Ecofriendly Synthesis of nano Zero Valent Iron from Banana Peel Extract

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Abstract. In this study, nano Zero Valent Iron (nZVI) were synthesized from banana peel extract (BPE) and ferrous sulfate. During the synthesis of nZVI both the precursor and the reducing agent were mixed in a clean sterilized flask in 1:1 proportion. For the reduction of Fe ions, 5 ml of filtered BPE was mixed to 5 ml of freshly prepared 0.001 M – 0.005 M aqueous of $FeSO_4$ solution with constant stirring at room temperature. Within a particular time change in colour from brown to black color obtained by nanoparticles synthesis. A systematic characterization of nZVI was performed using UV-Vis. UV–visible absorption is used to investigate SPR. Characteristic surface plasmon absorption band was observed at 210 nm for the black colored nZVI synthesized from 0.001-0.005 M ferrous sulfate with BPE concentration 5 ml. It has been found that the optimum concentration for the synthesis of nZVI is 0.001M Fe^{2+} ions. There is small decrease in the intensity of SPR band from 0.001 to 0.005 M. The characterization size of nZVI was performed using TEM. The result shows that formation of particles size of nZVI was more 100 nm.

1. Introduction

The term nano comes from the Greek word meaning very small. Nano-size shows one billionth of a meter, or 10^{-9} [1-3]. Nanotechnology is defined as the manipulation of the material through a particular chemical and / or physical processes to synthesize materials with specific characteristics, which can be used in particular applications. Nanotechnology is the art of how to create and manipulate materials at the nanoscale (1-100 nm). Nanotechnology is a field of science that is growing rapidly with a variety of applications in science and technology[9].

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Nanotechnology relates to the synthesis of nanoparticles about size, shape, chemical composition and dispersity aimed for human benefits. At this time, chemical and physical methods have been successfully produce pure, nanoparticles are well defined, but it is expensive and harmful to the environment. Utilization of biological organisms such as plant extracts, biomass plants and microorganisms could be an alternative to chemical and physical methods for the production of environmentally friendly nanoparticles[2]. Nanobiotechnology is a related field between biology and nanotechnology. It is an alternative for the synthesis of nanoparticles that are environmentally friendly by using biological resources such as plants and microorganisms[10-11].

Green synthesis nanoparticle has been achieved by using plant extracts for reducing and capping agents. Many research has been done in the biosynthesis of silver nanoparticles with plant parts such as Punica granatum peels [13], Citrus sinensis peel [14], lemon leaves [15], Myrica esculenta leaf [16], Wrightia tinctoria leaves [17] and mango peel [18].

In this study, we have reported for ecofriendly synthesis of nano Zero Valent Iron (nZVI) using the peels extract of the banana plant. Aqueous ferrous sulfate solution reacts with banana peel extract, causing rapid formation of very stable, crystalline nZVI. The rate of synthesis of the nanoparticles very quickly, which justifies the use of crop residues in the biosynthesis of the iron nanoparticles through ecofriendly methods and more secure. In the next section we have described the synthesis of nZVI by discoloration, changes in absorbance and particle size are formed after reduction.

2. Numerical Methods

2.1. Preparation of Banana peel extract

Banana peel extract was used as a reducing agent for the synthesis of nZVI. The fresh banana peels were washed repeatedly with distilled water to remove dust and dirt in it. Approximately 25 g of peel was taken in a glass of 250 ml containing 75 ml of double-distilled water and then boiled peel at 80 ° C for 10 minutes and filtered through Whatman No 1 filter paper. The resulting filtrate is stored at 4 ° C and is used as a reducing and stabilizing agents.

2.2. Synthesis and Characterization nZVI

In this study, the nZVI synthesis of both the precursor and the reducing agent is mixed into clean sterilized flask in a 1: 1 proportion. For the reduction of Fe ion, 5 ml filtered BPE mixed with 5 ml of freshly prepared 0.001 M - 0.005 M aqueous solution of $FeSO_4$ with constant stirring at room temperature. In particular time changes the color changes from brown to black shows the synthesis of nanoparticles. The formation of nanoparticles can be observed by UV-Visible spectroscopy at a wavelength of 150-550 nm. Observation of ultraviolet-visible spectra obtained using Shimadzu UV-1650pc Spectrophotometer. The images of nZVI were analyzed with a Philips EM 400T Transmission Electron Microscopy (TEM) operated at 100 kV.

3. Results and Discussion

Green synthesis of nano Zero Valent Iron and characterization

The detailed study of the green synthesis of nZVI was performed using BPE. The formation of colloids nZVI investigated with observation of the color change of the solution. The emergence of black colour in the reaction showed the formation of nZVI. Figure 1 shows the image discoloration of synthesis reaction nZVI: Tube A contains ferrous sulfate, tube B contains banana peel extract and tube C contains nZVI in colloidal form. Banana peel contains polyphenols which can reduce Fe ions into Fe^0. Polyphenols are biology components that interact with the metal salts through functional groups, OH and mediate their reduction to nanoparticles [19].

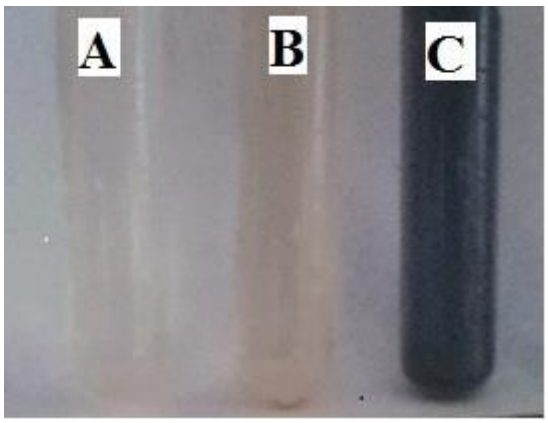

Figure 1. Tube A contains ferrous sulfate, tube B contains banana peel extract and tube C contains colloidal nZVI

UV–Visible analysis

Early detection is done by visual observation of the reaction solution changes color nZVI. These changes were associated with excitation of surface plasmon resonance (SPR) in nZVI. To observe the SPR, usually using a UV-visible. The observation of the characteristics of the surface plasmon absorption band at a wavelength of at 210 nm for the black colored nZVI from BPE concentration (5 ml) with 0,001-0,005 M ferrous sulfate [3, 12]. The optimum concentration for synthesis nZVI is 0,001 M of Fe^{2+} ions. There was a decrease in the intensity of the SPR band from 0,001 to 0,005 M. There is a decrease in the intensity of the SPR band when the concentration is increased further. The decrease in the intensity of the SPR band [Fig. 2 (a-e)] is due to the formation of less nZVI despite high initial concentration of Fe^{2+} ion

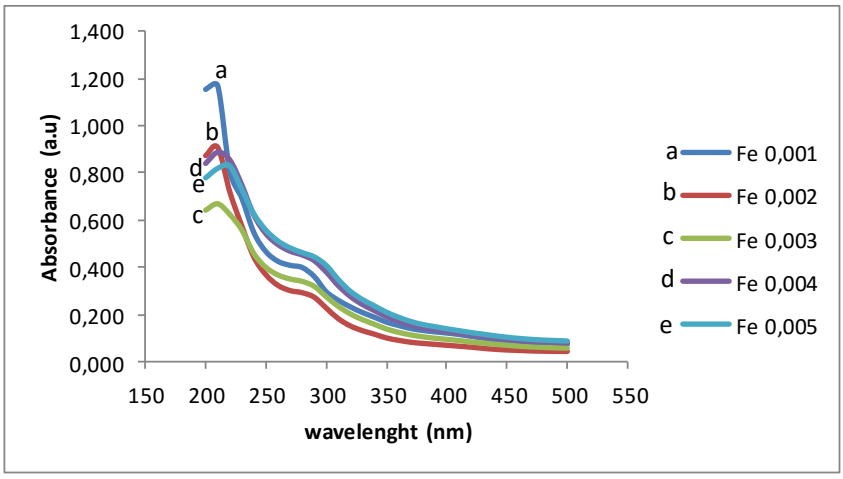

Figure 2. UV Vis spectra for the nZVI prepared with 5 mL Banana peel extract with various Fe^{2+} aqueous concentration

TEM analysis

According Hoag et al. (2009), the reaction between Fe ions and extract containing polyphenols produce nZVI [20]. Samples were characterized using transmission electron microscopy (TEM). TEM analysis is presented in Figure 3. From the image confirm that the density grid elements in each zone is related with the intensity shading. The size similar nZVI can be seen in Figure 3. However, due to the agglomeration causes the particle size nZVI becomes larger 100 nm [21]. These results require further study and research.

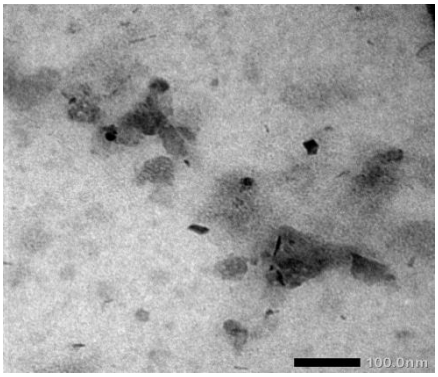

Figure 3**.** TEM image nZVI synthesized using BPE

Conclusion

In conclusion, nano Zero Valent Iron can synthesized directly betwen ferrous sulfate with banana peel extract in aqueous media without the addition of chemicals (capping agent). So this process is environmentally friendly nanoparticle synthesis. However, the size of particles nZVI was more 100 nm.

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