Research Article

Synthesis of Iron Nanoparticles Using *Murraya koenigii* Fruit Bulb Aqueous Extract

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ABSTRACT

This paper deals with green synthesis of iron particles by an aqueous extract of *murraya koenigii* fruit bulb. The spectroscopic analysis of Iron nanoparticles confirms that there is a broad peak from 275 - 500 nm in the spectrum. It confirms the presence of iron nanoparticles in the solution. The biosynthesized iron nanoparticle is characterized by SEM, XRD and FTIR. These characterization confirms the size of particles and formation of iron nanoparticles in the solution.

INTRODUCTION

The term nanotechnology is employed to describe the creation and exploitation of materials with structural features in between those of atoms and bulk materials, with at least one dimension in the nanometer range (1 nm $=10^{-9}$ m). Nanotechnology is an interdisciplinary research field that integrates chemistry, physics, biology and engineering. Properties of materials of nanometric dimensions are significantly different from those of atoms as well as those of bulk materials. It will offer better built, longer lasting, cleaner, safer, and smarter products. Several useful nano technological applications have been identified in cancer biology, including technologies for the early detection of tumors, cancer biomarkers and the development of treatment approaches that are impossible to achieve using conventional technologies. Nanoparticles are bits of a material in which all three dimensions of the particle are within the nano scale (1-100nm). The term nano is adapted from the Greek word meaning “dwarf”. Nanoparticles are of great scientific interest as they bridge the gap between bulk materials and atomic or molecular structures. A bulk material has constant physical properties regardless of its size, but at the nanoscale this is often not the case. Several well-characterized bulk materials have been found to possess most interesting properties when studied in the nanoscale. This is because nanoparticles present higher surface to volume ratio with their decreasing size. As the specific surface area of nanoparticle increases, their biological effectiveness can increase due to the increase in surface energy. Nanoparticles can be synthesized by two main approaches namely, “bottom-up” approach and “top-down” approach. In bottom-up approach materials and devices are built from molecular components, which assembles themselves chemically by principles of molecular recognition. In the top-down approach, nano objects are constructed from larger entities without atomic level control. Nanotechnology is an emerging and fast-growing technology.

Iron nanoparticles have attracted a great deal of attention among specialists because of their multifunctional properties such as small size, high magnetism and low toxicity and microwave absorption properties. Iron nanoparticles are increasingly being used in environmental remediation and hazardous waste treatment. Over the past few years, various methods have been developed to synthesize iron nanoparticles, modify surface properties, and enhance their efficiency for field delivery and reactions. Extensive laboratory studies have demonstrated that nanoscale iron particles are effective for the transformation of a wide array of environmental contaminants such as chlorinated organic solvents, organochlorine pesticides, polychlorinated biphenyls (PCBs), organic dyes, and various inorganic compounds.

Mimosa pudica is also known as Sensitive plant, sleepy plant or touch-me-not. It is a creeping annual or perennial herb. The compound leaves fold inward and droop when touched or shaken, to protect them from predators, re-opening minutes later. It grows mostly in shady areas, under trees or shrubs. All parts of the tree are considered to possess medicinal properties and used in the treatment of biliousness, leprosy, dysentery, vaginal and uterine complaints, inflammations, burning sensation, fatigue, asthma, leucoderma and blood diseases. *M. pudica* contains Mimosine, which is a toxic alkaloid. Adrenalin like substance has been identified in the extract of its leaves. Roots contain tannin up to 10 per cent. Seeds contain mucilage, which is composed of d-xylose and d-glucuronic acid. The plant extract contains green yellow fatty oil up to 17 per cent. The plant is reported to contain tubuline and a new class phyto hormoneturgorines is found to be active in the plant. The periodic leaf movement factors are reportedly the derivatives of 4-α-(b-D-glucopyranosyl-6-sulphate)gallic acid.

Scientific classification

Kingdom: Plantae
Binomial name: Mimosapudica
Tamil name: Thottalchinungi

CHEMICAL CONSTITUENTS

- Alkaloids
- Flavonoids
- Carbohydrates
- Amino acids
- Tannins

In Ayurveda and Unani medicine, *Mimosa pudica* root is used in the treatment of leprosy, dysentery, vaginal and uterine complaints, and inflammations, burning sensation, asthma, leucoderma, and fatigue and blood diseases. Decoction of root is used with water to gargle to reduce toothache. In Western medicine, Mimosa root is used for treating insomnia, irritability, premenstrual syndrome (PMS), menorrhagia, hemorrhoids, skin wounds, and diarrhea.

Advantage for using plant for synthesis

- ✓ Easily available
- ✓ Safe to handle
- ✓ Nontoxic in most cases
- ✓ Advantageous over other biological process

The potentials and promises of plant system in biologically assisted synthesis of metal nanoparticles are called “green synthesis” and it has become a key issue in nano science research. The green synthesis method is advantageous over conventional methods involving chemical agents associated with environmental toxicity. The main mechanism considered for the process is plant-assisted reduction due to phytochemicals. The main phytochemicals involved are terpenoids, flavones, ketones, aldehydes, amines and carboxylic acids. This paper deals synthesis of Iron nanoparticle by green synthesis method using the root extract of *Mimosa pudica and* to characterize the synthesized Iron nanoparticle.

MATERIALS AND METHODS

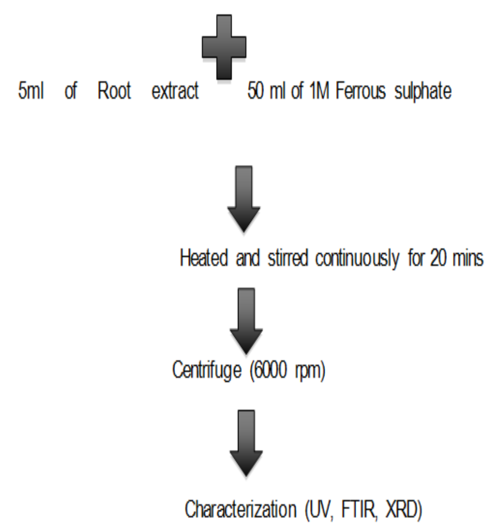
Preparation of root extract

Fresh roots of *Mimosa pudica* were collected from Coimbatore. The roots were surface cleaned with running tap water, followed by distilled water and were chopped into small pieces. It was dried and crushed into powder. From that, 5 grams of powder was soaked in 100 ml of distilled water and were placed under vigorous magnetic stirring for 4 hours at 80^{o}C for 20 mins. Then it was filtered through Whatman No: 1 filter paper and the filtrate was collected and stored at 4^{o}C for further process.

Synthesis of FeNPs

5 ml of the stock solution of root extract is added to 50ml of 1M Ferrous sulphate solution and stirred continuously for 20 mins. Reduction takes place rapidly at 60^{o}C. The light brown solution changes into black color which gives colloids of Iron nanoparticles. The colloidal solutions were then centrifuged at 6000 rpm for 15 mins. The experiments were repeated thrice to access the consistency and reproducibility of nanoparticles thus produced.

Methodology



CHARACTERIZATION

UV- visible spectroscopy

The reduction of pure Iron nanoparticles was primarily monitored by measuring the UV-visible spectrum of the reaction medium after diluting the solution with the range between 100 – 900 nm in UV-visible spectrophotometer. UV–vis absorption spectrum measures the wavelength of the light that the nanoparticles absorb. UV- spectrum is shown in the Figure 1. It shows a broad peak of Iron nanoparticles at the 275nm and 500 nm to detect the presence of Iron nanoparticles in the solution. Green synthesis of Iron nanoparticle was achieved using the plant *Mimosa pudica* as the color change was observed after the addition of ferrous sulphate solution due to the excitation of Surface Plasmon Resonance (SPR). In UV-visible spectrometer, the absorbance spectrum was measured. This shift has been suggested due to the availability of biomolecules (alkaloids, flavonoids, tannins and carbohydrates) present in the extract.[10-13,17-19]

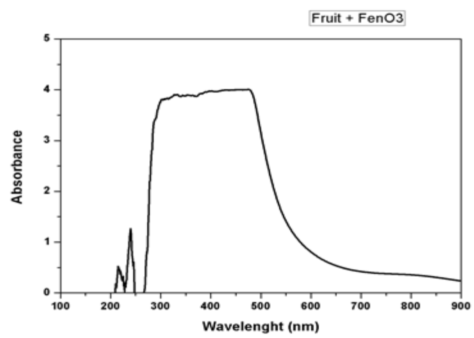


Fig. 1: UV-Visible spectrum of Iron nanoparticles

FT-IR Analysis

FTIR spectroscopy is used to identify the functional groups of the active components in the root extract based on the peak value in the region of infrared radiation. FTIR analysis was performed to identify the biomolecules responsible for reducing, capping and stabilizing the Iron nanoparticles present in the root extract of *Mimosa pudica.*10 ml of root extract was dried and ground with KBr to form a pellet and analyzed with the range of 400 – 4000 cm^{-1}. Figure 2 shows the FTIR spectrum of the root extract, which shows peaks at 3866, 3806, 3741, 3700, 3657cm^{-1}corresponding to the O-H stretching of hydroxyl group. The peaks at 3575$cm^{-1}$and 3400cm^{-1} indicated the characteristic IR absorption of alkaloids due to the stretching of O-H. The absorption peak around 1652cm^{-1} indicated the characteristic IR absorption of flavonoids due to the stretching of C=O. The obtained results suggest the presence of various functional groups in the leaf extract[13-16,18,20].

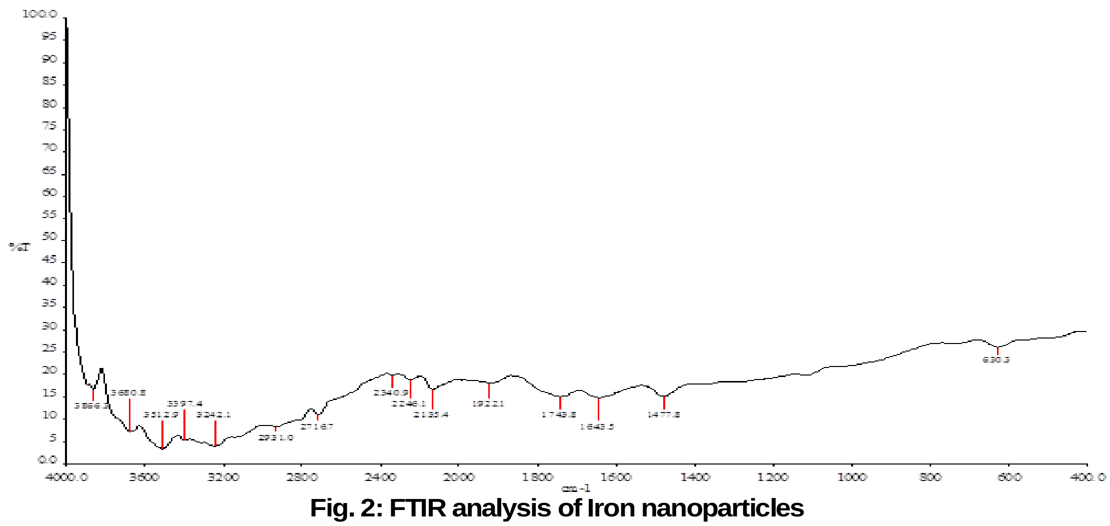


Fig. 2: FTIR analysis of Iron nanoparticles

Table 1: FT-IR spectrum of root extract

S.NO	Peak (cm^{-1})	Stretching bonds	Compounds
1	3866, 3806, 3741, 3700, 3657	N-H/O-H	Phenolic components
2	3575, 3400	O-H	Alkaloids
3	1652	C=O	Flavonoids (hesperetin)

X-ray diffraction (XRD)

XRD is an effective characterization to identify the phase and to confirm the crystal structure of the synthesized iron nanoparticles. The X-ray diffraction patterns obtained for the NPs synthesized using the root extract of *Mimosa pudica* is shown in Figure 3. The 2θ peaks at 70 and 80 are attributed to the crystal planes of magnetite. The iron nanoparticles are well-crystalline and the position and the relative intensity of the diffraction peaks match well with the standard XRD data for bulk magnetite (JCPDS file, No. 04-0755) [21]. The average particle sizes of the synthesized magnetite nano particles were calculated using Debye-Scherrer formula:

$D = K \lambda / (\beta \cos \theta)$

Where,

D = the mean diameter of nanoparticles

β = the full width at half-maximum value of XRD diffraction lines.

λ = the wavelength of X-ray radiation source 0.15405 nm.

θ = the half diffraction angle –Bragg angle

K = the Scherrer constant with value from 0.9 to 1.

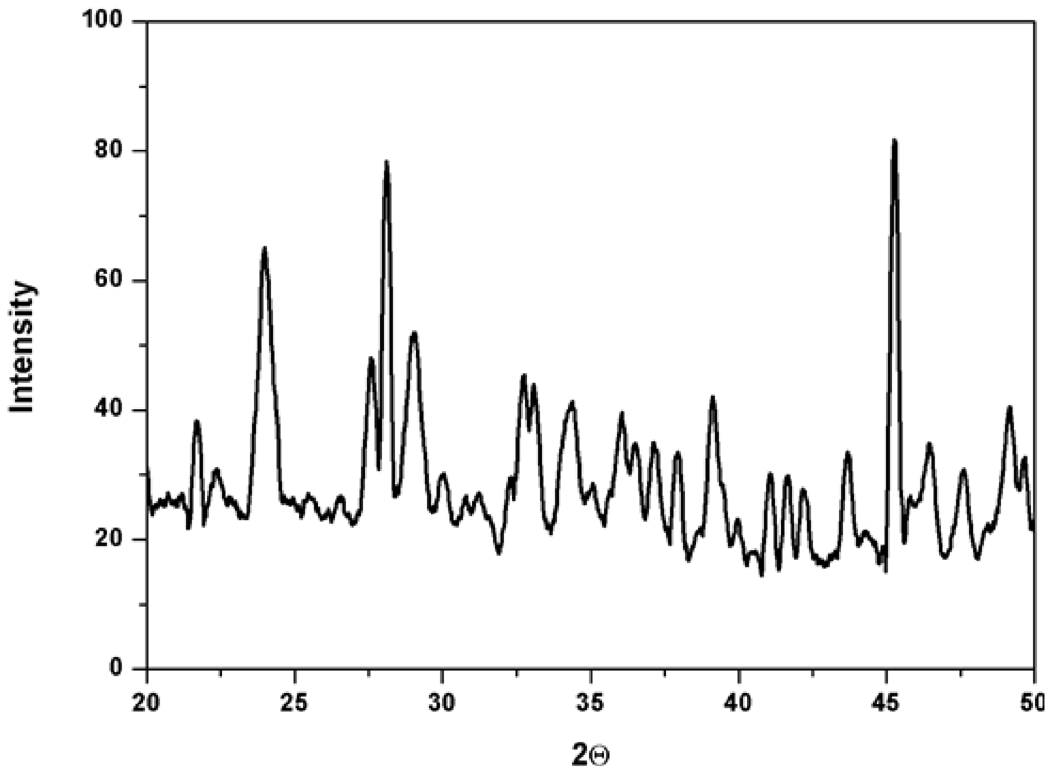


Fig. 3: XRD Pattern of Iron nanoparticles

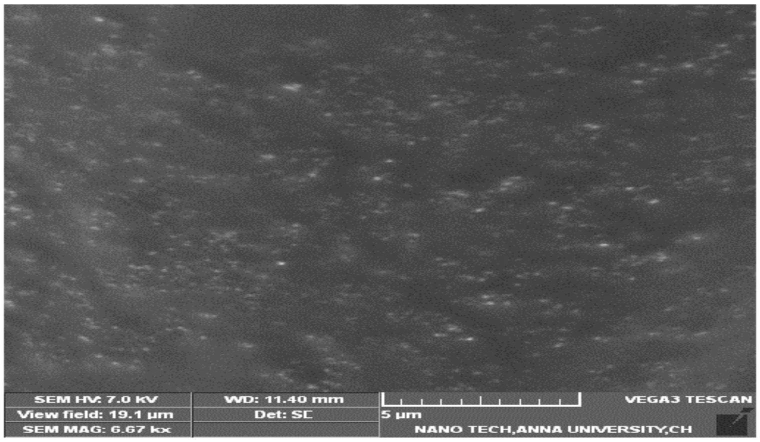


Fig. 4: SEM of Iron particles at 5 microns

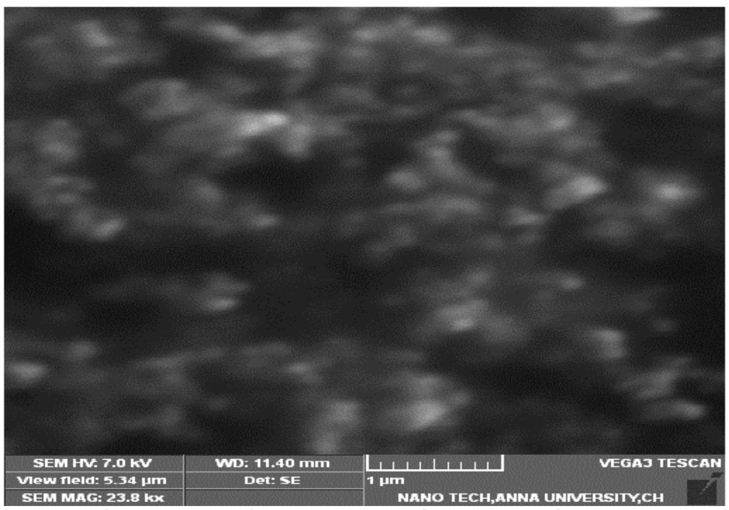


Fig. 5: SEM of Iron nanoparticles at 1 microns
The SEM studies confirm that Iron nanoparticles has the dimension in the range of Nano size

Fig. 6: Biosynthesized Iron nanoparticles

The figure 6 shows biosynthesized iron nanoparticles which has susceptible to magnetic attraction.

Antimicrobial Potential of Iron nanoparticles

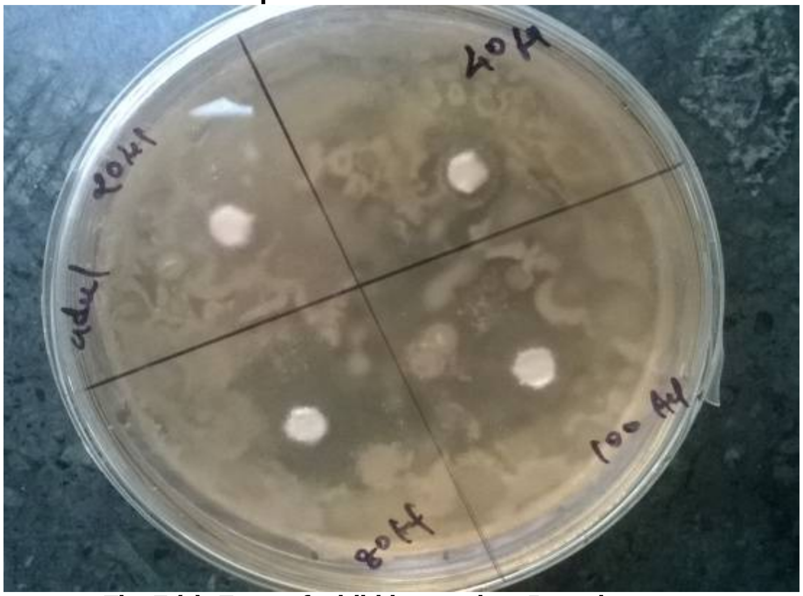


Fig. 7 (a): Zone of Inhibition against Pseudomonas

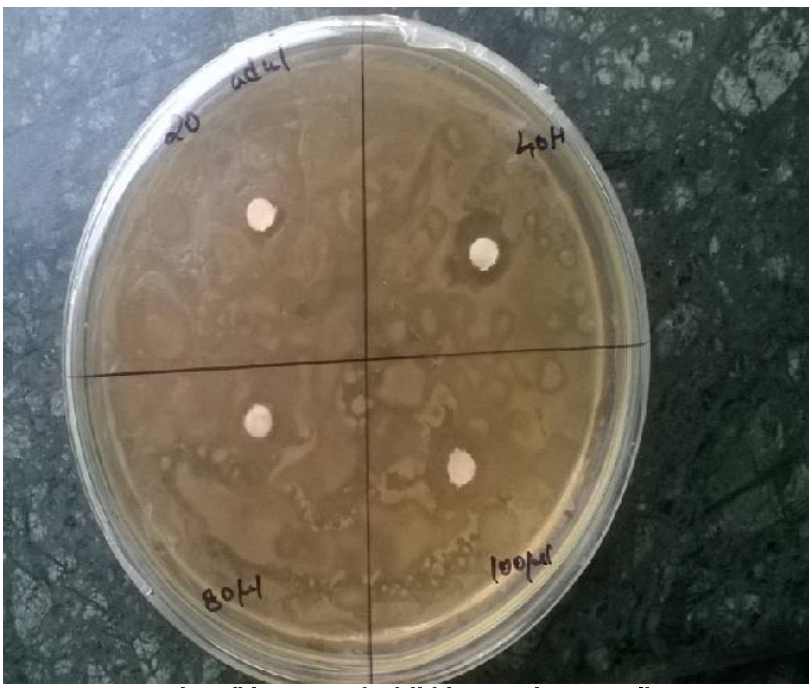


Fig. 7(b): Zone of Inhibition against E.coli

Figure 7 confirms the antimicrobial potential of iron nanoparticles against microbes. The iron nanoparticles produced significant zone of inhibition. However, the antimicrobial potential of Iron nanoparticles depends on the type of microorganism like gram positive and gram negative organisms.

CONCLUSION

An aqueous extract of *murraya koenigii* fruit bulb is used to synthesize iron nano particles successfully. The future work is to characterize the synthesized Iron nanoparticle using Particle size analysis (DLS), TEM and VSM and to analyze the cytotoxicity effect of the synthesized Iron nanoparticle.

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