

GREEN BIOSYNTHESIS OF MAGNETIC IRON OXIDE NANOPARTICLES OF *VITEX NEGUNDO* AQUEOUS EXTRACT

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ABSTRACT

Objective: The green synthesis of magnetic iron oxide nanoparticles is a convenient, economical, rapid and eco-friendly method compared to physical and chemical synthesis methods.

Methods: In the present study iron oxide nanoparticles synthesized by *Vitex negundo* leaves extract.

Results: The formation of iron oxide nanoparticles was confirmed by the colour change and further characterized by UV-Visible Spectroscopy and XRD. The morphology and the size of nanoparticles were analyzed by SEM and HR-TEM analysis.

Conclusion: On the basis of this research work, green synthesized iron oxide nanoparticles can be a good source for alternative therapy for human diseases.

Keywords: Green synthesis, Iron oxide, Nanoparticles, *Vitex negundo*

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INTRODUCTION

In nanotechnology, magnetic iron oxide nanoparticles are microscopic particles and sized between 1 and 100 nanometers [1]. It has unique and most important property i. e larger surface area than superior particles which cause them to be more reactive to some other molecules. They are extensively synthesized by using physical and chemical methods. These synthesized methods are needed to use high energy, temperature, toxic chemicals and expensive. The primary goal of nanotechnology is to develop convenient, economical, rapid and eco-friendly green synthesis methods [2]. Magnetic iron oxide nanoparticles research is presently an area of passionate scientific interest due to a broad range of prospective applications. It is used as catalysis [3] high-density magnetic storage media [4] and chemical sensors [5]. It is an effective nano-agent to remove a number of pollutants from water resources [6]. It has many important biomedical applications such as for targeted drug delivery in clinical trials [7], contrast agents in magnetic resonance imaging (MRI) [8], antibacterial activity [9] and anticancer activities [10].

Vitex negundo Linn. is a large aromatic shrub distributed throughout India. Herbal medicine, rather than merely curing a particular disease, aims at returning the body back to its natural state of health. It has been used since ancient times as a female remedy and also for pains in Ayurveda and also in Roman medicine. It became known as the chaste berry tree. This species is globally distributed in Indo-Malesia, cultivated in America, Europe, Asia and West Indies. Within India, it is found throughout the greater part of India, in the outer Himalayas. Myriad medicinal properties have been ascribed to *Vitex negundo* Linn. and the plant has also been extensively used in the treatment of a plethora of ailments as traditional medicine, folk medicine and pharmacological evidence. Traditionally the leaves of *Vitex negundo* Linn. are documented to possess antibacterial, antitumor, astringent, febrifuge, sedative, tonic and vermifuge. It has been reported to possess potent pharmacological properties like anti-inflammatory, anti-rheumatic, antibiotic, Hepatoprotective, antioxidant, anticonvulsant, oxidative stress, anti-androgen, snake venom neutralization and anti-allergic activities. The various chemical constituents like flavonoids, flavones glycosides, volatile oil, triterpenes, tannins and many others were identified in this plant. This review gives a bird's eye view mainly on the pharmacokinetic

characteristics. traditional uses, phytochemistry and pharmacological actions of *Vitex negundo* Linn. Furthermore, a study by Lv *et al.* (2013) [11] revealed sesquiterpenes are the main constituents in the essential oil of *Vitex negundo*. Considering the ethnomedicinal properties and reported activities of *Vitex negundo* L., in the present investigation was preferred for nanoparticles synthesis.

MATERIALS AND METHODS

Collection and identification of plant

Fresh healthy leaves of *Vitex negundo* were collected from Presidency college, Chennai and were authentically identified by Prof. P. Jayaraman, Institute of Herbal Science, Plant Anatomy Research Centre, West Tambaram, Chennai, India as Verbenaceae with voucher specimen number PARC/2017/3149.

Synthesis of iron oxide nanoparticles using *Vitex negundo* extract

About 200 g of fresh healthy leaves of *Vitex negundo* were washed thoroughly with running tap water and double distilled water, cut into fine pieces and shade dried for 15 d under dark condition. After drying the leaves were powdered using a kitchen blender. The powdered leaves were soaked in the 400 ml of double distilled water for overnight in a fridge for 4 °C and then the rinsed mixtures were boiled for 10 min. The extracts were cooled to room temperature and then filtered through Whatman filter paper. Iron oxide nanoparticles were synthesized by taking FeCl₃.6H₂O and FeCl₂.4H₂O (1:2 molar ratios) and were dissolved in 100 ml of double distilled water in a 500 ml beaker and heated at 80 °C with mild stirring using magnetic stirrer under atmospheric pressure. After 10 min, 20 ml of the aqueous solutions of *Vitex negundo* extract was added to the mixture, immediately the light green colour of the *Vitex negundo* extract of the mixture changed to dark brownish colour. After 10 min, 20 ml aqueous solution of sodium hydroxide was added to the mixtures with the rate of 3 ml per minutes for allowing the iron oxide precipitations uniformly. From the first addition of sodium hydroxide, the dark brown mixture changed to black suspended particles. The mixture was allowed to cool down to room temperature and the iron oxide nanoparticles were obtained by decantation to form magnetite. The magnetites formed were washed 3 times with double distilled water and 3 times with ethanol and air dried at room temperature.

Characterization

The surface Plasmon resonances (SPR) of synthesized iron oxide nanoparticles have been studied by UV-Vis double-beam spectrophotometer Elico-BI-198 using the software Spectral Treats Version 2.37.4 Rel-1 in the range of 300 to 700 nm. The diffraction pattern was recorded by Seifert Rayflex Software which provides control modules for the complete range of diffractometer accessories together with the corresponding analysis software XRD with Cu-K α radiation. Morphological analysis of nanoparticles was done using Vega 3 Tescan SEM machine. The morphology of magnetic iron oxide nanoparticles was viewed under a Transmission electron microscope (HR-TEM, Jeol model 3010, at 200 Kv and 104.1 μ A).

RESULTS AND DISCUSSION

Synthesis of Iron oxide nanoparticles

Fig. 1 shows the iron oxide nanoparticles synthesized by chemical precipitation method. The powder form of synthesized nanoparticles using the aqueous extracts of *Vitex negundo* black in colour (fig. 1) and the intensity of color increased with time and dosage of plant extract it indicates the more growth of nanoparticles. The color change is the most easy and commonly used indication of

the metal nanoparticles formation. The plant extract contained much organic content. Hence the mechanism study of iron oxide nanoparticles formation is a little difficult. However, the organic compound, which is present in the plant extracts act as a reducing as well as capping or binding agent to form iron oxide nanoparticles.

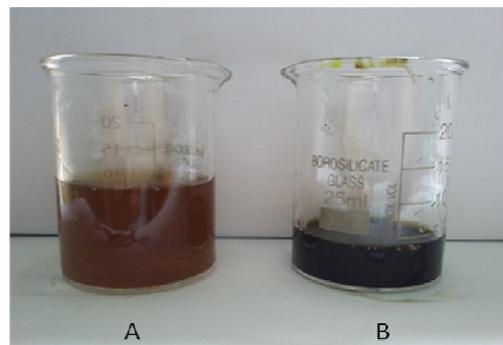


Fig. 1: A-*Vitex negundo* leaves aqueous extract, B-*Vitex negundo* leaves aqueous extract based synthesized iron oxide nanoparticles

Characterization of Iron oxide nanoparticles

UV-visible spectroscopy

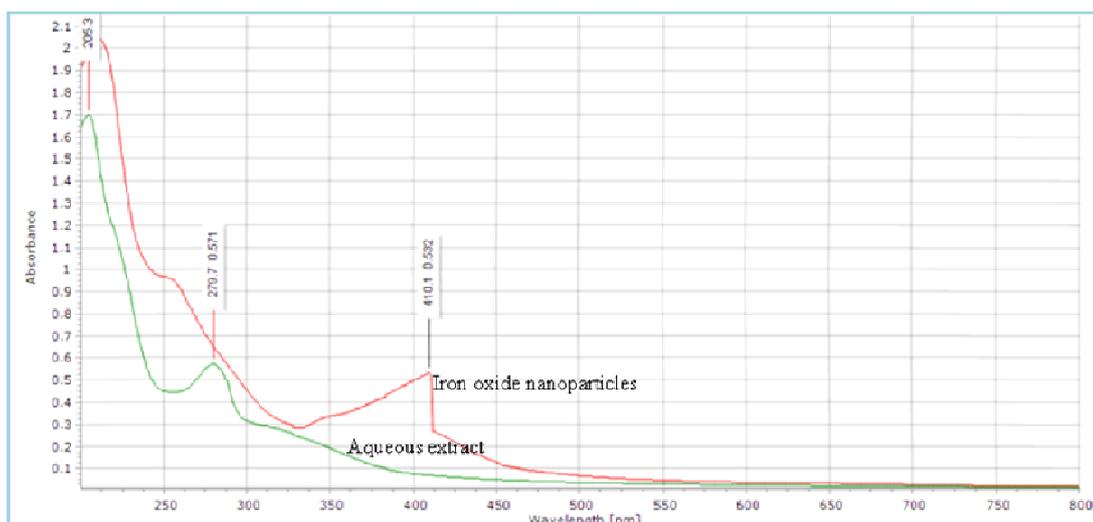


Fig. 2: Shows the UV-Visible spectra of *Vitex negundo* leaves iron oxide nanoparticles of with the varying λ max peaks around at 410 nm respectively

XRD spectral analysis

Fig. 3 shows the XRD pattern of Iron oxide nanoparticle. The narrow peaks in the fig. confirm the crystalline structure of iron oxide nanoparticles. The Structural characterization of the material was performed by using Powder X-Ray diffraction (XRD) analysis. The sample showed the major characteristic peaks for prepared crystalline metallic nanoparticles at two data values of 24.2, 33.1, 35.7, 40.9, 49.4, 54.1, 57.6, 62.6, and 64.0 degrees corresponding to (012), (104), (110), (113), (024), (116), (018), (214), and (300) respectively. The XRD analysis of *Vitex negundo* iron oxide nanoparticles clearly indicates the presence of high crystalline phases while the "d" value point out the presence of Fe₂O₄ and γ -Fe₂O₃. The d values are calculated from standard XRD pattern for Fe₃O₄ refers to the JCPDS data (88-2334). The plasma synthesis permits to produce highly crystalline nanoparticles in which the degree of the disorder can be tuned. The transmission electron microscopy analysis points out that, increasing the plasma current, the morphology of the nanoparticles changes from a symmetric spherical shape to a lower symmetry hexagonal shape as shown in the fig. 3.

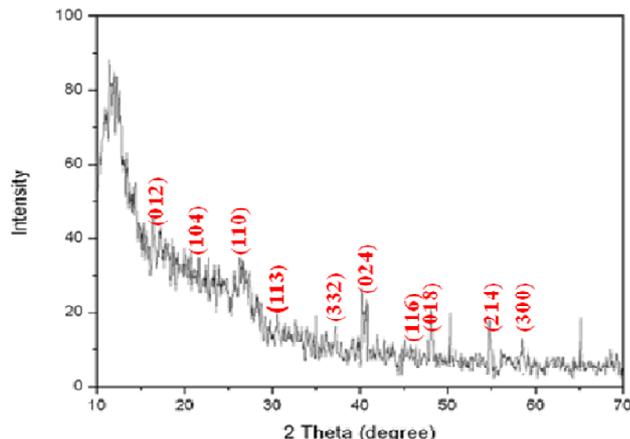


Fig. 3: XRD analysis of *Vitex negundo* iron oxide nanoparticles

SEM analysis

Fig. 4 shows the SEM image of Iron oxide nanoparticle synthesized by chemical precipitation method and the size of the particles in iron oxide nanoparticles were found to have agglomerated in its structures showing spherical, oval and triangle shapes. This is comparable to the findings of Wang *et al.* (2014) [12] who reported the size of iron nanoparticles by using Eucalyptus leaves was diameter ranging from 20 to 80 nm. On the contrary, Latha and Gowri (2014) [13] analysed the SEM image of iron oxide nanoparticles synthesized by Carica papaya leaf extracts demonstrated uniformly distributed spherical shaped particles. The increase in the size of nanoparticles confirms the presence of iron oxide nanoparticles with agglomerated in its structures.

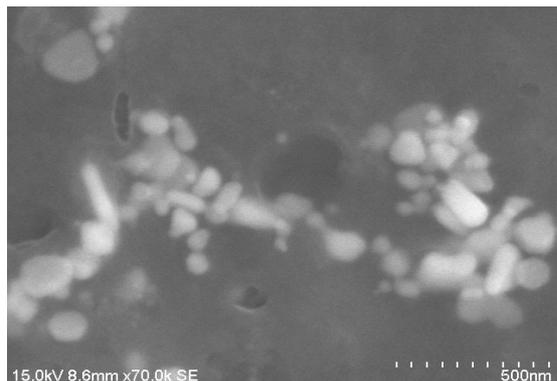


Fig. 4: FE-SEM image of *Vitex negundo* iron oxide nanoparticles

HR-TEM analysis

In addition, the iron oxide nanoparticles were analyzed by HR-Transmission Electron Microscopy. Fig. 5 shows the HR-TEM image of *Vitex negundo* iron oxide nanoparticles prepared from aqueous leaves extract of TEM image reveal that the iron oxide nanoparticles have the average core diameter of 20 to 22 nm and the nanoparticles are agglomerated and cluster. The aggregation may be due to a magnetic property of iron oxide nanoparticles as shown in the fig. 5 Iron oxide nanoparticles have a large surface to volume ratio and therefore possess high surface energies and consequently, they tend to aggregate so as to minimize the surface energies. The SAED pattern (fig. 6) reveals that nanoparticles are polydisperse in nature. HR-TEM image also revealed the successful synthesis of nanosized iron oxide particles, the average core diameter of 100 nm and the nanoparticles are agglomerated and cluster. The aggregation might be due to a magnetic property of iron oxide nanoparticles. Iron oxide nanoparticles have a large surface to volume ratio and possess high surface energies. Accordingly, they tend to aggregate so as to minimize the surface energies [14].

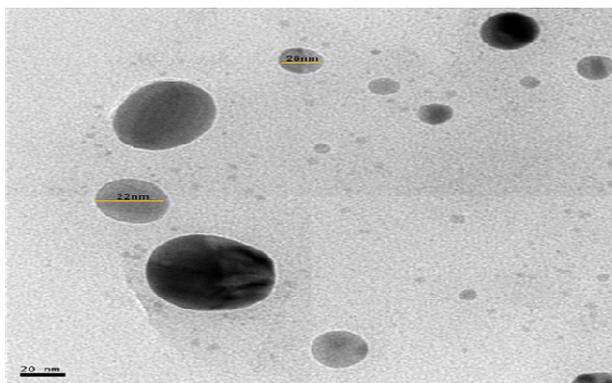


Fig. 5: HR-TEM image of *Vitex negundo* iron oxide nanoparticles

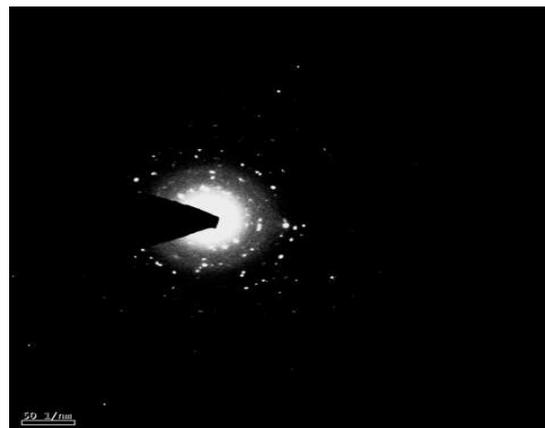


Fig. 6: SAED pattern image of *Vitex negundo* iron oxide nanoparticles

CONCLUSION

For the first time, biosynthesis of magnetic iron oxide nanoparticles by using *Vitex negundo* aqueous extract is reported. Measurement of UV, IR, XRD, SEM, and HR-TEM analysis confirmed the structures. On the basis of this research work, green synthesized iron oxide nanoparticles can be a good source for alternative therapy for human diseases. The study can be extended for nanomedicine application and preclinical studies in relevant animal models.

AUTHORS CONTRIBUTIONS

All the author have contributed equally

CONFLICT OF INTERESTS

Declared none

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