A Study of Physical and Mechanical Properties of Nata de Coco in the Market

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Abstract. Nata de coco is a bacterial cellulose produced by Acetobacter xylinum in the process of fermenting coconut water. It is renowned for its high fiber content. The chewiness of nata de coco is proportional to the fiber content. There are many brands of nata de coco available in the market. Six different brands are included in this study. The mechanical strengths have been evaluated using a Universal Testing Machine. Based on the tensile test results, the lowest Young's modulus is 3 MPa, attributed to the brand labeled as F as the most elastic nata de coco among the six brands. The degree of elasticity of nata de coco also corresponds to the sugar content. Further, the optical properties have been observed using a UV/Vis Spectrometer. Clearer nata de coco yields higher transmittance value. Meanwhile, the turbidity commensurate the nitrogen content.

Keywords: nata de coco, elasticity and transmittance

1. Introduction

One of the popular products from coconut water is nata de coco. Nata de coco is produced from the fermentation process of Acetobacter xylinum using coconut water as a source of micronutrients called bacterial cellulose [1,2]. Nata de coco is easy to make, easy to process and easy to obtain with inexpensive production costs. At present, nata de coco industry is growing rapidly. Many brands of nata de coco are sold in the market. The price offered varies for each brand of nata de coco. If we observe with the naked eye, nata de coco available in the market show generally yellowish white, white to clear color variations. The texture of each brand of nata de coco also varies, some are rather hard or even very soft/chewy. On the other hand, there has been no published research on the characterization of various brands of nata de coco in the market. The study on the characterization of several brands of nata the coco available in the market may seem unimportant, as many people assume it in a normal way and apparently can not benefit from it. However, we will show here that it is necessary. Information about the characteristics of each market-traded nata de coco is needed to determine whether the nata de coco sold in the market has the same standarization. Indeed, there are many common phenomena around us that could be interesting topics of research that have not been considered as such by many people [3-5]. The study of the characteristics of each nata de coco is also important for the development of research on nata de coco. This material is interesting since it is composed (network) of strong nano fibers. Some researchers have also examined the application of Nata de coco for different purposes. These findings have highlighted the benefits of bacterial cellulose composite for material of future application [6-11].

2. Methods

In this study, six brands of nata de coco in the market were tested (Figure 1). Several characterizations have been employed such as physical properties, optical properties and mechanical properties. Mechanical strength of the sample was tested using a Universal Testing Machine (Micro Control Systems model MCS-UTE60 equipped with a MCSUTE STDW2KXP), as shown in Figure 2(a). Spectrometer UV-Vis (Nano Calc 2000-UV-VIS Serial No. I2J8280) was used to examine the transmittance of all nata de coco is shown Figure 2(b).

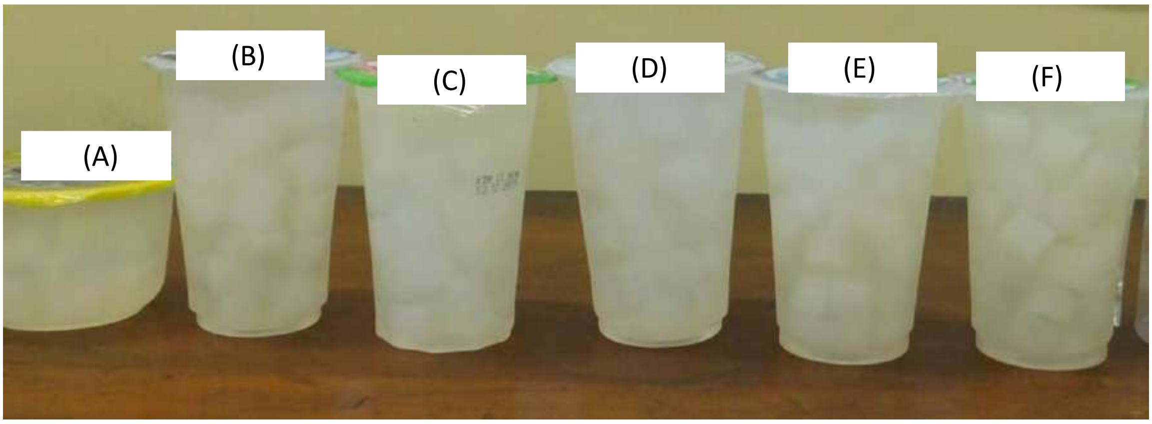

Figure 1. Six brands of nata de coco available in the market and are labeled as (A) brand A, (B) brand B, (C) brand C, (D) brand D, (E) brand E and (F) brand F.

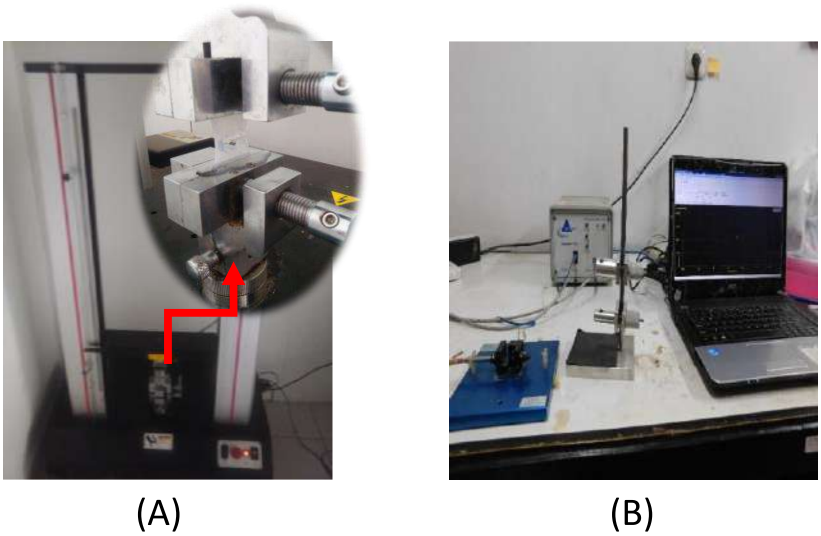

Figure 2. (A) Tensile strength tester dan (B) UV/Vis Spectrometry.

3. Results and Discussion

Nata de coco is a fermentation product derived from coconut water with the help of the bacterium Acetobacter xylinum. Coconut water can stimulate bacterial growth because of its rich and relatively complete nutritional content, so that it can be a natural medium suitable for microbial growth. Bacteria also need other additives for fermenting nata de coco, including carbon and nitrogen sources. Maltose, sucrose, lactose, fructose and mannose are carbonaceous compounds necessary for the fermentation of nata derived from monosaccharides and disaccharides. The type and level of sugar added will affect the thickness and nature of the Nata formed. Sucrose is often used as a carbon source to produce nata a thick and hard nata. Sucrose levels of 5 to 10% in a fermented medium will produce a thick and hard nata [12]. In this study, to measure the degree of elasticity of nata de coco, we used tensile strength test. The results of the characterization of tensile strength on commercial nata de coco samples are presented in Table 1. In this study, Universal Tensile Machine (UTM) were used to investigate tensile behavior of all samples. The Young's modulus also can be estimated. The Young's modulus value of all samples can be determined from the gradient value of the stress versus strain curve, as shown in Figure 3.

Table 1. Results of tensile strength test.

	$\Delta l_m\,(mm)$	$F_m\,(N)$	$\sigma_m\,(MPa)$
Brand A	3.30	18.42	0.41
Brand B	3.06	7.36	0.35
Brand C	11.71	43.04	0.31
Brand D	11.12	57.96	0.21
Brand E	12.15	46.99	0.14
Brand F	6.42	11.42	0.12

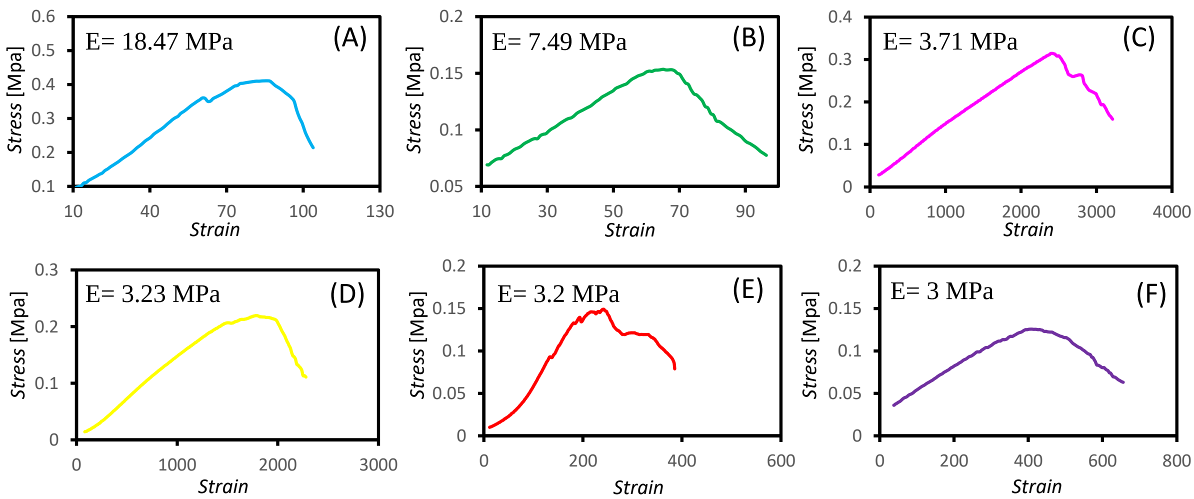

Figure 3. Curve of stress vs strain by (A) brand A, (B) brand B, (C) brand C, (D) brand D, (E) brand E and (F) brand F.

From tensile strength test, data of increase of length Δl_m were obtained. The value of maximum tensile strength F_m and maximum voltage σ_m can also be estimated. We observe from Table 1 that the highest maximum voltage was obtained by the sample of nata de coco brand A, 0.41 MPa. The higher value of maximum voltage correlates with higher tensile strength. Physically, the sample of nata de coco brand A has texture had such a hard texture. Based on the result of the tensile strength test, the Young's modulus can be estimated. Figure 3 shows that the lowest Young's modulus was obtained from the sample of nata de coco brand F, which is equal to 3 MPa. Meanwhile, the sample of nata de coco brand A has the highest Young's modulus value, 18.47 MPa. It also in line with the measurement graph of tensile strength test, in which the line of elongation at break of the sample nata de coco brand F is higher and longer than any other method. The line of elongation at break in the tensile strength test determines the elasticity of the material. It can therefore be concluded that the sample of nata de coco brand F was the most chewy nata. With increasing levels of sugar in the medium, the hardness of the nata will be lower and the elasticity will increase. This is because high sugar levels will cause looseness of the bonds between the fibers and, therefore, most of the formed gel will be filled with water and little solid. The elasticity of nata is influenced by a lot of lack of fibers [13]. The higher the fiber content, the more elastic the texture of nata.

Other supporting factors for the growth of bacterial activity in nata de coco are sources of nitrogen which can come from organic nitrogen and inorganic nitrogen. Sources of organic nitrogen include protein and yeast extract, peptone and tripton, while inorganic nitrogen such as ammonium phosphate, urea, potassium nitrate, and ZA. In the manufacture of nata de coco, it generally uses inorganic nitrogen, such as ammonium phosphate because it is very economical and its function is not inferior when compared to organic nitrogen sources. In addition, ammonium sulfate has advantages such as cheap, soluble, and selective to other microorganisms [14]. In the market, Nata de coco is generally yellowish white, white to clear or transparent, as shown in Figure 1. The clearer nata de coco indicates even greater transmittance. Based on results of UV/Vis spectrometer (Figure 4) for samples of nata de coco brand A, brand B, brand C, brand D, brand E and brand F, 75%, 57%, 50%, 48%, 42 and 38% were obtained, respectively. Meanwhile, the sample of nata de coco brand A attained the highest transparency value. The higher the level of ammonium sulfate added to the nata, the more yellow it will be. In fact, the hydrolysis ions of ammonium sulphate react with sugar, so that the results give a darker color [15].

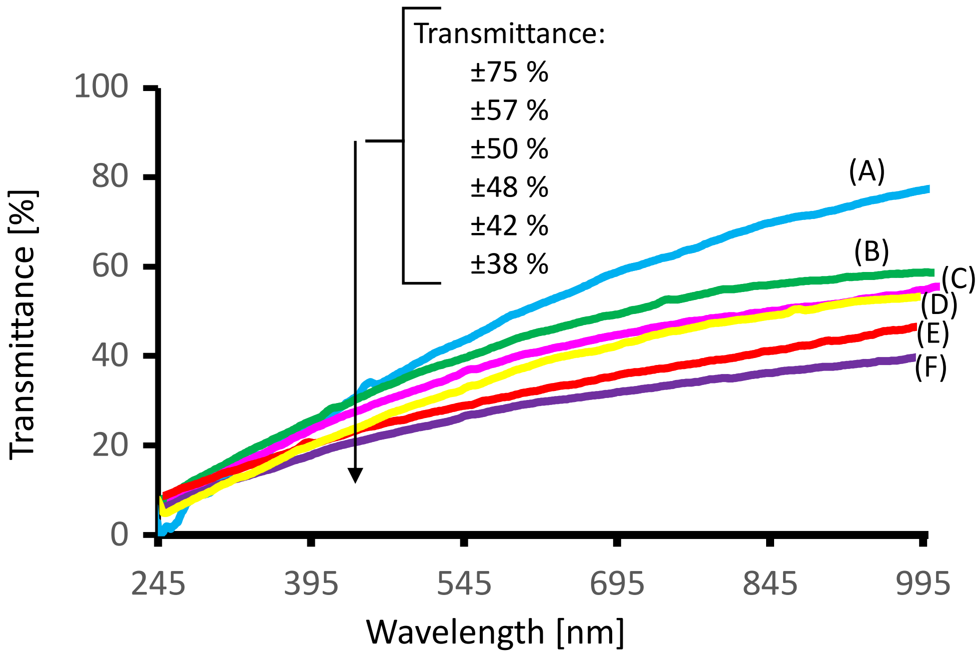

Figure 4. Characterization results of UV/Vis Spectrometer for (A) brand A, (B) brand B, (C) brand C, (D) brand D, (E) brand E and (F) brand F.

4. Conclusion

Based on the UV/Vis test, the highest transmittance was obtained by sample of nata de coco brand A, which visually showed the clearest color. If the color of nata de coco is more yellowish white, it indicates higher nitrogen content in nata de coco. The tensile strength test shows that nata de coco brand F is the most elastic nata de coco of the others. The more elastic the nata de coco is, more sugar content in nata de coco.

5. References

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Acknowledgement

Thank you for the PMDSU (Program Magister Doktor Sarjana Unggul) research grant from the Ministry of Research and Higher Education, Republic of Indonesia No. 535C/I1.C01/PL/2018 for HDR.