The Electrical properties of nanomaterials derived from durian skin waste by using a various types of electrodes for bio-battery application

Khairiah¹, Shinta Marito Siregar¹, Juliandi Siregar¹, Lia A Nasution¹ and Abdul Halim Daulay²

¹Alwashliyah Nusantara Muslim University, Sumatera Utara, Indonesia
²Islamic state university of North Sumatera, Medan, Indonesia

corresponding author: khairiahlubis10@gmail.com

Abstract. This research aimed to show on electricity from Durian skin waste nanomaterials. The compounds that abundant in Durian skin waste are phosphate compounds (PO₄). This phosphate compound makes the Durian skin waste has a high and unique electrical properties. Durian skin waste was synthesized using co-precipitation method to obtain LKD nanopowder with an average crystal size of 5 nm. LKD was dried at 250 ºC and then washed with 100 ml distilled water and measured the electrode with variations of Pb, Al, Zn, Fe and Cu. Obtained the electrical properties as much five times greater than before, which is an average of 6.5 Volts. It was concluded that the electrical properties of Durian skin waste will increase when the crystal size is smaller and Durian skin waste can be as bio-batteries. From electrode variations was obtained that the Zn electrode had a greater electrical voltage than the Al, Fe, Pb and Cu electrodes.

1. Introduction

Durian skin waste is one of much waste in North Sumatra, Indonesia. Indonesia is a rich country in natural resources. Energy from natural resources could be used optimally by synthesizing waste. Energy is the prime requirement of all sectors including industry, transportation, agriculture and domestic use without which advancement of technology and survival of life is not possible. Most of the energy around the world comes from non-renewable sources including such as petroleum, coal, oil and natural gas which are being depleting at a high rate [2]. Fossil fuels are the major source of global warming and pollution due to increase in greenhouse gases, volatile matter and particles in the atmosphere. However, technologies of renewable energy are growing worldwide that can overcome these drawbacks. Renewable energy from abundant Durian skin waste in Indonesia can overcome the energy crisis problem. Its abundant volume is a problem for the environment and health. Durian skin waste contains proportionally high cellulose (50-60%) and lignin content (5%), and low starch content (5%). Another mineral content in Durian skin waste is Calcium (Ca). Phosphor (F), Folic Acid, Magnesium (Mg), Potassium (K), Iron (Fe), Zinc, Manganese (Mn) and Copper (Cu) and Eco-friendly of bio-batteries produce electricity from renewable materials (glucose, fructose, sucrose, folic acid and other minerals). [1] The renewable material is obtained from fruit waste. Durian skin waste contains high phosphate compounds (PO₄), around 75%, which could be used to flow positive and negative ions. The content of this compound then creates electricity. [8] With the existence of this bio-battery, it can...
minimize mercury, cadmium and other heavy metals. In previous studies, searches and comparisons of large electric currents from several types of waste have been carried out where Durian skin waste has the highest electrical level of 1.5 Volts. [7] So that in this study Durian skin waste will be further enhanced by using advanced technology, namely nanotechnology-based technology. It is known that when the particle size goes to the nanometer order, the applicable laws of physics are dominated by the laws of quantum physics. [6] Changing properties of nanoparticles are usually related to quantum phenomena as a result of the limited space for electrons and other charge carriers in particles. Phenomenon affects the material properties with increasing electrical conductivity. [5] Nanomaterials derived from Durian skin waste will be synthesized by co-precipitation method which is one method of the development of nanotechnology.

The co-precipitation method is one (wet method) method of synthesis of organic compound nanomaterials based on the precipitation of more than one substance together when it passes through the saturation point. [10] Co-precipitation is a promising method because the process uses low temperatures and is easy to control particle size so that the time needed is relatively shorter. Some of the substances most commonly used as precipitating agents in co-precipitation are hydroxides, carbonates, sulfates and oxalates. In co-precipitation the basic materials are deposited together stoichiometrically with certain reactants. [2] A round particle must be $10^{-6}$ m in diameter to settle in solution as a precipitate. The method used is dissolving with distilled water, drying and washing. The co-precipitation includes recrystallization where there are seven methods in recrystallization, namely: selecting solvents, dissolving solutes, removing the color of the solution, removing solids, crystallizing the solution, collecting and washing crystals, drying the product (yield). [3] There are several things that can be analyzed to minimize co-precipitation with crystalline deposits. Impurity ions will be present in lower concentrations during deposition. When the liquid is cooled, the translational movements of the molecules become smaller and the molecular force is greater. Until after crystallizing the molecule has a certain position in the crystal. The heat formed in crystallization is called crystallizing heat.[9] During a fixed temperature crystallization, here the regulated equilibrium will again decrease the crystallization was complete. The reverse event of crystallization is called melting.[4]. The co-precipitation method was the right method to synthesize the Durian skin waste into nanometer size.

2. Research Method

The results of the synthesis of Durian skin waste by co-precipitation method which has become nano powder with an average crystal size of 5 nm then measured the electricity to see the performance of the sample. Electrical tests were carried out by measuring the acidity level of the sample first with a pH meter. Samples of Durian skin waste can be seen as shown in figure 1.

![Nano powder samples before measuring electrical properties.](image-url)
After measuring the pH of the sample then wash with 100 ml of distilled water and dissolve it in a beaker until homogeneous. Then stirring used a magnetic stirrer with a temperature of 70 ºC for approximately six hours (figure 2). After that the sample was cooled to be measured by using a variety of electrodes, Pb, Al, Zn, Fe and Cu. The five electrodes were measured alternately with the continuity of time for 10, 20, 30, 40, 50, 60, 70, 80, 90 and 100 minutes. Measurements were carried out using a simple method as shown in figure 3.

3. Result and Discussion
Electrical measurements for each electrode variation are Zn, Pb, Al, Fe and Cu. Measurement of voltage, current and electrical conductivity was 10 minutes as much as 10 times the test with a load of 1000 Ω up to 1900 Ω. The results obtained on the electrodes are as follows.

| Time (Minutes) | Zn Electrode | Pb Electrode | Al Electrode | Fe Electrode |
|----------------|--------------|--------------|--------------|--------------|
| R (Ω) | V (V) | I (A) | R (Ω) | V (V) | I (A) | R (Ω) | V (V) | I (A) |
| 10  | 1000  | 6.50  | 0.0072  | 10  | 1000  | 5.50  | 0.0052  |
| 20  | 1100  | 6.40  | 0.0064  | 20  | 1100  | 5.40  | 0.0044  |
| 30  | 1200  | 6.35  | 0.0057  | 30  | 1200  | 5.35  | 0.0037  |
| 40  | 1300  | 6.24  | 0.0053  | 40  | 1300  | 4.44  | 0.0033  |
| 50  | 1400  | 6.11  | 0.0051  | 50  | 1400  | 4.11  | 0.0031  |
| 60  | 1500  | 5.95  | 0.0048  | 60  | 1500  | 3.95  | 0.0028  |
| 70  | 1600  | 5.60  | 0.0045  | 70  | 1600  | 3.60  | 0.0025  |
| 80  | 1700  | 5.48  | 0.0035  | 80  | 1700  | 3.48  | 0.0015  |
| 90  | 1800  | 5.20  | 0.0034  | 90  | 1800  | 3.20  | 0.0014  |
| 100 | 1900  | 4.60  | 0.0029  | 100 | 1900  | 2.60  | 0.0009  |
From the five data above, it can be seen that the voltage value of the electric current from LKD nano powder with the same time and the same resistance, where the maximum stress was found on the Zn electrode which is 6.5 Volts. When compared with Durian skin waste samples before the nanometer order, a voltage increase of approximately four times was obtained. Voltage and current were obtained that each time and resistance or load increase, the voltage and current experience a significant decrease in digits. For this reason, the data can be seen clearly and accurately, and then made into a graph with Microsoft Office 2013. The results of the graph of the five types of electrodes for each unit of time are as follows.

| Cu Electrode |
|---------------|
| Time (Minutes) | R (Ω) | V (V) | I (A) |
| 10 | 1000 | 6.30 | 0.0062 |
| 20 | 1100 | 6.20 | 0.0054 |
| 30 | 1200 | 6.15 | 0.0057 |
| 40 | 1300 | 6.24 | 0.0053 |
| 50 | 1400 | 6.11 | 0.0041 |
| 60 | 1500 | 5.55 | 0.0038 |
| 70 | 1600 | 5.10 | 0.0035 |
| 80 | 1700 | 4.48 | 0.0025 |
| 90 | 1800 | 4.20 | 0.0024 |
| 100 | 1900 | 3.60 | 0.0019 |

From the five data above, it can be seen that the voltage value of the electric current from LKD nano powder with the same time and the same resistance, where the maximum stress was found on the Zn electrode which is 6.5 Volts. When compared with Durian skin waste samples before the nanometer order, a voltage increase of approximately four times was obtained. Voltage and current were obtained that each time and resistance or load increase, the voltage and current experience a significant decrease in digits. For this reason, the data can be seen clearly and accurately, and then made into a graph with Microsoft Office 2013. The results of the graph of the five types of electrodes for each unit of time are as follows.
Figure 4. Graphic of increased current for various types of electrodes

From the five graphs, it can be seen that the voltage and electric current values of Durian skin waste are linearly decreased both for Pb, Zn, Cu, Fe and Al electrodes. The decrease that occurs was not too drastic but slowly increases with the measurement time. To see the difference between the five types of electrodes, a parallel graph was made as shown below.

Figure 5. The correlation of increased combination current for various types of electrodes
From the graph above showed that the electrode that had the highest current and voltage values was the Zn electrode then following the Fe, Al, Cu and Pb electrodes. Where to Zn the value of the voltage generated is 6.5 - 4.6 Volts, while Fe electrode generated voltage values of 5.3- 1.6 Volt, Al produces a voltage of 4.5- 3.5 Volts, Cu produces a voltage of 6.3 - 3.6 Volt and finally Pb electrode produces an electrical voltage of 5.5 - 2.6 Volt, as well as for the value of the electric current. So that measurements made with different electrode materials also produce different voltage values. This is caused by the material contained in each electrode which is electrolyzed with an electrolyte solution of Durian husk waste. This is linear with the voltaic series theory of the series Zn, Ni, Sn, Cu, Li, Ba, Na, K, Mg, Fe, Mn, Pb, Al, Hg, Au, Cu, Ag, Pt. The row of metals where the left side of the position is getting more reactive (the easier it is to release an electron) and the metal was the strongest to reduce the agent (the most easily to be oxidized). On the contrary, to the right of the position of a metal, the metal was increasingly less reactive and the metal was a strong oxidizing agent (which was easy to reduce).

4. Conclusion
From this research, it can be concluded that the variation of the electrode material influences the voltage and electric current values of the 5 nm LKD nano powder. Where the size of crystals from Durian skin waste caused the voltage and electric current to increase compared to previous studies which increased 4 times larger. Electrodes that showed the greatest voltage value was Zn electrode at 6.5 Volts due to the oxidizing properties of Zn which was releasing electrons then followed by Fe, Al, Cu and Pb electrodes.

5. References
[1] Abdalla, A. S. Al-Ghamdi and F. Al-Marzouki. 2012. Green Energy: Electric Batteries from Food, Saudi Arabia, Physics Department, Faculty of Science.
[2] Abdul Majeed Khan. 2015. Comparative bioelectricity generation from waste citrus fruit using a galvanic cell, fuel cell and microbial fuel cell. Journal of Energy in Southern Africa Vol 26 No 3 August 2015
[3] Alaudina, H. N. 2012. Let’s Fly Around The World With King Fruit, APEC Youth Scientist Journal 3: 34-47
[4] Abhishek Kumar Dewangan. 2018. Design and Experimental Studies on Bio-Waste Batteries. International Journal of Applied Engineering Research ISSN 0973-4562 Volume 13, Number 1 (2018) pp. 47-52
[5] Carvalho, J., Ribeiro, A., Castro, J., Vilarinho, C. And Castro, F. 2011. Biodiesel production by microalgae and macroalgae from north littoral Portuguese coast. In: 1st International Conference held by Centre for Waste Valorisation (CVR) – Wastes: Solutions, Treatments and Opportunities, Guimarães, Portugal, CVR, September 12th – 14th, 2011.
[6] Kannan, V. Renugopalakrishnan, S. Filipke3, P. Li, G. F. Audette,and L. .2011. Bio- Batteries and Bio-Fuel Cells: Leveraging on Electronic Charge Transfer Proteins. Journal of Nanoscience and Nanotechnology Vol.9,1665–1678
[7] Jayashantha, N., Jayasuriya, K.D., dan Wijesundera, R.P. 2012. Biodegradable Plantain Pith for Galvanic Cells. Srilangka. Proceedings of the Technical Sessions(28)
[8] K.Pathrikar. 2013. The Future Of Energy Bio Battery. International Journal of Research in Engineering and Technology. Vol 2. ISSN: 2319-1163
[9] Khairiah, Lia A Nst. 2018. Phase Composition And Crystal Structure Of Durian (Durio Zibethinus) Husk Waste Powder Using Rietvield Method. FISITEK Journal Vol 1. No 1. ISSN 2580-989X
[10] M. Oliniyan, “Effect of extraction condition on the yield and quality of oil from castor bean,” Journal of Cereals and Oil Seeds, vol. 1, pp. 24-33, 2010.
Acknowledgment
Thanks for the Ministry of Technology Research and the Directorate General of Higher Education (DIKTI) through the 2017 Research Grant Program.