Green Synthesis and Characterization of Zero Valent Iron Nano particles from the Leaf Extract of Abies Webbiana Plant and Their Antibacterial Activity

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Abstract

The green collection of metal nanoparticles has accumulated a final interest over the past decade due to its unique properties applicable in various fields of science and technology. Metal nanoparticles integrated using plants have emerged as non-toxic and eco-friendly. In this study, a very inexpensive and simple conventional heating method was used to obtain iron nanoparticles (FeNPs) using extracts from the leaves of the AbiesWebbianaplant. The obtained iron nanoparticles were subjected to UV-vis spectroscopy, FTIR spectroscopy, XRD, SEM EDAX and the antibacterial activity was studied against Staphylococcus aureusby the standard disc diffusion method.The bundled FeNPs were found to be 27nm, which was confirmed by XRD.

Keywords: FeNPs, AbiesWebbiana, UV-Vis, FTIR, XRD, SEM-EDAX

1Introduction

Subject matter can be divided into two categories: macroscopic and mesoscopic. A macroscopic object is visible to the naked eye, whereas mesoscopic particles such as bacteria and cells with dimensions in the micron (s) order can be observed with optical microscopes. Another type of material that falls into the space between the microscope and the mesoscopic is nanoscopic particles. [1,2]. Nanotechnology is a vast area that includes nanoparticles, nanotechnics and nanotechnics. Nanoparticle iron particles have recently been of great interest in environmental solution circles for the removal of organic and mineral contaminants from aquatic solutions [3]. With the development of green production technology the focus on zero-valent iron nanoparticles has increased significantly, with extracts from the leaves being used [4, 5]. Nowadays iron nanoparticles (Fe NPs) are synthesized used to remove nitrates from plant juices and water. These iron nanoparticles are considered to be pure products that can be used to effectively remove nitrate [6]. This method of green synthesis does not require high pressure, energy, temperature or toxic chemicals. So nowadays many researchers are distracting themselves from using artificial methods [7]. Zero-valent iron nanoparticles (nZVI) have already proven their effectiveness in reducing a wide range of environmental pollutants in numerous laboratory and field experiments [8]. The synthesis of nZVI is highly promising with the recently developed green under-up system [9]. The biology of metal nanoparticles extracted from different parts of the plant (mostly leaves) is an excellent process for synthesis at a very affordable price. Biology takes place during the synthesis of metal ions. According to the researchers, the polyolcomponents in plant extracts help to reduce iron ions, while the water-soluble heterocyclic components stabilize the nanoparticles. Suitable precursors such as ferric chloride can be used to reduce plant extracts [10-17].

2. Materials and Methods

Reagents and chemicals

Ferric Chloride (FeCl3) and all analytical grade chemicals were purchased from TCI Chemicals, Chennai. Freshly prepared triple distilled water was used throughout the experiment.

Preparation of leaf extract by boiling method

AbiesWebbina leaves were selected from Nagamalai area, Madurai, Tamilnadu, India on the basis of costeffectiveness and ease of availability (**Figure 1**). Fresh and healthy leaves are collected internally and first rinsed well in tap water, after which the filtered water is removed to remove all dust and unwanted visible particles and cut into small pieces. These thin leaves weighed about 10 g and were transformed into 250 ml beakers with 100 ml of distilled water and boiled for about 20 min. The juices were filtered three times through Whatman No. 1 filter paper to remove particles and clear solutions, then refrigerated in 250 ml Erlenmeier flasks (4 °C) for further testing. At each step of the experiment, infertility conditions are maintained Efficiency and accuracy in results without pollution.

Figure 1 Image of AbiesWebbina

3 Characterization

UV-Vis spectra Analysis

Samples of suspension (1 mL) were collected from time to time to monitor the bioavailability of Fe3 + in aqueous solution, then diluted with 2 ml of deionized water and then scanned on ultraviolet (WIS) spectroscopy at wavelengths up to 700. (Beckman - Model No.Du - 50, Fullerton), with a resolution of 1 nm.

FTIR analysis

FTIR analysis of dried FeNPs was carried out using the potassium bromide (KBr) pellet (FTIR grade) method at a ratio of 1: 100 and using the Jasco FT / IR-6300 Fourier Transformer infrared spectrum at Jasco IRT-

7000 intron infrared resolution of 4 cm using the microscope.

X-ray Diffraction (XRD)

The crystal structure of FeNPs was determined and stabilized using the x-ray difframeter (model PW1710 control unit Philips anode object Q, 40 kV, 30 mA, optical: automatic deflection) with Cu Kα radiation using = 1.540 5 ° A. At wide pragmatic angles (30 ≤ ≤2θ≤80). A basic analysis of the model was explored by energy diffusion analyzes of X-rays with the JED-2300 instrument. The crystal domain size was calculated from the width of the XRD peaks, which ensured that they were free from homogeneous strains. The particle size of the manufactured model is determined using D≈0.94λ / βcosΘ using Sheres' equation, where D is the average crystal domain perpendicular to the reflected planes, the X-ray wavelength, β is the full width at half maximum (FWHM) and Θ is the diffraction angle.

Scanning Electron Microscopy – Energy Dispersive X-ray Spectrometry (SEM–EDX) Analysis

The microstructure and hybrid integrity of the samples obtained using the SEM / EDX scanning microscope JEOL-JSM 64000 LV were examined. Energy diffuse X-ray analysis measurements were carried out under stable conditions. The iron nanoparticles were centered at 10,000 rpm for 30 min, the hole was redistributed in 10 mL ethanol, and washed 3 times in sterile filtered water to obtain particles. The particle was dried in an oven and thin films (10 mg / ml) of the dried samples were used for synthesis analysis.

Antibacterial activity by disc diffusion method

Antibacterial activity was carried out in human pathogens Staphylococcus aureus by standard disk diffusion. The discs were soaked individually with double filtered water, leaf extract, ferric chloride solution and a solution containing nanoparticles of iron in each category. The discs were then air-dried in sterile condition. Nutrient agar (NA) trays were sown with an 8-hour broth culture of different bacteria. Using sterilized tubes, the samples were carefully added to the wells at different concentrations (10, 20, 30, 40 1/ well) and allowed to spread for 2 h at room temperature. The plates were then incubated at 37–2 C for 18–24 h. Gentamicin (10 g) was used as a positive control. Then, the maximum zone of inhibition type was observed and measured for analysis against each type of test bacterium

4 Results and Discussion

Synthesis of Iron nanoparticles

The fresh leaves of AbiesWebbianabroth solution were prepared by taking 100g of thoroughly washed and finely cut plants in a 500ml Erlenmeyer flask along with 200ml of sterilized double distilled water and then boiling the mixture for 15min before finally decanting it. The extract was filtered through Whatmann filter paper no 1 and stored at -4°C. The filtrate was treated with an aqueous 1mM $FeCl_3$ solution in an Erlenmeyer flask and the mixture was heated at 60°-70°C for 10-15 minutes. As a result, a black colored solution was formed; indicating the formation of Ironnanoparticles. The Iron nanoparticle solution thus obtained was purified by repeated centrifugation at 10,000 rpm for10 min.As a black color solution was further confirmed by

UV-Visible spectrum analysis. It showed that aqueous Iron ions could be reduced by aqueous extract of plant parts to generate extremely stable Iron nanoparticles in water

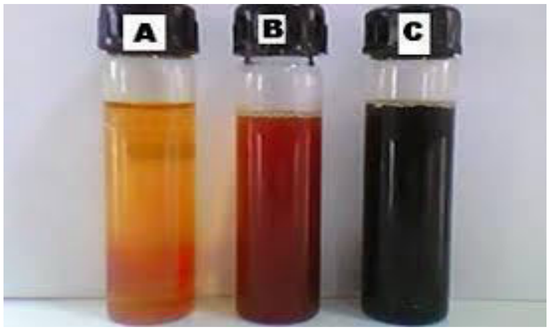


Figure 2 Formation of Iron nanoparticles and it is identification by the color change. (A) FeCl3 solution, (B) plantextract (C) plant extract with FeCl3 solution.

UV – Visible spectral analysis

FeNPs compiled using UV-visible spectroscopy are examined and recorded spectra are shown in Figure 3. The absorption behavior shown in Figure 3 arises due to surface plasmon vibration (SPR) [18]. As Abieswebbianaleaf juice is added to aqueous FeCl3 solution, the color of the solution changes from yellow to black, indicating the formation of FeNPs. Fsigure 3 shows the UV-Vis spectrum of integrated FeNPs, providing a wide absorption band at 267nm. Such observational change is characteristic of metallic elements, where the wide peaks observed are coordinated by changes in the filled and unfilled D-orbit by the influence of other external factors [19]. This peak at 267 nm is shown to be due to the presence of iron nanoparticles in the state of Fe0.

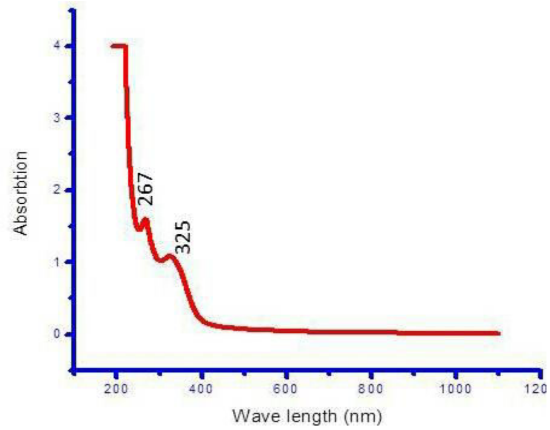


Figure 3 (A) UV-Visible absorption spectra of AbiesWebbinaleave extract. (B) UV-visible absorption spectra of synthesized Iron nanoparticles, showing thesurface plasmon resonance peak at 267 nm

FTIR analysis

FTIR analysis was performed to identify the interactions between biomarkers and Fe3 + during biodegradation reactions. FTIR data for FeNPs containing AbiesWebbianaleaves extract are shown in Figure 4. Band OH extension at 3466 cm-1 with alcohol and phenol compounds and 2075 cm-1, 1637 cm-1, 670 cm. -1 CO extension of carbonyl functional groups in alcohols, ethers, acids and esters is due to the C = O elongation pattern. The carbonyl band at 1637 cm-1 was changed to 1690 cm-1 when forming FeNPs. The change in band at 1690 cm-1 clearly indicates the integration of carboxylic acid with FeNPs and 688 cm-1 is reported in the literature as zero valent iron, Fe0. Figure 4 FTIR Spectra a) Carbonyl group from amino acid residue, carbohydrates and phytochemical components from the FTIR study of iron nanoparticles synthesized using AbiesWebbianaleaf extract and b) sodium guava extract We revealed that we have Strong ability to bind metal NPs (closure of FeNPs) to prevent accumulation and thereby stabilize the medium. This suggests that biological molecules may play a dual role in the formation and stabilization of FeNPs in aquatic media. Water-soluble heterocyclic compounds such as flavonoids and alkaloids were mainly responsible for reducing and stabilizing NPs. These results indicate that the tannins, spores, flavonoids, steroids, carbohydrates, polyphenols, and glycosides in AbiesWebbiana leaf extract play an important role in reducing Fe3 + [20].

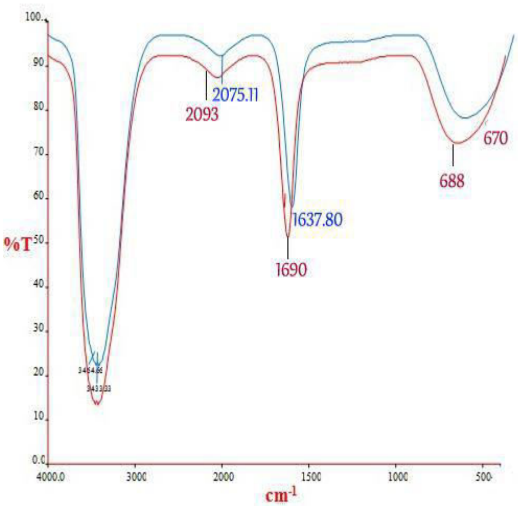


Figure 4: FT-IR spectrum of ferric Using AbiesWebbiana leaf extract

X-ray Diffraction (XRD)

Samples of FeNPs can be classified by X-ray differential analysis of dry powders. Variation intensities ranging from 10 to 80 were recorded at 2 theta angles (Figure 5). The results for FeNPs are heavily coded into four variation peaks [42 (100), 44 (002), 48 (101), 77 (110)] (JCPDS file number-655099). (101) The average size of a nanoparticle is determined using the Debbie-Sherer equation by determining the width of the peak [21,22]. Figure 6 X-ray defectogram of iron nanoparticles All peaks in XRD format can be immediately coded to a hexagonal structure of iron according to the available literature. The size of the sample was calculated from Shearer's formula and the size of the iron nanoparticles integrated by the green set was estimated at 27 × 10-9 nm.

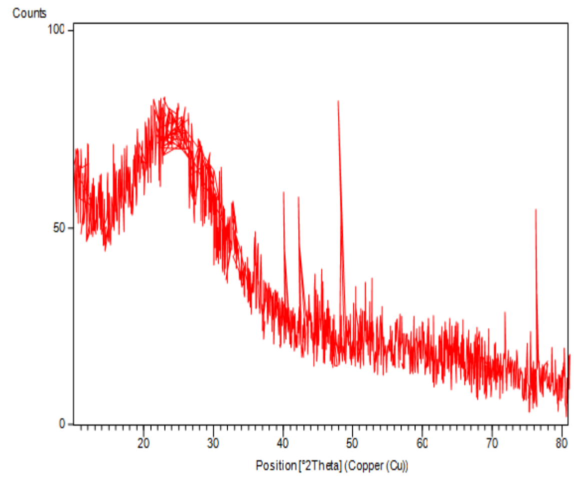


Figure5: XRD pattern of Ferric synthesized using supernatant of AbiesWebbiana leaf

Scanning Electron Microscopy- Energy Dispersive X-ray Spectrometry (SEM-EDX) Analysis

The presence of elemental iron can be seen in the diagram provided by EDAX, which indicates the reduction of iron ions to base iron. The result of EDAX is a clear idea of the components in biodegradable nanoparticles. The EDAX profile of phyto-enclosed FeNPs indicates the crystal property of the strong signal of the Fe atom as shown in Figure 6 while the vertical axis shows the number of X-ray numbers while the horizontal axis shows the keel energy. The optical absorption peak is at 7Kev, which is common for the absorption of metallic iron nanocrystallites. In addition to these signals for C and O, PHNPs due to plant components may appear from surface-covered biological molecules such as Mn and Cl.

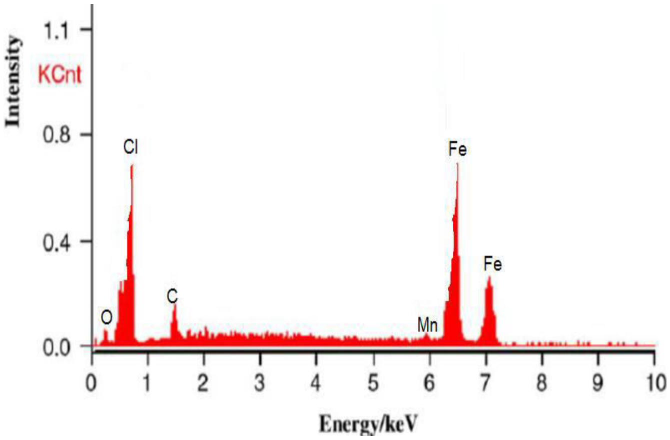


Figure 6 The EDX of Ferric nanoparticles of AbiesWebbiana leaf

Sample scanning was analyzed by electron microscopy (SEM) to determine the morphology of the compiled FeNPs. FeNPs synthesized using the extract of the leaves of sodium abbieswebbiana are examined under SEM and shown in Figure 7. This indicates that the resulting FeNPs are accumulating due to the irregular nature of the adhesive.

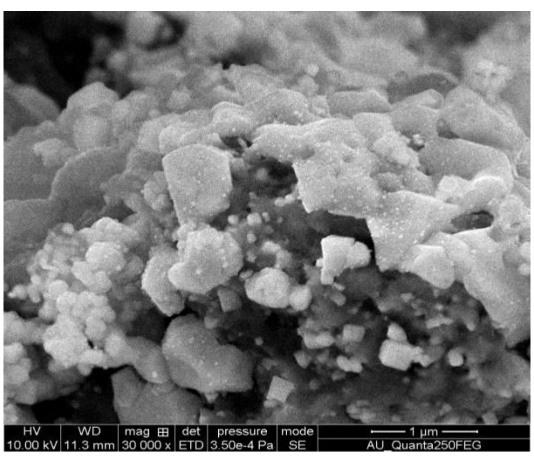
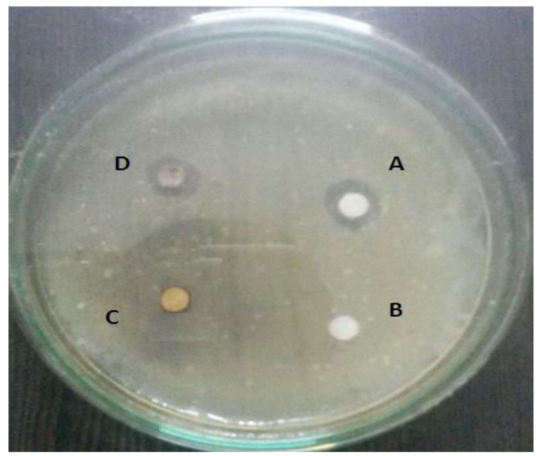


Figure 7SEM image of the synthesized Iron nanoparticles

Antibacterial activity for FeNPssynthesized from AbiesWebbiana leaf extract

The results of the antibacterial activity of various samples were tested against pathogens by disk diffusion method. The Sample D showed growth inhibitory activity against Staphylococcus aureus (6 mm) fig [8]. At sample C exhibited the antibacterial activity for the bacteria. However, the crude extract and synthesized nanoparticles showed better inhibitory actions against pathogens



Staphylococcus aureus

Figure 8: Anti-Bacterial Activity disc diffuce method

5. Conclusion

The extract of the AbiesWebbianaplant may be capable of producing iron nanoparticles. Under ultraviolet-visible wavelengths, nanoparticles exhibited a surface plasmon vibrational behavior. The color change was also noticeable when ferric chloride was mixed with a plant extract reducing agent. Biodegradable FeNPs were characterized by UV-vis spectroscopy, FTIR spectroscopy, XRD, cyclic voltmeter, SEM-EDAX, and antibacterial activity. From XRD analysis, the average crystal of iron nanoparticles was found to be 27nm.

Overall, this approach is very promising for the green sustainable production of FeNPs.

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