GREEN SYNTHESIS OF IRON PARTICLES USING CAMELLIA SINENSIS EXTRACT

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Abstract: The interest in nanotechnology in environmental remediation has been increasing in recent years. Metallic nanoparticles of different sizes and morphologies can be readily synthesized using chemical and physical methods. However, these techniques involve hazardous chemicals as organic solvents, reducing agents and nonbiodegradable products. They are potentially harmful to the environment and biological systems. The biosynthesis of nanoparticles has been suggested as an environmental friendly and sustainable alternative to chemical and physical methods. In that manner, microorganisms and plant extracts can be used for the green synthesis of nanometals. The aim of this study was the production of green iron nanoparticles (GnIP) using extracts of natural products. This study indicated that GnIPs can be synthesized successfully and sustainably with green tea leaf extract without producing any hazardous chemicals.

Keywords: Green Synthesis, Iron Particles, *Camelia Sinensis*

I. INTRODUCTION

Using Zero valent iron nanoparticles (ZVInP)[1-5] to remove various pollutants has gained importance in the environmental engineering due to their reducing properties recently. ZVInPs are more preferred than micro-sized iron particles due to highly reactive surface area-to-mass ratio of their nano-sized features [2, 6]. Environmentally, green manufacturing technologies reducing waste amount and wastewater volume without chemical usage have developed to produce green iron nano-particles (GInPs) instead of advanced nanotechnologic processes with high-cost and toxic substance consumption [7].

The most recent method of green iron nano-particle synthesis is using of vegetables, fruits, and organic waste extracts by mixing certain proportion of an iron compound without energy and any toxic chemical requirements [8]. Green iron nanoparticles production occurs with special reaction, which are defined as the color change from pale green to dark green or black color, between iron compound and polyphenols found in plant extract in very short time at room temperature [9]. GInPs were produced by this method with 10 to 100 nm size distribution [10].

In the literature, GInPs was reported to be synthesized from various plants, such as tea [3, 9, 11], coffee [3], mint [6, 10], moss [7], banana [12], eucalyptus, pineapple and mango extracts containing polyphenols [13]. Various iron compounds are mixed with different plant extracts of certain volumetric ratio to produce green iron nanoparticles. Iron compounds used in the synthesis of green iron nanoparticles are iron (III) chloride [11, 14-17], iron (II) sulfate [17-19] and iron (III) nitrate [9, 19, 20]. The percentage of iron compound in total GInP solution depends on polyphenols fraction in plant extract, and thus the volumetric ratio of iron solution to plant extract must be investigated for each plant extract to achieve nano-sized iron particle.

GInPs can be used in a variety of treatment methods in environmental engineering with changing zero-valent iron nanoparticles instead of micro sized iron particles already used in many processes [14, 21]. GInPs was used to remove heavy metals such as arsenic [10, 16, 17, 22], chromium [2, 6], lead [2, 19, 23, 24], cadmium [21, 24], and the removal of various dyes [7, 11, 20, 25, 26] and chlorinated organic compounds [4] which cannot be treated by conventional methods. In recent years, green iron nano-particles have been used for arsenic removal from groundwater in many studies [2, 10, 16, 17, 20, 22].

For the green synthesis of iron nanoparticles, green tea leaf extract was used in this study. The volumetric ratio of iron solution and tea leaf extract was investigated to produce iron nano particle. As a result of this study, GnIPs were synthesized successfully and sustainably by using green tea leaf extract without producing any hazardous chemicals.

II. DETAILS EXPERIMENTAL

2.1. Materials and Procedures

A. Production of Green Iron Nanoparticle

In this study, GnIP synthesis with green tea (*Camellia sinensis*) leaf extract to be used in purpose of water and wastewater treatment was investigated. 15 g leaf was extracted in 100 mL water at 80 °C during 15 minutes before adding 0.1 M $FeCI_3.6H_2O$ (Merck) as a source of iron. Same trials were made for GInP solution with different volumetric ratio of iron solution and leaf extract to achieve nano-sized iron particle efficiently.

B. Size Distribution of Green Iron Nanoparticle

In order to determine size distribution of iron particle Zetasizer (Malvern 500210) analysis was performed for each trials. The refractive index was chosen 2.65

for FeO compound in GInP solution. In size analysis, GInP solutions were prepared freshly and these solution were sonicated in ultrasonic bath at 45 kHz frequency.

2.2. SEM-EDX Analysis of Green Iron Nano-particle

In order to characterize GInPs, SEM (Zeiss EVO 40) and EDX (Bruker) analyses were performed for each solution. Each solution were sampled on to different glass piece and dried at 80 °C for 1 hour. Gold-palladium coating was made for these samples before SEM-EDX analysis.

III. RESULTS AND DISCUSSION

3.1. Size Distribution Results of Green Iron Nanoparticle

According to the results of size distribution analysis, it was obtained that size of produced GnIPs ranged from 10-100 nm in the solution of 10 %(v/v). Green tea extract was observed to have 10-30 µm, and iron solution 30-60 µm particles. When GnIP solution was not prepared freshly and sonication was not applied, agglomeration occurred in the solution instantaneously.

3.2. SEM-EDX Analysis Results of Green Iron Nanoparticle

The main elements were O, Si and Fe in EDX spectrum. Also, C, Na, Mg, Al, P, Cl, and K elements found in GnIP solution.

SEM images of green iron nanoparticle at 20 kV EHT voltage and 11 mm working distance with different magnification were given in Figure 1.

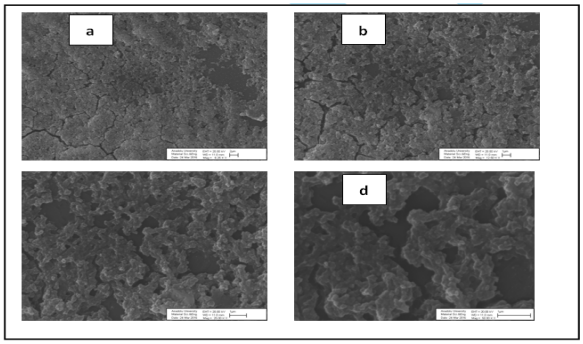

Figure 1:SEM images of green iron nanoparticle at 20 kV EHT voltage and 11 mm working distance (a:6250X magnification, b:12500 X magnificaiton, c: 25000X magnification, d:50000X magnificaiton)

SEM images demostrated that size of GnIPs were smaller than 100 nm. Also, it was clearly obtained from these images that GnIPs were agglomerated.

CONCLUSIONS

As a result of this study, GnIPs were synthesized successfully with green tea leaf extract without any hazardous chemicals production and energy consumption. The optimum volumetric ratio of iron solution to tea leaf extract to produce iron nano particle was investigated. The results showed that fraction of polyphenolic compounds was nearly 10 % (v/v) in tea leaf extract. The size of GnIPs ranged from 10 nm to 100 nm and GnIPs easily agglomerated in solution.

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