Tridax Procumben Leaf Extract Mediated Green Synthesis of Iron Oxide Nanoparticles: Spectroscopic and Microscopic Studies

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ABSTRACT

An ecofriendly green synthesis of iron oxide nanoparticles were rapidly synthesized by reduction of Ferric chloride using Tridax Procumbens leaf extract. UV-visible spectra showed the maximum absorbance of 450 nm due to the surface Plasmon viberations in the iron oxide nanoparticles formation. The average particle size of the synthesized iron oxide nanoparticles was estimated to be 4-5nm using Scherrer's equation. The formation of Fe3O4 nanoparticles as well as their morphological dimensions in the SEM study revealed that the particles were aggregated

KEYWORDS: Iron oxide nanoparticles, Tridax Procumbens leaf extract.

INTRODUCTION

Nanoparticles are ultrafine particles with their size ranging from 1-200 nm.Nanoparticles have attracted considerable attraction due to their unusual and fascinating properties with various applications, over their bulk counterparts[1-2]. Synthesis of metal nanoparticles using plant extract is very cost effective so can be used as an economic and valid alternative for the large scale production of metal nanoparticles[3].The bioreduction of metal nanoparticles by combination of biomolecules found in plant extract such as enzymes, proteins, aminoacids, vitamins, polysaccharides typically obtained by contact of a broth of plant with metal salts, has been intensively investigated in recent years[4]. Iron as a nanoparticles has been somewhat neglected. This is unfortunate, but understandable, extreme reactivity has traditionally made iron nanoparticles difficult to study and inconvenient for practical applications. Recent work has begun to take advantages of irons potential and work in this field appears to be blossoming[5] . Iron oxide nanoparticles have attracted intensive research interest because of their important applications in cancer therapy, drug delivery magnetic resonance imaging (MRI) and waste water treatment[6].The biosynthesis of iron oxide nanoparticles of different sizes and shapes has been reported using bacteria[7], fungi[8] and plant extract. Green synthesis of nanoparticles is very cost effective, environment friendly and non toxic. In the present scenario, there is an urgent and continuous need of exploration and development of cheaper, effective new plant based nanoparticles with better bioactive potential and least side effects. The entire plant of Tridax procumbens is used by indigenous people in Guatemala for the treatment of protozoal infections (malaria, leishmaniasis, dysentery) and gastrointestinal disorders (colic/stomach pains, gastritis/enterocolitis)[9-11]. Local people known it as "Ghamara", in English popularly called 'coat buttons' and is dispensed for "Bhringraj" by some of the practitioners of Ayurveda. Tridax procumbens is a widely

occurring medicinal herbs used by Ethnomedicinal practionars. To the best of my knowledge, the use of Tridax procumbens leaf extract for the biosynthesis of iron oxide nanoparticles has been less reported. The extension of our previous work[12] we investigated the synthesis of Iron oxide nanoparticles with the bioreduction method using Tridax procumbens leaf extract.

MATERIAL AND METHODS

Reagents and Chemicals:

For the synthesis of iron oxide nanoparticles, Tridax procumbens leaf extract was used as reducing agent. Ferric chloride ($Fecl_3$) was used as precursor. Milli Q water was used throughout the experiment.

Preparation of Tridax procumbens Leaf Extract:

About 10-20 gm of fresh and healthy leaves of Tridax procumbens were collected, washed thoroughly with Milli Q water, cut into fine pieces and boiled with 100 ml Milli Q water in Erlenmeyer flask at 80 ^{0}c for 15-20 minutes. The extract was cooled at room temperature and filtered using Whatman No.42 filter paper and stored at 4^{0}c for further analysis.

Green synthesis of Iron oxide Nanoparticles:

In a typical experiment, 50 ml of 0.01M ferric chloride solution was mixed with 20 ml of the Tridax procumbens leaf extract at a temperature of about 50-60^{0}c [13]. After the addition of leaf extract to the salt solution, the colour changed from faint yellow to brownish yellow and finally blackish green indicating the formation of iron oxide nanoparticles. The reaction mixture was centrifuged at 10,000 rpm for 15 minutes. The supernatant was discarded and the pellets were repeatedly washed with Milli Q water and dried for the evaporation of aqueous phase in hot air oven.

Characterization of Iron oxide Nanoparticles:

The blackish green colored solid characterized for the bioreduction of Fe^{2+} ions using UV-Visible spectroscopy, Morphology of iron oxide nanoparticles using Scanning electron microscopy (SEM), X-ray diffraction spectroscopy (XRD) and Elemental analysis was performed by Electron Diffraction X-ray analysis (EDX).

RESULTS AND DISCUSSIONS

The addition of ferric chloride solution to the plant extract containing carbohydrates as a major component which have aldehyde group may cause the partial reduction of Fe^{3+} to form Fe_3O_4. The possible reduction mechanism giving to Fe_3O_4 only from the single iron precursor, $Fecl_3$ is proposed in the following equations.

$Fe^{3+} + 3H_2O \rightarrow Fe(OH)^3 + 3H^+$ ……(1)

$Fe(OH)^3 + R\text{-}CHO \rightarrow Fe_3O_4 + R\text{-}COOH$ ……..(2)

UV-Visible Analysis of Iron Oxide Nanoparticles:

UV-Visible spectroscopy is most widely used technique to investigate the optical properties of the particles. The colour changes from faint yellow to blackish green indicated the formation of iron oxide nanoparticles (Fig.1). UV-Visible spectroscopy was done in the range of 200-800 nm. Absorption spectra

of iron oxide nanoparticles formed in the reaction media has absorbance peak 450 nm (Fig.2). The broadening of peak indicated that the particles are polydispersed.

Figure 1: Visual observations of A - Leaf extract, B - Ferric chloride, C - Iron oxide Nanoparticles

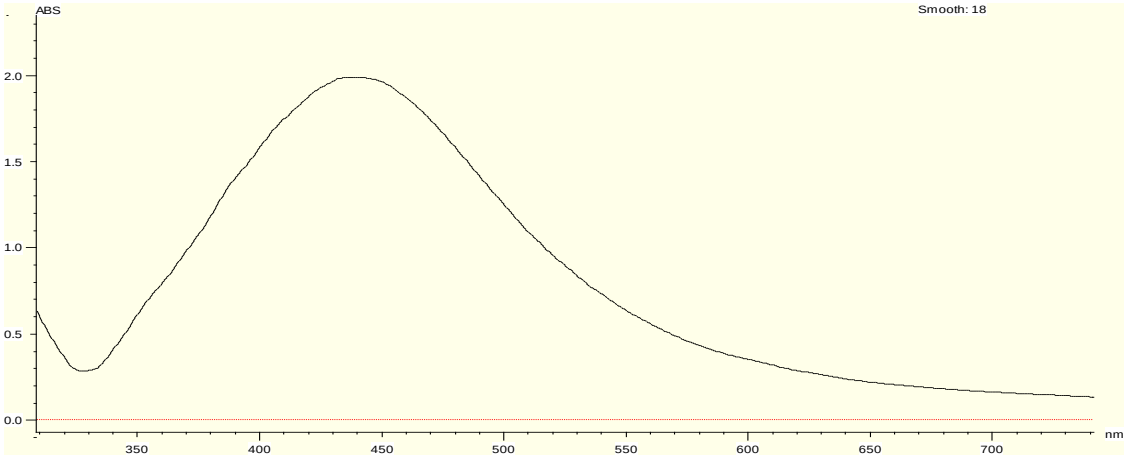

Figure 2: UV-Visible spectrum of Fe_3O_4 nanoparticles synthesized using Tridax procumbens leaf extract

SEM Analysis of Synthesized Iron Oxide Nanoparticles:

The powdered sample was analyzed for the structure and morphology of the synthesized iron oxide nanoparticles using SEM (Fig.3). SEM images revealed that the synthesized iron oxide nanoparticles were aggregated.

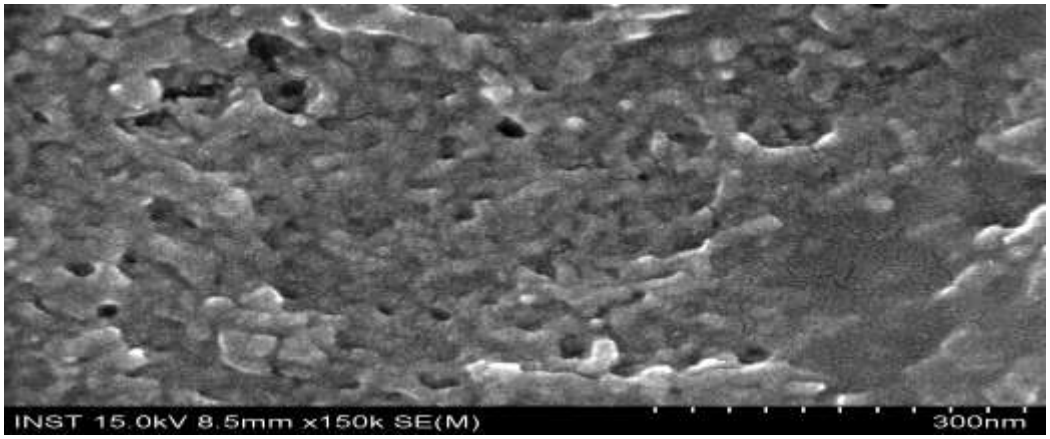

Figure 3: SEM micrograph of Fe_3O_4 nanoparticles synthesized using Tridax procumbens leaf extract

XRD Analysis of Synthesized Iron Oxide Nanoparticles:

The X-ray diffraction patterns obtained for the Fe_3O_4 nanoparticles synthesized using Tridax procumbens leaf extract is shown in (Fig.4). The XRD spectrum contains two peaks that are clearly distinguishable. All of them can be perfectly indexed to crystalline. The peaks with 2θ values of 28º, 32.4º Fe_3O_4 resp. The crystallite sizes can be estimated using Scherrer's formula $D=k\lambda/\beta\cos\theta$ where the constant K is taken to be 0.94, d is the wavelength of X-ray and β and θ are the half width of the peak and Bragg angle resp. Using the equation , the crystallite sizes found to be in the range of 4-5 nm.

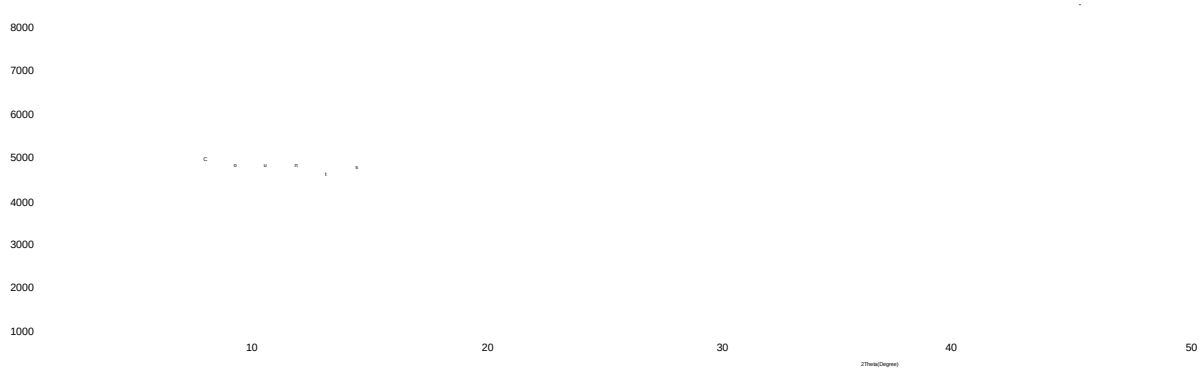

Figure 4: XRD pattern of Fe_3O_4 nanoparticles synthesized using Tridax procumbens leaf extract

EDX Analysis of Synthesized Iron Oxide Nanoparticles:

EDX analysis gives qualitative as well as quantitative status of element that may be involved in the formation of nanoparticles. Fig.5. Shows elemental profile of synthesized nanoparticles using Tridax procumbens leaf extract.

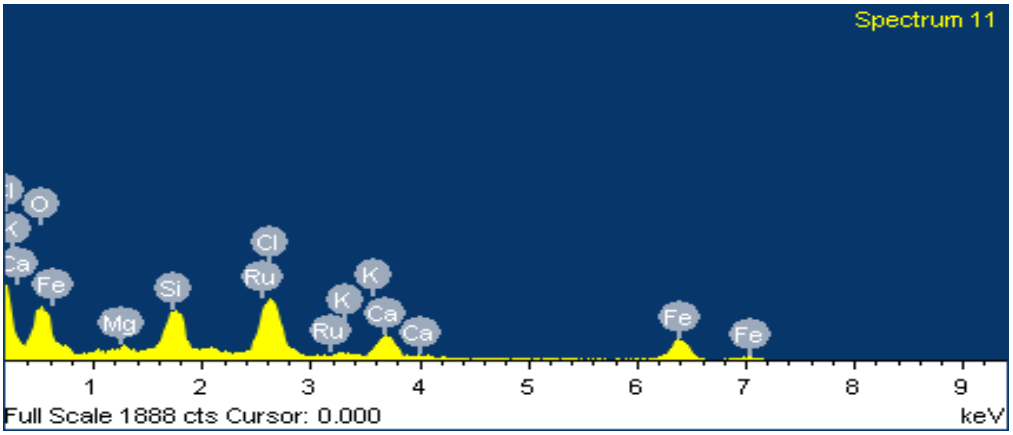

Figure 5: EDX pattern of Fe_3O_4 nanoparticles synthesized using Tridax procumbens leaf extract

CONCLUSIONS

The rapid biological synthesis of Iron oxide nanoparticles using leaf extract of Tridax procumbens provides an environment friendly simple and efficient route. SEM study revealed that the synthesized nanoparticles were in the form of irregular shape in aggregated form. This Fenps may be used in effluent treatment and in environmental remediation. In addition, this simple, low-cost and greener method for development of nanoparticles will give a positive message that nanoparticles synthesized thoroughly greener routes are much safer for human use.

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