A Preliminary Study of Synthesized Fluorescence Carbon Nanoparticles from Lignin Residual Liquid

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Abstract: Lignin residual liquid is a macromolecule compounds resulted from the delignification process of empty bunches of palm oil within alkaline condition. This study reports the potential results of lignin residual liquid as the precursor of fluorescence carbon nano-particles synthesized from heating treatments. The characteristics of samples were tested by using FTIR, Spectrophotometry UV-Vis, and UV-lights observation. The results showed that FTIR spectra confirmed the functional groups of hydroxyl, while the visible spectrum displayed none absorbance. The UV spectrum displayed varied peaks from 214 to 319 nm which indicated different absorbance features within highly alkaline condition, whereas green-neon colour was shown under the UV-lights. This implies that various fluorescence properties occur from this study.

1 INTRODUCTION

Carbon dots (C-dots) synthesis from biomass material has been widely considered as an alternative solution due to renewability and environmentally friendly. Many studies have reported extensively in the use of fruits such as apples(Mehta et al., 2015), bananas(De and Karak, 2013), grapes(Huang et al., 2014; Xu et al., 2015), lemons and oranges(Ding et al., 2017; Tyagi et al., 2016), while the use of daily-consumed goods such as eggs, and dried shrimp are also concluded the results of C-dots(D'Souza et al., 2016; Wang et al., 2012). However, only a few studies reported the industrial biomass as the precursor in synthesising C-dots and those include cellulose(Gea et al., 2018; Marpongahtun et al., 2018) and lignin. Therefore, the use of industrial biomass is also one of the potential strategies in producing this material.

Regarding to the properties, one of the most promising characteristics of C-dots is its fluorescence properties. The characteristics have been mainly used for bio-imaging application. For examples, HeLa cancer was detected by using C-dots throughout *in vitro* (Li et al., 2010), while the *in vivo* method was performed for the detection of brain cancer and glioma within mice(Gao et al., 2014; Goh et al., 2012; Zheng et al., 2015). Therefore, finding the luminescence characteristic is important during the synthesis of C-dots.

On the other hand, the most promising methodology in synthesizing C-dots is still being conducted. For instance, hydrothermal method has been reported to yield 1-5 nm of C-dots(Qin et al., 2013), while the microwave methodhas yielded C-dots 2-4 nm (Bankoti et al., 2017). This implies to the interesting implementation of heating process in synthesizing C-dots. In short, in this study, it is offered two-steps heating of lignin residual liquid to generate fluorescence nanoparticles within short time.

2 MARTERIALS AND METHODS

2.1 Materials

The empty fruit bunches of palm oil were collected from local industries. Chemical reagents that were used were distilled water and sodium hydroxide, in which they were in analytical pure.

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2.2 Residual Lignin Liquid Isolation

An amount of empty fruit bunches of palm oilwere collected from local industries. These bunches then were cut randomly to be immersed within 2% of sodium hydroxide (NaOH). Then, these immersed samples were soaked for 24 hours which were followed by steam explosion procedure for two hours at 130ºC within 170 kPa of pressure. Afterwards, the separation of bunches fibres and brownish liquid were obtained. Then, the liquid samples were separated from the bunches, and they were allowed to reach room temperature.

2.3 Synthesized C-dots

The procedures in synthesizing C-dots were performed by two-steps heating. Firstly, 100 ml of brownish samples were prepared, and this amount of liquid was placed inside beaker glass to be heated at 100ºC to reduce the water content. After the volume of this liquid was reduced for 80%, the samples were allowed to stand in reaching room temperature. Next, this sample was placed into a furnace for second heating treatments. 20% of residual heated liquid samples which were inside a beaker glass were covered by aluminium sheet. The beaker glass was placed inside a furnace tube at 180ºC for one hour. After an hour of treatment was completed, the sample was allowed to stand to reach room temperature. The sample was poured with 50 ml of distilled water and it was constantly stirred to get dissolved. Next, the samples were placed within centrifuge at 10,000 rpm for 15 minutes to remove larger particles. Finally, the amount of centrifuged liquids was placed in a beaker glass.

2.4 Characterisations

The samples were characterized by using FTIR, Spectrophotometer UV-Vis, and photographic observation under daylight and UV-light. To perform this, the preparation was carried out by dissolving 2 ml of samples with 15 ml of distilled water.

3 RESULTS AND DISCUSSION

3.1 Experimental Results

The process of synthesizing was one of the critical features. As residual lignin liquid was resulted from the steam explosion, the 2% of sodium hydroxide indicated the high contents of water. Therefore, the reduction of water contents was important due to the heating process. It was found that during the first step of heating, the dilution of the liquid sample became denser. In this study, the water content was not determined in further investigation because of the focus of this study in the methodology.

The second heating process generated green-shaped which resembled to dried-green algae. This shape was interesting due to the previous phase that was in dense liquid. However, after being poured by distilled water, the samples developed into black solution with several colloids. The centrifugation process resulted the black condition with less colloids implying to the higher solubility within the solution.

3.2 FTIR Analysis Results

To ensure both the solubility and C-dots, FTIR analysis was performed to do the investigation.

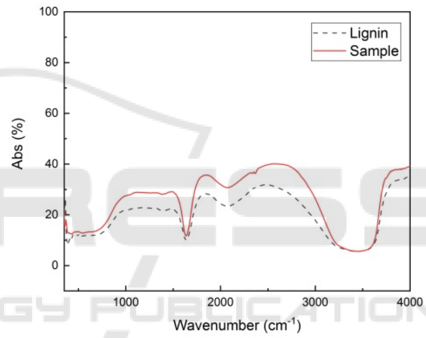

Figure 1: FTIR Spectra of Sample and Lignin.

The following Figure 1 displays the FTIR spectra of lignin and the samples.According to Figure 1, it can be observed that there was alteration in range of 2500-2000 cm^{-1}. In this range, the functional groups that were changed were triple bond region of carbon (C≡C). The differences in absorbance implied to the alteration, whereas the results.

3.3 UV-Vis Spectrum Results

The results of UV-Vis were performed to investigate the ability of photoluminescence properties. The following Figure 2 and Figure 3 demonstrate the UV-Visible spectrophotometric results.

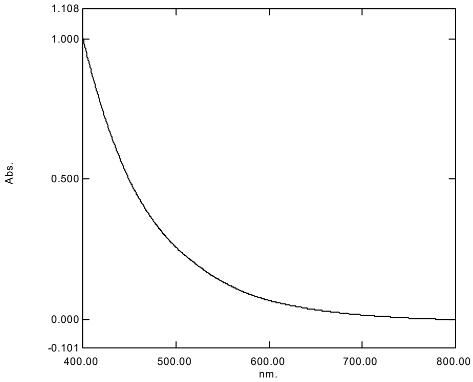

Figure 2: Visible Spectrophotometric Results.

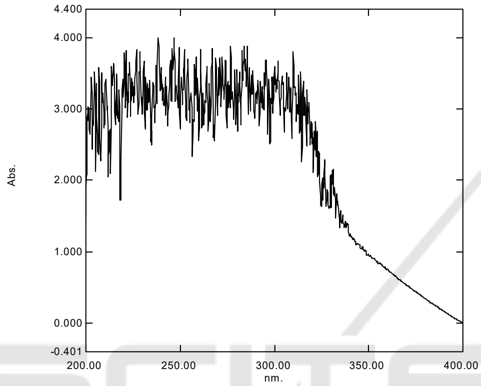

Figure 3: UV Absorption of Samples.

The spectrophotometric results demonstrated that the visible light had no absorption at all, while the UV light absorption showed the possibility of fluorescence particle. Interestingly, samples that were dissolved within 15 ml of distilled water had 14 of pH. The base condition indicated the potential possibility of fluorescence properties which were based on the pH. The following Figure 4 below showed the different observation of samples under daylight and UV-lamp.

Figure 4: Observation of Daylight and UV-Lights.

Based on Fig. 4, the different colours were displayed from the picture. Under the daylight, the colour was similar to brown, while under UV-light, it emitted the yellow colour.

4 CONCLUSIONS

The use of residual liquid lignin has shown the potential precursor for synthesising C-dots, and the FTIR analysis reported the alteration in triple bonds chains. Furthermore, the UV spectrophotometric results confirmed the possible different UV-light based on the pH.

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