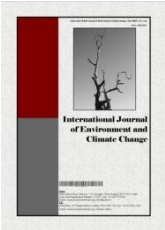

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Synthesis of Iron Oxide Nanoparticles Using Weed Leaf Extracts

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Authors' contributions

This work was carried under the guidance of my guide author HMJ Entire experiment was done by me. I along with coauthor performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. All authors read and approved the final manuscript

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ABSTRACT

Researchers have recently been involved in the green synthesis of nano iron particles using plant extract because of its wide applicability and ecofriendly nature of green synthesized nanoparticles. Iron oxide nanoparticles were synthesized in the current study carried out using weed leaf extracts. When weed leaf extract mixed with the precursor ferric chloride significant changes in colour from green to black along with change in pH from neutral to acidic was observed. And colour change which a visual confirmation of synthesized nanoparticles. A UV-visible spectrophotometer and a particle size analyzer were used to characterize the synthesized nanoparticles. The plant extract used in this study is unique in that it is both cost-effective and environmentally friendly, making it a viable option for large-scale synthesis of iron nanoparticles. The ecofriendly synthesized nano iron particle can also be used for seed treatment and foliar application as a source of fertilizer to help crops to overcome iron deficiency.

Keywords: Particle size analyzer (PSA); Tidex procumbace; Achyranthes aspera.

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1. INTRODUCTION

Green synthesis of nanoparticles is considered to be significant in modern techniques in the field of material science, life sciences, etc., due to its physicochemical properties such as extreme small size, large surface area to volume ratio, biocides, and antimicrobial [1]. Advancement in nanoparticle synthesis with improved production of energy, change in thermophysical properties, implementation in modern devices/ technology etc. will improve the quality of materials and matter and utilization in various industrial sectors [2]. Phytoconstituents play an important role in the green synthesis of nanoparticles due to its biocompatibility and cost effective and it does not involve any external force (high energy, temperature, pressure, etc.) [3]. Green synthesis of metal nanoparticles extracted from different parts (mostly leaf) of the plant is the most effective process of synthesis at a very affordable cost. During the synthesis bioreduction of metal ions takes place. According to the researchers the polyol components present in the plant extract are responsible for the reduction of iron ions whereas water soluble heterocyclic components stabilize the nanoparticles formed. Appropriate precursors such as Ferric Chloride can be used for the reduction of plant extracts [4].

Due to the cost-effective, safe and non-toxic method of nanoparticle synthesis, and the ability of plant extracts to act as capping/stabilizing agents thus reducing particle size and improving reactivity, green synthesis method is preferred. This method of synthesis will not release any toxic chemicals into the environment during their synthesis process as compared to chemical method of synthesis [5]. Plant extracts contain biomolecules like flavonoids, terpenoids, and other polyphenols that coat the nanoparticle surface and prevent agglomeration, resulting in a more uniform particle size distribution. [6]. Metal oxide nanoparticles have immense potential applications in the field of nanoscience, because of their semiconducting, antibacterial, antifungal, wound healing, UV-filtering properties and also used as fertilizer sources [7]. Knowing the importance of the metal oxide nanoparticles the present study was taken to synthesized the nano particles using various leaf extracts.

2. MATERIALS AND METHODS

Iron oxide nano particles were synthesized using weed leaf extracts of *Tridex procumbance, Achyranthes aspera* acted as reducing agent. Ferric chloride ($FeCl_3$) was used as iron precursor. Distilled water was used throughout the experiment. Details of weed that was used for leaf extract preparation include, *Tridex procumbance* common known as coat buttons, it belong to asteraceae family. The flavonoid procumbenetin has been isolated from the leaves. Other chemical compounds present in the plant include alkyl esters, sterols, fatty acids, pentacyclic triterpenes, and polysaccharides [8]. *Achyranthes aspera* belong to amaranthaceae family it is commonly called as chaff-flower or prickly chaff flower, the phytoconsttituent such as saponins and triterpenoid which possess oleanolic acid as the aglycone, ecdysterone an insect moulting hormone and long chain alcohols presence is reported [9].

Fig. 1. *Tridex procumbance*

Fig. 2. Achyranthes aspera

2.1 Leaf Extract Preparation

Leaf extracts were prepared by taking 50gm fresh leaves, they were of thoroughly washed with distilled water, dried on the absorbing paper and finely crushed with the help of mortar and pestle by adding 100 ml of deionized water gradually. The mixture was poured in a flask and heated for 5-10 minutes at 70^0 C followed by the mixture was then filtered using Whatman No. 1 filter paper. The filtered extract was centrifuged at 5000 rpm for 5 minutes and the supernatant was collected as the leaf extract and was used for further

2.2 Synthesis of Iron Oxide Nanoparticles

For synthesizing the iron oxide nanoparticles 0.1M ferric chloride ($FeCl_3$) used as a precursor. Both precursor and weed leaf extract was mixed with equal 1:1 proportion. 15 ml of leaf extract added drop by drop in 15 ml of 0.1M ferric chloride ($FeCl_3$) with constant stirring on magnetic stirrer at 500 rpm maintaining temperature of 70^o C followed by the synthesized solution was subjected to ultrasonication for 15 min.

2.3 Characterization of Nanoparticles

Characterization of synthesized particles was done using through UV-Vis Spectroscopy and Particle size Analyzer (PSA). Ultraviolet-visible spectroscopy (UV-Vis) refers to absorption spectroscopy in the UV-Visible spectral region (200–400 nm) which works with light in the visible and adjacent wavelength ranges (near-UV and near-infrared (NIR)). The color of the chemicals involved is directly affected by absorption in the visible range.

2.4 pH Analysis

The pH was measured with a Systronics Digital pH metre. The normal pH range of leaf extract was 7 to 8 that is neutral. The pH of reduced solution containing nanoparticles was observed to be acidic (2 to 3 pH range). After reduction, the pH of each sample dropped and moved closer to the acidic range (≤ 3).

3. RESULTS AND DISCUSSION

3.1 Iron oxide Nanoparticles Synthesis

The leaves extract acted as reducing as well as capping agent. Fe^{+3} ions were reduced into Fe^0 nanoparticles when leaves extracts was mixed with $FeCl_3$ solution. The water dispensed leaf extract when mixed with bright yellowish colour ferric chloride solution and it changed to black colour along with reduction in pH from of the solution was noticed from 7.21 to 2.84 in case of *Tridax procumbens* leaf extract synthesized nano iron and 7.37 to 3.17 in *Achyranthes aspera* leaf extract synthesized nano iron. The intensity of colour increased steadily up to 3 hours and it turned black colour within 24 hours indicated the synthesis of nano iron particles. After 24 hours there was no significant colour change, which was evidence for the completion of reduction reaction. This result was in conformity with the work of [10].

3.2 UV-Vis Spectroscopy

The reduction of Fe^{+3} in aqueous solutions was monitored by periodic sampling of aliquots of the mixture and subsequently measuring UV–Vis spectra. UV-Vis spectral analysis was done by using UV-Vis spectrophotometer Systronics 118 at the range of 215- 650 nm nm and observed

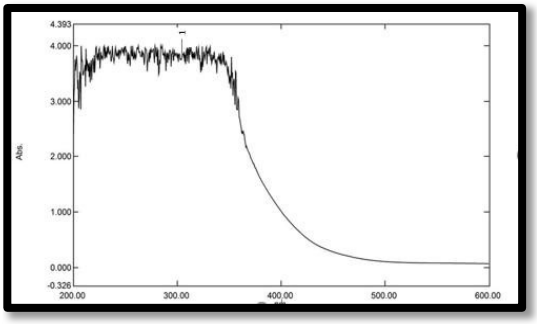

Fig. 3. *Tridex procumbance* Uv peak

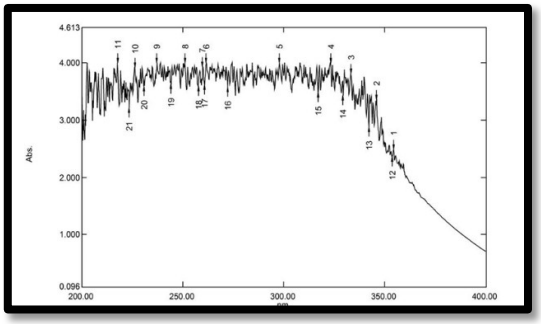

Fig. 4. *Achyranthes aspera* Uv peak

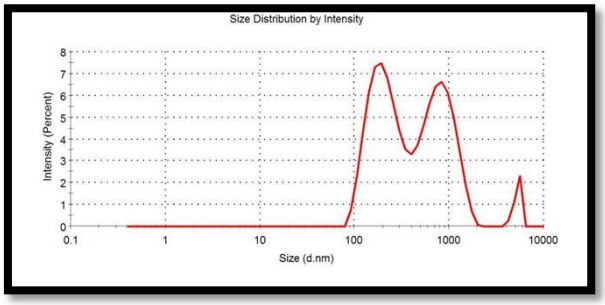

Fig. 5. PSA from *Tridex procumbance*

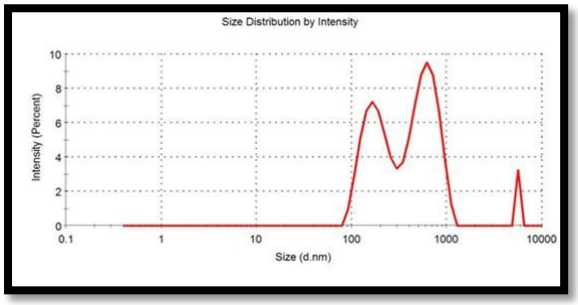

Fig. 6. PSA from *Achyranthes aspera*

the absorption peaks 305 nm (*Achyranthes aspera*) and 355 nm (*Tridax procumbens)* respectively. And this is due to the excitation of surface plasmon vibrations in the iron nanoparticles and this work is in conformity with the work of [11]. The result pertaining to this is presented in below.

3.3 Particle Size Analyzer (PSA)

The size distribution of synthesized nano particles measured by particle size analyser using a Malvern Zeta sizer Nano ZS90 based on quasi-elastic light scattering. The size of synthesized nano iron from *Tridax procumbens* was 364 nm and synthesized from *Achyranthes aspera was* 466nm further the size was reduced below 100 nm by centrifuging the sample at 10000 rpm for 5 minutes resulted in sample with less than 100 nm. The result pertaining to this is presented below,

4. CONCLUSION

Weed leaf extracts may be capable of producing Iron oxide nanoparticles. Nanoparticles exhibited good surface plasmon resonance behaviour when exposed to UV light. When Ferric chloride was mixed with a reducing agent, such as weed leaf extract, the colour change was also noticeable. The colour of the solution changed as reduction occurred, indicating a change in pH. The ability to synthesise metallic nanoparticles on such a short time scale is a viable alternative to chemical synthesis protocols and a low-cost reductant for iron nanoparticles. Higher characterization techniques such as XRD, SEM, TEM, FTRI, and others can be used for further confirmation of synthesizing the nanoparticle. Iron oxide nanoparticles that have been synthesised can be used to solve problems in agriculture, medicine, manufacturing, chemistry, military, water purification, and other fields. As green synthesis approach is an eco-friendly and sustainable approach that helps to reduce dependency on chemical methods of synthesis that release hazardous chemicals into the environment during the synthesis process.

DISCLAIMER

The product used for this research are commonly and predominantly use products in our area of research and country. Also the research was not funded by the producing company rather it was funded by personal efforts of author.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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