OPTIMIZATION OF MEDICAL PERSONAL PROTECTIVE EQUIPMENT (PPE) AS A 'SELF CLEANER' AND ANTIVIRAL USING CARBON QUANTUM DOTS (CQDs) FROM RICE STRAW WASTE

[1]Gema Aditya Mahendra, [2]Muhamad Mahfud Muzadi, [3]Nurjaya

Gema021001@gmail.com

[1]Chemical Engineering Study Program, Faculty of Engineering, Universitas Negeri Semarang, Semarang, Indonesia
[2]Chemical Engineering Study Program, Faculty of Engineering, Universitas Negeri Semarang, Semarang, Indonesia
[3]Chemical Engineering Study Program, Faculty of Engineering, Universitas Negeri Semarang, Semarang, Indonesia

ABSTRACT

COVID-19 cases in the world have reached 100 million cases. One of the preventive measures in preventing COVID-19 is by using Personal Protective Equipment (PPE). PPE is a set of medical devices to cover the body consisting of Surgical Masks, N95 Respirators, Eye Protection, Face Shields, Examination Gloves, Surgical Gloves, Disposable Dresses, Medical Coveralls, Heavy Duty Apron, Waterproof Boots, and Shoe Covers . The use of PPE in nowadays can only be used once. Meanwhile, the need for PPE has increased since the COVID-19 case. As a result, the production of PPE becomes crisis and tends to pile up as trash. The idea offered in this project is the use of Carbon Quantum Dots (CQDs) from rice straw as a self-cleaner and antiviral for PPE. Carbon Quantum Dots (CQDs) are a zero-dimensional carbon nanomaterial that is below 10 nm in size, has an amorphous structure, and spherical in shape. CQDs has a unique property that called luminescence. The luminescence of CQDs can trigger a photocatalyst reaction so that it can kills virus (antiviral) that attached to the surface of CQDs. In addition, its small dimensions and size can prevent viruses from entering through its surface. The main material used to make CQDs in this project is rice straw waste. By looking at the composition of the rice straw in general, it consist of Neutral Detergent Fiber (NDF) 77.00%, Acid Detergent Fiber (ADF) 57.91%, cellulose 23.05%, hemicellulose 19.09%, and lignin 22.93%. These composition are composed more of the carbon content which has the potential to be the main composition in the manufacture of CQDs. With the idea of this project, it is hoped that it can answer problems regarding the PPE crisis and waste pollution due to PPE.

Keywords : COVID-19, Personal Protective Equipment (PPE), Carbon Quantumdots (CQDs), Rice straw waste, Antiviral

I. INTRODUCTION

Currently the COVID-19 pandemic outbreak is increasingly widespread, more than 200 countries have contracted this virus. As of now, COVID-19 cases worldwide have reached 100 million cases with details of 55.4 million recovered, 2.16 million people died, and the rest are still indicated as positive (WHO, 2021). One of the most effective preventive measures in tackling COVID-19 is by using Personal Protective Equipment (PPE). PPE is a set of medical devices to cover the body consisting of surgical masks, N95 respirators, eye protection, face shields, examination gloves, surgical gloves, disposable gowns, medical coveralls, heavy duty aprons, waterproof boots, and shoe covers. . In the response to COVID-19, health workers must use complete PPE because health workers are directly involved in handling patients, especially those who have been confirmed as Covid-19 (Kemenkes, 2020).

The complete PPE that health workers usually use is all disposable, so when it is finished using it in one day it must be discarded because it is feared that there will be a virus attached to PPE. Meanwhile, the number of positive cases of COVID-19 around the world continues to increase, so the use of disposable PPE is inefficient because it can make PPE scarce and cause waste that causes environmental pollution. Therefore, many researchers are trying to optimize PPE so as not to cause PPE crisis polemics and environmental pollution. Such as studies that decoment PPE using dry heat and microwave-generated steam protocols (Pascoe et al., 2020), research that decoments PPE using UV light (Weaver et al., 2020), and research decomenting PPE using nanoparticles (Talebian et al., 2020)

The idea offered in this project is the use of Carbon Quantum Dots (CQDs) from rice straw as a self-cleaner and antiviral for PPE. Carbon Quantum Dots (CQDs) are a zero-dimensional carbon nanomaterial that is below 10 nm in size, has an amorphous structure, and spherical in shape. CQDs has a unique property that called luminescence. The luminescence of CQDs can trigger a photocatalyst reaction so that it can kills virus (antiviral) that attached to the surface of CQDs. In addition, its small dimensions and size can prevent viruses from entering through its surface. The main material used to make CQDs in this project is rice straw waste. By looking at the composition of the

rice straw in general, it consist of Neutral Detergent Fiber (NDF) 77.00%, Acid Detergent Fiber (ADF) 57.91%, cellulose 23.05%, hemicellulose 19.09%, and lignin 22.93% (Gummert et al., 2020). These composition are composed more of the carbon content which has the potential to be the main composition in the manufacture of CQDs. With the idea of this project, it is hoped that it can answer problems regarding the PPE crisis and waste pollution due to PPE.

II. MATERIAL AND METHODS

Rice Straw Waste Preparation

Rice straw waste is collected and washed using tap water several times until it is clean. After that, the rice straw was washed with Purified Water. Furthermore, rice straw is dried using an oven set the temperature at 90 ℃ for 6 hours. The dry rice straw is mashed in a blender and followed by a 40 mesh sieve method so that a very fine powder is obtained.

Synthesis of Carbon Quantum Dots (CQDs) using the Microwave Method

A total of 20 g of mashed rice straw waste was dissolved in distilled water in a ratio of 1: 5 and stirred at 70 ° C for 2 hours. Before putting in the microwave, 20 ml of rice straw waste extract in a porcelain dish was added with 2 g of urea and stirred until evenly distributed. The addition of urea as a passivation so that the rice straw waste extract can become CQDs. The radiation process was carried out at a temperature of 250 ° C with a variation of microwave radiation time (20, 25, 30, 35, 40, 45) minutes. Then the CQDs were dissolved with 20 ml of distilled water and filtered with micron filter paper.

Characterization of Carbon Quantum Dots (CQDs)

The resulting solution will be tested simply to determine the success of the synthesis of CQDs. Testing is done by illuminated UV light from the laser with an excitation wavelength of 405 nm on the sample to be tested. The successful synthesis of CQDs is indicated by the presence of luminescence. The UV-Vis spectrophotometer was used to determine the absorption wavelength and the absorbance peak of each solution being tested, so that it could analyze the electron transitions that occurred in CQDs. The results obtained are in the form of a graph between absorbance and

wavelength. The characterized CQDs solution was applied as a fluorescence solution. The CQDs solution was poured into the PPE without any modification.

III. DISCUSSION

The Result of Carbon Quantum Dots (CQDs) from Rice Straw Waste

Research on synthetic CQDs from rice straw waste has been carried out using a bottom-up approach. In this research, 20 g of cleaned rice straw waste were turned into CQDs using the microwave method. The success of synthetic CQDs is characterized by the presence of colored luminescence with a wavelength of less than 500 nm (Nguyen et al., 2020). In terms of color, CQDs from rice straw waste produce strong blue luminescence under UV light luminance. The wavelength of the blue luminescence light ranges from 450 nm - 495 nm. This indicates the success of synthetic rice straw waste as CQDs.

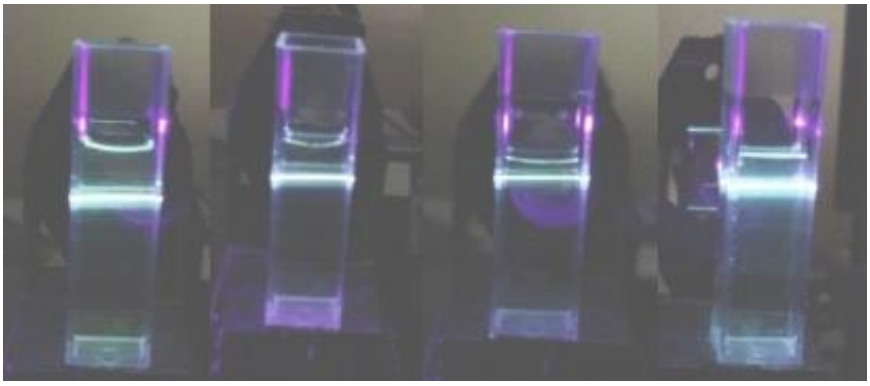

Figure 1. Testing of CQDs luminescence from rice straw with UV Laser 405 nm

Characterization of Carbon Quantum Dots (CQDs) from Rice Straw Waste

Characterization was carried out by the UV-Vis spectrophotometer which was used to determine the absorption wavelength and absorbance peak of the samples tested, so that it could analyze the electron transitions that occurred in CDQs from rice straw waste. The results obtained are in the form of a graph between absorbance and wavelength. The absorbance value has no unit because it is the logarithm of the photon absorption ratio at a certain wavelength (Surendran et al., 2020). This measurement is carried out at a wavelength of 200-800 nm. However, only 200-500 nm wavelengths will be analyzed.

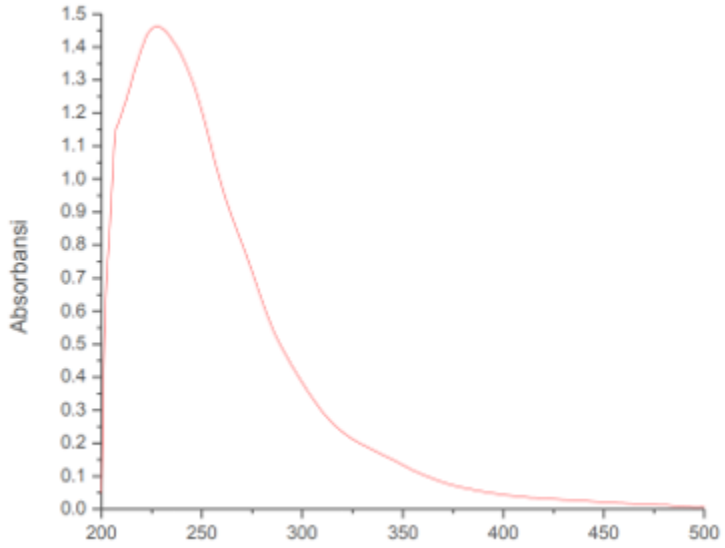

Figure 2. Graph of UV-Vis Characterization Results on CQDs Samples

Based on Figure 2, it can be known that CQDs based on rice straw waste produces 2 peaks, namely at a wavelength of 225 nm and 330 nm. The first peak shows the electron transition from Л to Л * in the C = C bond in the carbon nanodote. While the second peak shows a transition from n to Л * in the C bond with other atoms on the surface of the CQDs (Liu et al. 2017). Based on the absorbance value at the obtained wavelength, CDQs based on rice straw waste can produce a high luminescence intensity, which is 5800 a.u (arbitary unit).

'Self Cleaner' and Antiviral Effect of Carbon Quantum Dots (CQDs)

In a recent article by Garg et al., elaborated the inhibitory mechanism of human coronaviruses by hetero atom doped carbon dots. The research group propose the potential development of triazole-based carbon dots against SARS-CoV-2 infection using a series of bioisosteres. Since carbon dots have a large number of hydrophilic functional groups on borders, they are appropriate for diverse biomedical applications. In addition to this the surface functionality of these magic nano substance is vital to fine-tune the of interaction level with virus (Garg et al., 2020).

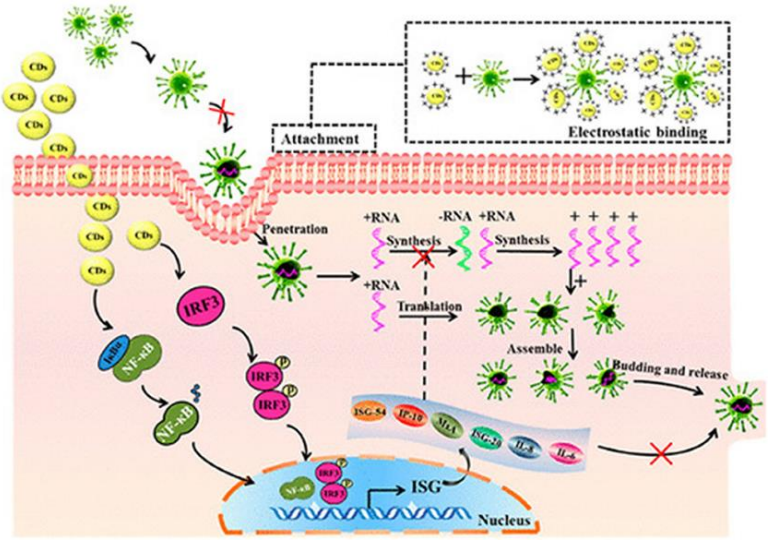

Figure 2. Mechanism of viral inhibition of Carbon Quantum Dots (CQDs)

Carbon Quantum Dots (CQDs) can efficiently inhibit coronavirus infection. This CQDs were found to inhibit the entrance of virus, production of the negative strand of RNA as well as budding. Suppression of viral replication was found to be due to stimulation in the production of interferon stimulating genes as well as pro-inflammatory cytokines and also due to the accumulation of ROS. This was proved as a multisite inhibitor for Enteric Coronavirus in Figure 2 (Ting et al., 2018).

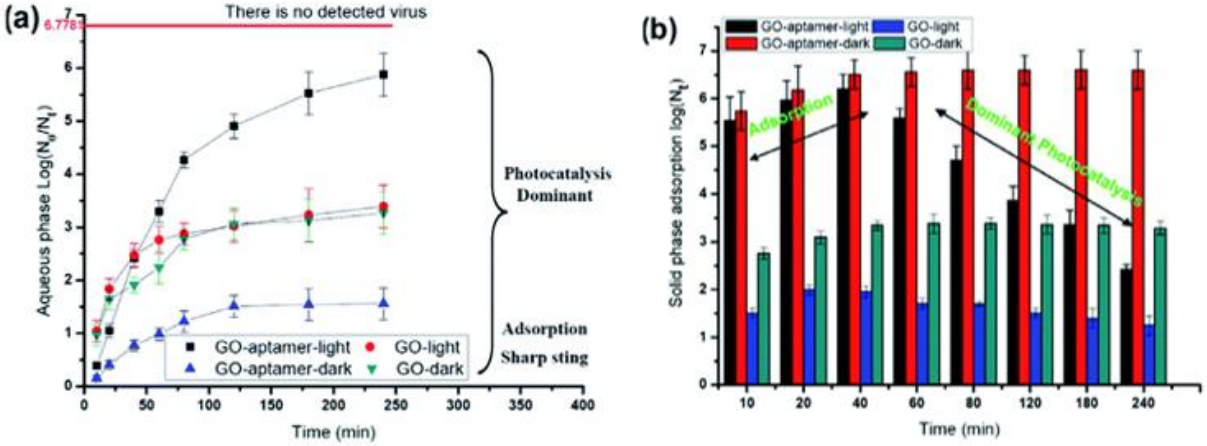

Figure 3. Survival of viruses in the aqueous phase (a) and solid phase (b) with visible-light irradiation or under dark conditions in surface of CQDs

Carbon Quantum Dots (CQDs) can act like ‘self cleaner’ through photocatalysis. This CQDs has a unique property that called luminescence. The luminescence of CQDs

can trigger a photocatalyst reaction so that it can kills virus (antiviral) that attached to the surface of CQDs . To achieve consistent photocatalysis, the virus should stay close to the CQDs surface under UV irradiation (Liu et al., 2017). Because of its characteristics, it can be used as a 'self cleaner' properties of CQDs upon illumination with UV light from sunlight. The survival test of viruses in the aqueous phase (a) and solid phase (b) with visible-light irradiation or under dark conditions in surface of CQDs can be seen in figure 3. The line of no detected viruses expresses only one virus in the suspension**.** Based on the graph, the number of viruses getting decrease while it get iluminated by UV irradiation in surface of CQDs.

IV. RECOMMENDATION

Regardless of the encouraging results, still much more research is needed to address some issues to make the dream come true. Firstly, the exact antiviral mechanism of these carbon dots is still not much explored and most of the literature reported an early stage inhibition except few. Secondly, the optimization of the characteristics of Carbona Quantum Dots from rice straw waste for Personal Protective Equipment (PPE). Therefore the implementation of CQDs from rice straw waste, would be more effective

V. ACKNOWLEDGMENTS

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