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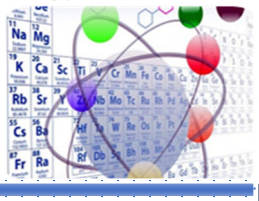

Synthesis and Characterization of Activated Carbon/Alginate-Fe Composites as Slow Release Fertilizer

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ABSTRACT

Research on the slow release kinetics of Fe(III) ions from Activated Carbon/Alginate-Fe(III) composites or abbreviated as K/A-Fe(III) has been carried out. The aim of this research was to synthesize K/A-Fe(III) composite as a material that has the potential to become a slow release micronutrient fertilizer and to study the kinetics of slow release of Fe(III) ions from the composite. The K/A-Fe(III) composite was synthesized by mixing alginate suspension and activated carbon (alginate: activated carbon weight ratio = 1:3 and 3:1) until homogeneous. Composite grains were characterized using Fourier Transformed Infrared (FTIR) spectroscopy, the kinetics of Fe(III) release from the three composite variations found that KAlg31 composite showed more absorption and release of Fe ions than KAlg13.

Keywords: Composite, Fe, OPEFB, alginate, activated carbon

1. INTRODUCTION

Oil palm plantations are one of the dominating plantations in Indonesia, in terms of the area of oil palm plantations (community plantations, private plantations, and national plantations) over the last 25 years have experienced rapid development. However, besides increasing the area of oil palm plantations, processing oil palm will produce waste that has not been utilized optimally, namely EFB (empty palm oil bunches) [1]. Porous materials with superior properties are usually used for catalysts, water separation, renewable energy, etc [2]. One of them is the composite which is now one of the most researched today, has appeared in the 20th century, the

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properties of the composite material itself have characteristics that are very suitable for today's large industrial fields such as automotive, agriculture, plantations and etc [3].Composite material is an artificial/engineered material consisting of two or more constituent components [4], Therefore, environmentally friendly composite materials are in great demand at this time, whether in the form of natural fibers or artificial fibers [5].

Alginate is a linear polysaccharide of the carbohydrate family, derived from brown algae and a water-soluble natural polymer. Chemically composed of acidic compounds, namely α-1-gulure and β-D- manure, alginate has attracted attention mainly due to its low biocompatibility, high hydrophilicity and non- toxicity. Alginate is a natural polysaccharide consisting of guluronic and mannuronic acid units. Sodium alginate has shown many uses in biomedical and pharmaceutical applications due to its low cost, low toxicity, biocompatibility and biodegradability [6]. The absorption capacity of activated carbon depends on the number of carbon compounds, the absorption capacity of activated carbon is determined by the surface area of the particles, and can be further increased by activating using chemicals or by heating to high temperatures, so that the physical and chemical properties of the activated carbon under goes changes. The properties of the activated carbon produced depend on the starting material used, activated carbon is divided into 2 types, namely activated carbon as a bleach and as a vapor absorbent, usually in the form of powder, thesize of the grain diameter reaches 1000°A°, used in the liquid phase to transfer substances - interfering substances that cause unwanted color and odor, and the second is granular or pellet activated carbon which isphysically hard, has a finer pore diameter of between 10-200A°, usually used in the gas phase which functions to recover solvents, catalysts , separation, and gas purification [7].

Slowrelease fertilizer is a fertilizer that can control or slow down the release of plant-stimulating nutrients. These elements are usually easily lost in fertilizers due to their highwater solubility, volatility and denitrification processes. Slowrelease fertilizers are designed to ensure that the delayed release of nutrients is synchronized with the plant's nutritional needs. This in turn increases efficiency when using fertilizer components and increases yields. Slow-release fertilizers are characterized by a slower release of nutrients, which allows them to be applied close to the roots. They may contain fertilizer components with different solubility. Nanoparticles made from various elements are often used in fertilizer production.

Fourier Transform InfraRed (FTIR) is an analytical method that can provide fast and accurate analysis results. The FTIR spectroscopic method allows analysis without damaging the sample and requires only simple sample preparation. FTIR spectroscopy is also very efficient and environmentally friendly, especially if solvents and other materials are not used excessively [8].

2. EXPERIMENTAL

2.1. Chemicals, Equipment and Instrumentation

The tools used are glassware, grinder, 200 mesh sieve, analytical balance, vacuum pump, oven, furnace, hotplate, centrifuge. The materials used are empty palm oil bunches from PTPN II PKS Pagar Merbau, Metal $FeCl_3.6H_2O$, 10% H_3PO_4, alginate, distilled water, filter paper and pH meter, and characterization

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Fourier Transform InfraRed (FTIR).

2.2. Research Procedure

2.2.1. Carbonization and Activation of Activated Carbon

Empty Palm Oil Bunches (EFB) are washed in running water and dried in the sun then crushed and sifted. The biosorbent was carbonized in a furnace at 500℃ for 2 minutes. Carbon was activated with 10% H_3PO_4 for 24 hours, then washed until neutral and dried in an oven at 105 ℃ [9]. Activated carbon is characterized by FTIR.

2.2.3. Synthesis of Activated Carbon/Alginate-Fe Composite

Activated carbon dan alginate are mixed in 100 mL of distilled water with the composition according to Table 1 until homogeneous. The solution was dripped using a syringe into 0.1 M $FeCl_3$ solution, filtered and washed after 24 hours until the pH was neutral. then dry in the oven. Activated carbon/alginate-Fe composite characterized by FTIR.

Table 1. Composite Variation

Composite	Composite Variation (g)	
	Activated Carbon	Alginate
KAlg31	3	1
KAlg13	1	3

3. RESULTS AND DISCUSSION

3.1. Carbonization and Activation of Activated Carbon

The activated carbon activation process was carried out by immersing the carbon in 10% H3PO4 for 24 hours. This activation process aims to activate the pore side of the carbon, attract impurities, and expand the pore structure of the activated carbon by forming new surface pores[10]. Carbonized carbon results, cooled and put in a closed container. Carbon activation in this study is a chemical activation because it uses H_3PO_4 activator which can help expand pores[11]. After 24 hours, the activated carbon was filtered and washed using distilled water until the pH was neutral to remove any remaining phosphate residue. Activated activated carbon has the ability to absorb metal ions, especially Fe metal ions as done by Nurhadiansyah, et al, 2018 that activated carbon activated by H_3PO_4 absorbs more Fe metal ions compared to an activator using HCl. And also activated carbon has an electrostatic interaction between activated carbon pellets and metal causingan iron magnetizing effect so that Fe has the ability to attract other Fe ions[12].

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3.2. Synthesis of Activated Carbon/Alginate-Fe Composite

FTIR characterization of activated Carbon Active/Alginate-Fe composites can be seen in figure 1. In Figure 1, the infrared spectra of composites with different ratios of base materials show that there are similar peaks with the base materials used. The spectrum results for the composites have characteristic absorption peaks that are similar to alginate and active carbon.

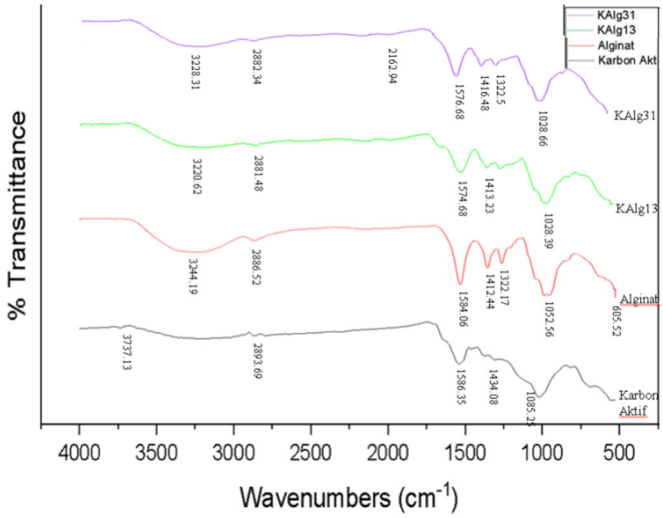

Figure 1. FTIR Characterization of Activated Carbon/Alginate-Fe Composite

The KAlg31 composite is in the 3228.31 cm^{-1} area which shows functional groups O-H, 2162.94 cm^{-1} indicates C≡C 1576.68 cm^{-1} indicates the C=C functional group, 1416.48 cm^{-1} & 2882.34 indicates the C-H functional group, 1332.50 cm^{-1} indicates NO2 and 1028.66 cm^{-1} indicates the C-O functional group. The KAlg13 composite, namely in the area 3220.62 cm^{-1} shows the O-H functional group, 2881.48 cm^{-1} & 1413.23 cm^{-1} shows the C-H functional group, 2161.68 shows the C≡C functional group, 1574.68 cm^{-1} shows the C=C functional group and 1028.39 cm^{-1} shows the C-O functional group. show the typical areas of guluronate and mannuronate fingerprints which are specific markers that thealginate compound used.

3.3. Slow Release of Fe (III) for 16 hours

The release of Fe (III) from the composite in citric acid media occurs through a complexation mechanism, citric acid is a weak acid that experiences incomplete ionization in solution form, 0.005 gram of composite was put into 5 mL of 0.33 M citric acid solution with a time variation of 16 hours, 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 binder to help absorb nutrients from the soil. Therefore, citric acid is used as a slowrelease fertilizer test medium which will absorb nutrients from the fertilizer.

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Table 2. Result of Fe release from composite 16 hours

	Sample name	Time (Hours)			
		4	8	12	16
ppm	KAlg13	0,103	0,112	0,124	0,136
	KAlg31	0,107	0,125	0,163	0,197

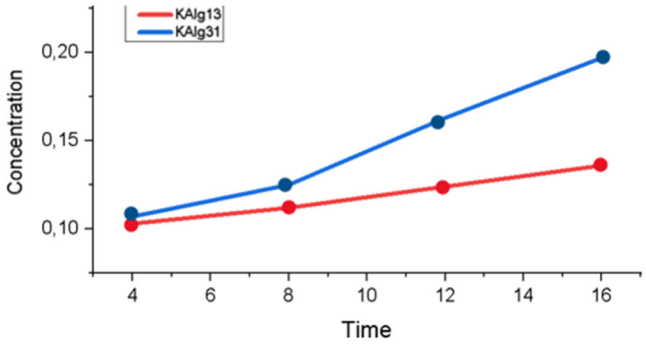

Figure 2. Result of Fe release from KAlg composite 16 hours

Based on Figure 2, the three composites show a slow release of metal ions, KAlg31 shows more metal ion absorption and KAlg13 shows the lowest release of metal ions, this means that the composite madecan be used as SRF 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

The synthesis of activated carbon/alginate-Fe composite can be used as a slow release fertilizer for plants (micronutrients), this is because there are functional groups in the basic ingredients, namely active carbonand alginate which can bind Fe metal ions and because it has been tested that the Fe from the composite comes out slowly and gradually. KAlg31 composite showed more absorption and release of Fe ions than KAlg13.

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