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Synthesis And Characterization of Activated Carbon/Alginate/Nanocellulose-Fe Composite as Slow Release Fertilizer

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ABSTRACT

Fe deficiency in plants results in yellowing of leaves on plants and also reduces the quality of fruit produced. Fe deficiency in plants can be treated by applying slow release fertilizer which will release the nutrients in the fertilizer slowly according to plant needs so that there will be no problem of deficiency or excess of Fe. Activated Carbon/Alginate/Nanocellulose-Fe Composite can be used as slow release fertilizer because this composite releases Fe slowly with citric acid medium and tested with AAS. The functional groups in the Activated Carbon/Alginate/Nanocellulose-Fe Composite showed no disappearance of the functional groups belonging to activated carbon, alginate or nanocellulose so that it can be said that these three components were successfully made into composites and can be carriers of nutrients in micro-fertilizers.

Keywords : Slow release fertilizer, composite, Fe

1. INTRODUCTION

One of the micronutrient elements needed by plants in small amounts is Fe. Although only slightly needed in plants, Fe is involved in many plant compounds and in physiological processes in plants. Fe functions in the process of forming chlorophyll and is needed in the function of enzymes in plants. In the process of forming chlorophyll, Fe is involved in causing chlorosis (yellowing) associated with a lack of Fe intake in plants.[1] Fe chlorosis in plants is caused by a lack of Fe in plants with the young leaves developing a distinctive yellow color instead of being green like other leaves. If there is a deficiency of Fe in the plant

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there will be changes in the plant such as physical changes in the plant, changes in the ability to absorb Fe, changes in the shape of the flowers and also reduces the quality of the fruit produced.[2]

Fe deficiency in plants can be prevented by applying fertilizer. Fertilizers that are suitable for nutrient deficiencies are Slow Release Fertilizers or slow release fertilizers. Slow release fertilizer is fertilizer that has been designed for plants so that the release of nutrients in the fertilizer is adjusted to the nutritional needs of these plants so that using this fertilizer will increase the yield of these plants.[3] Slow release fertilizers can be synthesized from natural materials which have potential as carriers in micro fertilizers. The results of the synthesis of natural materials that have the potential as carriers in micro-fertilizers are activated carbon, nanocellulose and alginate.

Activated carbon and nanocellulose can be synthesized from Palm Empty Fruit Bunch (EFB) waste, where this will reduce waste around our environment by processing it into more useful components. Activated carbon has pores that will store and retain nutrients in the soil and will be released slowly according to plant needs.[4] Nanocellulose is useful in the soil for controlling the release of nutrients and preventing excessive use of fertilizers.[5] The composite materials used in this study are Activated Carbon, Nanocellulose and Alginate which each have the potential to bind Fe metal. Activated carbon interacts with metals, namely by expanding the contact area between activated carbon and metal ions so that more dissolved ions are collected by activated carbon and increase absorption.[6] Alginate has many hydroxyl (R-OH) and carboxyl (R-CO-R) groups which can increase the adsorption capacity of heavy metal Fe.[7] And nanocellulose which has a very large surface area and the presence of carboxyl groups will increase the adsorption of heavy metals.[8]

Based on the description that has been submitted regarding activated carbon and nanocellulose which can be carriers in microfertilizers, the two components will be combined into a composite and will also be mixed with alginate, where alginate is designed to release nutrients from the fertilizer gradually.[9,10]

In this study, the kinetics of composites was tested using atomic absorption spectroscopy based on the absorption by the ground state atoms of an element present in the sample. Depending on the chosen absorption wavelength of the elements, concentrations are estimated. This technique provides valuable information about the required concentration of elements present in the sample. Concentrations are possible in ppm or ppb levels depending on the excitation source of the sample.[11]

2. EXPERIMENTAL

2.1. Activated Carbon Synthesis

The washed OPEFB powder samples were then put into the furnace at 500ºC for 2 minutes. After the carbonization was complete, the samples were cooled to room temperature.[12] The result of carbonization is then soaked in 10% H_3PO_4 solution for 24 hours. Then filtered and washed with distilled water until the pH is neutral. Then dried in an oven at 105ºC. Then it will be characterized by Fourier-Transform Infra Red (FTIR) for functional group analysis of activated carbon.

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2.2. Nanocellulose Synthesis

The OPEFB samples in the form of fibers were put into a 0.7% sodium chlorite ($NaClO_2$) solution which had been acidified with acetic acid to Ph=4 and then heated for 2 hours at a temperature of 70–80°C. The bleaching process is repeated four or five times until the fiber turns white and then it is filtered. The bleached cellulose product obtained was heated to about 70-80°C in 5% (w/v) sodium sulfite solution for 2 hours then filtered, washed with distilled water and dried in air. The fiber was treated in 17.5% (w/v) sodium hydroxide (NaOH) solution for 2 hours then filtered, washed with distilled water and dried in an oven. The resulting dried fiber was then hydrolyzed with 64% H_2SO_4 at 45°C for 45 minutes. Then, cold water was added and the diluted suspension was centrifuged for 10 minutes to obtain a precipitate. This process was repeated until the pH of the suspension reached 5 and then dialysis was carried out for 3 days.[13] Then it will be characterized by Fourier-Transform Infra Red (FTIR) for functional group analysis of nanocellulose.

2.3. Synthesis of Activated Carbon/ Alginate/ Nanocellulose-Fe composite

Activated carbon, alginate and nanocellulose are mixed in 100 mL of distilled water with a composition of 1 gram of each component and blended until homogeneous. The solution was then dripped using a syringe in 0.1 M $FeCl_3$ solution. The resulting beads were then washed with distilled water until the pH was neutral. After that it was dried in an oven at 60°C. Then it will be characterized by Fourier-Transform Infra Red (FTIR) for functional group analysis of the composite. The results of the composite are soaked in citric acid for 1 day, 2 days and 3 days to see the release of Fe contained in this composite and will be tested using AAS.

3. RESULTS AND DISCUSSION

3.1 Synthesis of Activated Carbon/ Alginate/ Nanocellulose-Fe composite

Activated carbon and nanocellulose were successfully synthesized from Empty Oil Palm Bunches with the physical form shown in Figures 1A and 1B, while the alginate used in this study was commercial alginate. The result of combining the three components above forms black beads as shown in Figure 2.

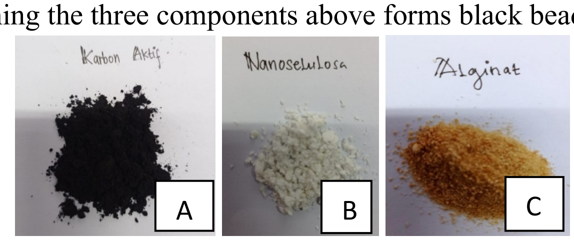

Figure 1. Activated Carbon/ Alginate/ Nanocellulose-Fe Composite Components

Figure 2. Activated Carbon/ Alginate/ Nanocellulose-Fe Composite Beads

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The Activated Carbon/ Alginate/ Nanocellulose-Fe composite that is formed looks like beads or is in the form of round beads due to the process of binding and absorption in this composite.

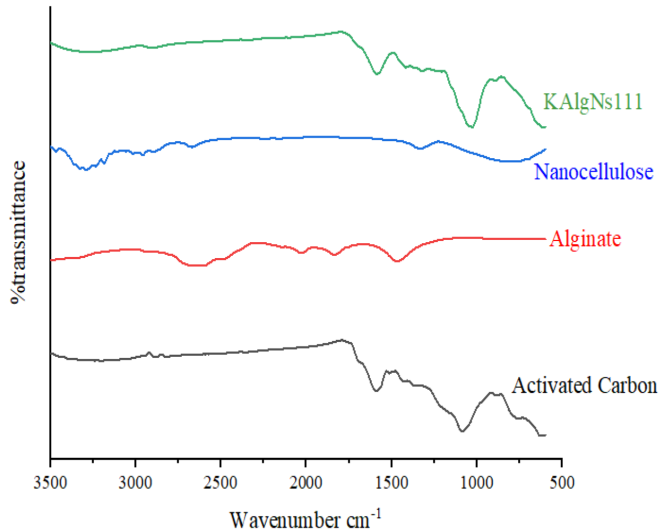

Figure 3. Combined FTIR results from Raw Materials and Composites

Figure 3 presents the results of the FTIR from the composite composite and the raw materials that make up the composite. It can be seen that the KalgNs111 composite, which is a composite, has similar functional groups as the constituent components of the composite. In the four data there are O–H functional groups that appear in the range of 3000–3600 cm^{-1}. There were peaks in the three samples above, namely in the composite, nanocellulose and activated carbon worth 2890-2900 cm^{-1} which was associated with the OH stretching and CH stretching of the cellulose present in the three samples which proved that the nanocellulose and activated carbon from Empty Palm Oil Bunches contains cellulose and is not lost in the resulting composite. The peak at 895 cm-1 shows the C-H vibrations of the cellulose present in the nanocellulose and also composite samples.[14] The peak in the spectrum in the alginate and composite of homopolymannuronate appears at 1100–1010 cm^{-1} which is associated with the C–O stretching vibration of the pyranosyl ring and the C–O stretching vibration. The asymmetrical O-C-O vibrational absorption band at wave number 1400 1650 cm^{-1} is a symmetric carboxylate stretching vibration. C-O of alcohols, acids, phenols, ethers, and/or ester functional groups. It is also a characteristic peak for phosphorus and phosphocarbon compounds present in surface activated phosphoric acid. Nevertheless, the transmission bands in this range may have overlap due to the presence of oxygen- and phosphorus-containing inactive groups, and thus makes it difficult to confirm the presence of certain functional groups.[15]

3.2 Slow Release of Fe(III) for 4 Days

To find out about the release of Fe in the Activated Carbon/ Alginate/ Nanocellulose-Fe composite, the composite was soaked in citric acid for a period of 1 day, 2 days and 3 days. The reason for testing in citric acid is because plant roots are able to excrete/excrete organic acids such as citric acid as a chelating agent or

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binder to help absorb nutrients from the soil. Therefore, citric acid is used as a slow release fertilizer test medium which will absorb nutrients from the fertilizer.

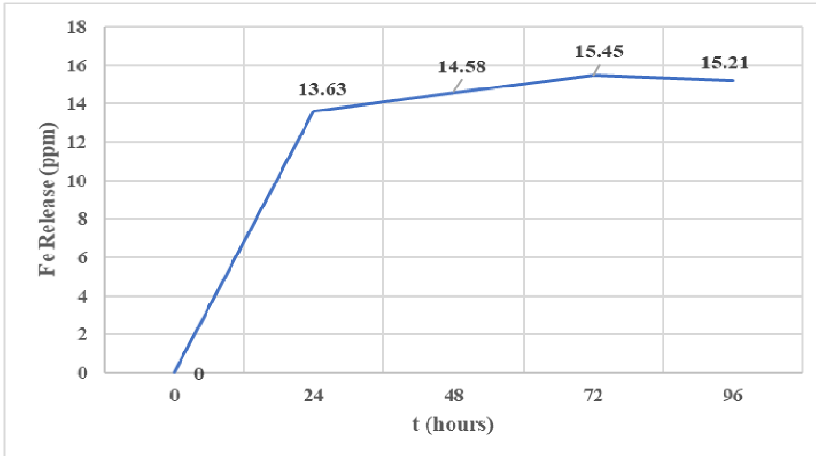

Figure 4. Result of Fe release from Activated Carbon/Alginate/Nanocellulose-Fe Composite for 4 days

Based on Figure 4, the test time in citric acid was carried out for 4 days and on the first day the Fe that came out of the composite was 13.63 ppm; on the third day, 14.58 ppm was obtained; while on the third day it was 15.45 ppm and the last day was 15,21 ppm. This means that the Activated Carbon/ Alginate/ Nanocellulose-Fe composite can be used as a slow-release fertilizer because the Fe that comes out of the synthesized composite seems to slowly come out and will adjust according to the nutrients needed.

4. Conclusion

Activated carbon, alginate, and nanocellulose can be used as composites to make slow-release fertilizers because they have different roles and functions as carriers in micro-fertilizers. Slow release fertilizer made from this composite will work slowly to remove the nutrients needed by plants so as to avoid excess or deficiency of Fe. The synthesized composite can be used as a slow release fertilizer because it has been tested that the Fe from the composite comes out slowly and gradually.

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