Research on Green Synthetic Iron Nanoparticles

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Abstract. For the last few years, nanoscience and nanotechnology are developing fast, and the use of green synthesis technology to prepare green nanoparticles has attracted widespread attention. Plants have become a substitute for various toxic agents, such as borohydrides, as compared to various toxic physical and chemical preparation methods. Moreover, plants have the preponderance of convenience and source, low cost and environmental protection. Moreover, the use of green synthesis technology not only avoids the use of chemical agents, but also reduces environmental pollution caused by toxic substances generated during the preparation process. Therefore, the preparation of nanoparticles by green synthesis technology is one of the most interesting areas to study. In this paper, focuses on the green synthesis of iron nanoparticles using papaya (melon) Nakai.

1. Introduction
Since the 19th century, scientists have been fully aware of the ability of biological entities to reduce metal precursors and nanoparticles have applications in many fields. Due to its particularity, zero-valent iron (ZVI) is commonly used for the repair of industrial wastewater, the degradation of dyes, and heavy metal water. Because of the reducibility of zero-valent iron itself, and the treatment of some high-heavy metal contamination in the wastewater can be reduced to a low level, the reduced product can be removed by precipitation. The iron nanoparticle has a diameter of only about 1 to 100 nm but it has a large specific surface area and good dispersibility, so that it can adhere to the surface as much as possible as a contaminant [1]. Moreover, the above advantages, iron nanoparticles also emerged in terms of health care, biomedicine, environment, energy science and other scientific research fields.

Nowadays, because of the chemical properties of iron nanoparticles, it is used to treat groundwater pollution, the degradation of heavy metals and toxic substances and some environmental problems affecting people's lives. At present, the synthesis methods of nano particles are generally divided into two kinds. One is the top-down synthesis method, which grinds large size metal into small nano size particles. This method generally meets the preparation requirements through physical means. It generally involves crushing, impact pulverization, such as mechanical pulverization. However, this method is very demanding on experimental instruments, and high cost, and the obtained nanoparticles are very few and poor dispersion. The other is a bottom-up synthesis that assembles small components into larger structures where the nanoparticles grow from simpler molecules called reaction precursors. Thus, by changing the precursor concentration and reaction conditions, the size and shape of the nanoparticles can be manipulated. This method is generally made by chemical methods. But it is undeniable that both methods are flawed. The methods for generating nanoparticles from the bottom up generally require the use of aggressive chemical reducing agents such as sodium borohydride,
hydrazine and blocking agents, and may also include volatile organic solvents such as toluene or chloroform. Therefore, it is clear that there is a need to develop alternatives that are more cost effective and environmentally sound than these existing methods [2]. Choose synthetic reagents that do not pollute the environment, ecological reducing agents and harmless nanoparticle capping agents to stabilize nanoparticles is the three main criteria for the synthesis of green nanoparticles.

Now it is necessary to continue to develop more convenient, effective and pollution-free green synthesis of nano zero-valent iron technology. Iron nanoparticles prepared by biological materials are superior to iron nanoparticles prepared by chemical and physical methods in all respects. In addition, biomaterials such as ascorbic acid, amino acids, microorganisms, leaf and many other plants can be used to prepare nanocomposites and magnetic nanocomposites. Among them, Ascorbic acid can be used to prepare stable zero-valent chain-like nanoparticles. In each chain, a single Fe nanoparticle is round with a diameter of about 20-75 nm. In addition, The magnetic iron nanoparticles prepared by ascorbic acid are widely used in the medical field because of their own stable nature and good dispersibility. Ascorbic acid is used as both a reductant and a stabilizer in the synthesis of iron nanoparticles and this point of ascorbic acid is also widely used in the synthesis of other kinds of nanoparticles. But in the process of synthesizing iron nanoparticles, the microorganism involved in the synthesis process is extremely demanding for highly sterile conditions. Therefore, it is not feasible to mass-produce iron nanoparticles by this method. Iron reducing bacteria are commonly used to synthesize iron nanomaterials [3]. It produces iron nanoparticles by altering the precursor of iron. However, the method is uncontrollable and the prepared iron nanoparticles are not stable enough. Therefore, compared with microorganisms, the use of plant extracts to prepare iron nanoparticles has potential advantages. Compared with other synthetic methods, plants have the advantages of easy improvement, less harm to organisms and easier to maintain stable cell culture. The enzymes contained in plant products can be used as stabilizers and reductants in the synthesis process to prepare iron nanoparticles. In addition, the addition of enzymes provides a natural blocking agent for the stability of iron nanoparticles, effectively reducing and limiting the use of toxic reagents. Plants have controllable costs, wide sources and environmental friendliness, making further large-scale production of nano-iron possible. Although the mechanism of the preparation of zero-valent iron nanoparticles from plants is still not very mature, it is undeniable that plants and their extracts are the best reagents for the preparation of iron nanoparticles. This experimental paper is about the process of the green synthesis of iron nanoparticles using Chaenomeles speciosa (Sweet) Nakai.

2. Experimental

1) Preparation of zero-valent iron nanoparticles

0.10M the Chaenomeles speciosa (Sweet) Nakai solution extract was prepared by heating until boiling. After settling for 1.0 h, the extract was filtered. Separately, a solution of 0.10 M FeCl2·4H2O was prepared by adding 19.9 g of solid FeCl2·4H2O (Aldrich 22029-9) in 1.0 L of deionized water. Subsequently, 0.10M FeCl2·4H2O solution was added to 0.10M the Chaenomeles speciosa (Sweet) Nakai solution in 2:3 volume ratio. The iron particles were then separated first by evaporating water from the iron solution on a hot plate (Freed Electric), and then by drying it overnight in a fume hood.

2) Characterization of zero-valent iron nanoparticles

The synthesized zero-valent iron nanoparticles were characterized using TEM, SEM, and XRD techniques.

A Philips X’Pert Pro instrument was used for the XRD analysis. The source consisted of Cu Kα radiation (λ = 1.54 Å). Each sample was scanned within the 2θ range of 20–70°. The samples of zero-valent iron nanoparticles were repeatedly washed with ethanol prior to XRD analysis.

SEM/EDX analysis was carried out using a Philips XL-30S FEG type instrument.

TEM images were obtained with a JEOL JEM 1200 EX Mk 2 TEM, operating at 120 keV. Nanoparticle samples were sonicated in analytical grade methanol for 30 s and mounted on 200 mesh holey carbon coated copper grids.
3. Results and discussion
SEM image and EDS spectrum of zero-valent iron nanoparticles are shown in Fig. 1 and Fig. 2. The zero-valent iron nanoparticles tend to form irregular nanoparticles, with particle size ranging roughly 50nm (as shown in Fig.3). The EDS spectrum contains intense peaks of C, O and Fe which must be originating from the Chaenomeles speciosa (Sweet) Nakai and FeCl₂ precursors used. The C and O signals are attributed mainly to the polyphenol groups and other C-containing molecules in the Chaenomeles speciosa (Sweet) Nakai extracts.

Figure 1. SEM image of zero-valent iron nanoparticles

Figure 2. EDS OF ZERO-VALENT IRON NANOPARTICLES

Figure 3. TEM image of zero-valent iron nanoparticles
The structure of the material was characterized also by XRD (Fig. 4) and the result shows that the zero-valent iron nanoparticles are amorphous.

4. Conclusions and future prospective

The experimental results show that the iron nanoparticles extracted from the Chaenomeles speciosa (Sweet) Nakai have a good dispersion and are extremely stable. Compared with the experimental process of preparing nano-iron by chemical, bacterial and fungal methods, the preparation of nano-iron by the Chaenomeles speciosa (Sweet) Nakai not only effectively reduces the risk of the experiment, but also ensures the safety of the researchers and reduces the experimental process. The unnecessary pollution caused by it is more in line with the principle of green chemistry and effectively protects the environment. Moreover, the Chaenomeles speciosa (Sweet) Nakai has more outstanding economic benefits. This ubiquitous organism reduces production costs, and add up the feasibility of producing nanometer iron on a large scale. Moreover, the Chaenomeles speciosa (Sweet) Nakai has a good catalytic effect on the preparation of iron nanoparticles. Therefore, the potential to produce iron nanoparticles in the Chaenomeles speciosa (Sweet) Nakai is unparalleled. However, this mechanism has not been clearly described. As a result, it is necessary for researchers to further study the mechanism of synthetic iron nanoparticles. But so far, we have not been able to determine the potential impact of the iron nanoparticles produced by the plant in the near future, not to mention whether the material will be groundwater, land creatures or even humans after large-scale use. Have an impact. Therefore, in future research, we should further explore and study the mechanism of action behind iron nanoparticles and make iron nanoparticles the most efficient use.

References

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