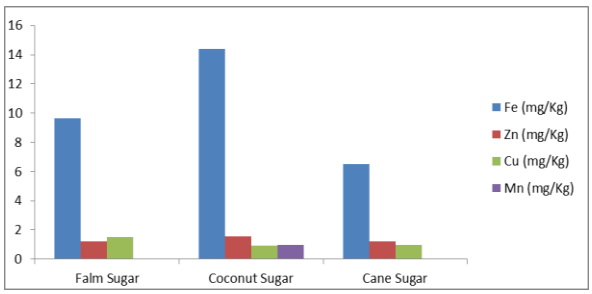

Fig 3. The content of metal minerals in palm sugar, sugar cane and coconut sugar

Table 2 showed that the complete metal content (Cu, Fe, Zn and Mn) were present in coconut sugar. Palm sugar contains Fe, Zn and Cu, while only refined sugar cane contains Fe and Zn. The metal content in food is the nutrient content needed by the body. Variations in food nutrient content are normal and occur depending on plant varieties, variations in nutrient content occur not only by means of cultivation, but also by soil, climate, culture, among other variables [14]. Some heavy metals such as Mn, Zn, Cu, and Fe are important nutrients in small amounts for the biological function of the human body, but high levels of them can cause problems for humans [15].

Small amounts of metal elements are needed for good health, but large metal elements can cause acute or chronic toxicity (poisoning). Especially the toxicity of heavy metals can result in damage or reduced mental and central nervous function, lower energy levels, and damage to the composition of the blood, lungs, kidneys, liver, and other vital organs [16]. For this reason, it is very important to recognized the metal content in food so that when consumed it can be a good nutrient for health.

IV. CONCLUSION

This study revealed that palm sugar has better nutrition compared to sugar cane and coconut sugar. It is proved by the water content in palm sugar is higher compared to coconut sugar and sugar cane so that palm sugar is more soluble in food additives. Although the ash and mineral content is less, but the fat content is much smaller therefore people who consume palm sugar will safe for high cholesterol disease. Palm sugar and coconut sugar contain, sucrose, fructose and glucose. While sugar only contains sucrose. Consuming coconut sugar is healthier because fructose and glucose will be easily absorbed and converted into energy, while sucrose must be broken down first into monosaccharides. The complete metal content is in coconut sugar which contains Cu, Fe, Zn and Mn. Palm sugar contains Fe, Zn and Cu, while only refined Granulated Sugar contains Fe and Zn. High metal content of Fe in coconut sugar and palm sugar is very good for avoiding anemia.

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