Green Synthesis and Characterization of Silver Nanoparticles using Fenugreek Seed Extract

E. Daisy Rani Angelina*, R. Bavyaa, Revathy Rajagopal**

* Department of Chemistry, Stella Maris College (Autonomous), Chennai- 600086. India.
** Department of Chemistry, Stella Maris College, Chennai, India

Abstract- Silver nanoparticles were synthesized at room temperature using fenugreek seed extract. The synthesized silver nanoparticles were characterized using UV-Visible spectroscopy, XRD and particle size analyser. The UV-Vis. spectra showed a red shift with time indicating the increase in particle size. The XRD data revealed that silver nanoparticles crystallizes in *fcc* structure with a space group of *Fm-3m*. The average size of the particles was found to be 174 nm.

Index Terms- Green synthesis, Nanocrystalline materials, Crystal structure, silver nanoparticles, particles,nanosize

I. INTRODUCTION

Silver nanoparticles have wide application in medicine [1]. The physical and chemical methods for preparation of silver nanoparticles employ toxic chemicals [2], on the other hand green synthesis [3-7] of nanoparticles uses natural plant, fruit, leaf or seed extracts and can be safely used for medicinal applications. Also the green synthesis is cost effective, environment friendly, fast in giving nanocrystalline materials. In the present work, we have found a cost effective method to synthesise silver nanoparticles using fenugreek seed extract.

II. RESEARCH ELLABORATIONS

All solutions were prepared using double distilled water. Initially 1 g of fresh organic grade fenugreek seeds were washed thoroughly and soaked in 100 ml of water for 24 h. It was then ground using a mixer and made into a paste. The resultant paste was diluted to get a homogenous solution with water and stirred for 3 h. Subsequently the solution was then centrifuged at 2000 rpm for 20 min. The supernated centrifugate was used as fenugreek extract. Silver nanoparticles were synthesized by adding 3.0 ml of fenugreek extract to $1x10^{-3}$M silver nitrate (Merck extrapure). solution The resultant solution was colourless initially and turned yellowish-brown colour within one hour. On addition of methanol, the precipitate obtained was then filtered and dried under deccicator.

III. RESULTS OR FINDINGS

The yellowish brown colour in Fig. 1 after one hour of addition of fenugreek extract indicates the formation of silver nanoparticles. It was observed that the solution colour intensified with time which can be attributed to increase in size of silver particles formed.

A B

Fig. 1. Colour of the solution of silver nitrate and fenugreek extract, (A) after 5 minutes and (B) After 1h.

The ascorbic acid and oxalic acid in fenugreek act as reducing agents and the other ingredients in fenugreek helps in stabilising the nanoparticles formed. The particle size graph is shown in Fig. 2 shows that the size of the particles is ranged between 43.82 nm – 1281 nm with a mean size of 174.18 nm. The broad spectrum of particle size may be due to agglomeration of silver particles with fenugreek seed extract.

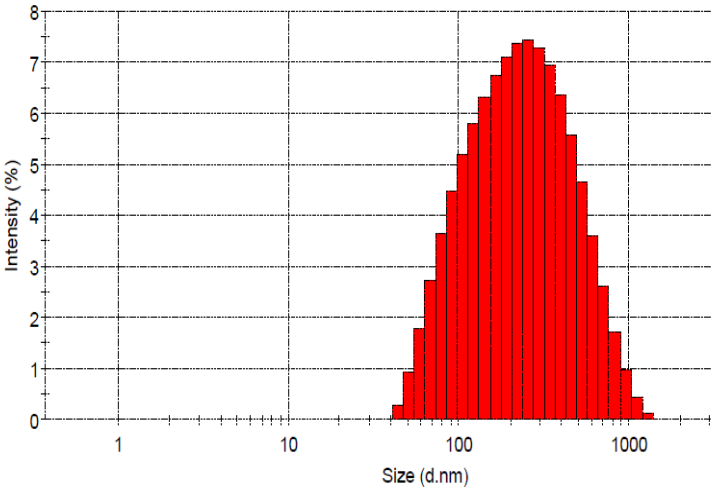

Fig. 2. Particle size distribution of silver nanoparticles.

UV-Vis spectrum was scanned after one hour and thereafter periodically once every day for a week. Figure 3 shows a peak at around 357 nm which was found to show red shift with broadening as time increases. The broadening and red shift may be due to increase in particle size. This observation can be confirmed by calculating the conduction band energy.

The conduction band energy represents the amount of energy required to excite the conduction electrons from the lowest energy state to higher energy states influenced by the UV-visible

electromagnetic radiation. The conduction band energy [8], *E* of Ag nanoparticles may be calculated using the relation

$E = hc/\lambda max$

Where *h* is the Planck's constant, *c* the speed of light, and λmax the wavelength of the absorption maxima. The absorption maximum λmax red shifted towards lower wavelength from 357 - 415 nm with time, corresponding to conduction band of 3.437 - 2.989 eV respectively. The conduction band energy is more for particles with small size as the number of atoms to make up the nanoparticles is few, so that conduction electrons are less attracted to protons of the Ag nanoparticles and, consequently increase the conduction band. Thus as the particle size increases with time, its conduction band decreases.

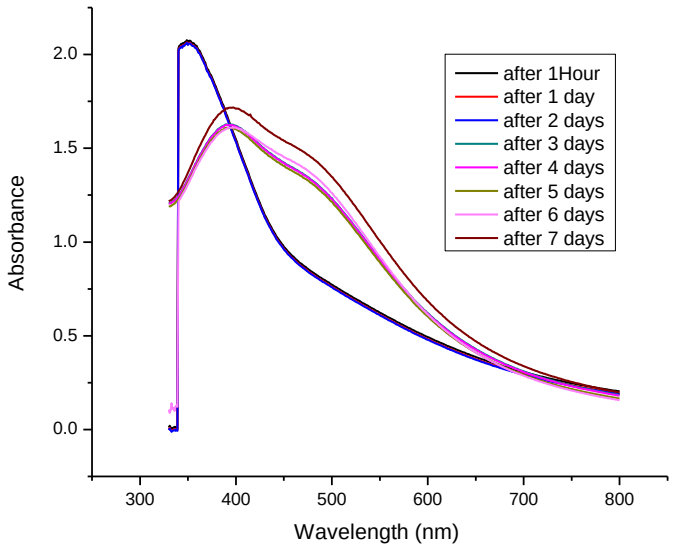

Fig. 3. UV-Visible spectra of silver nanoparticles.

The indexed xrd pattern in Figure 3 shows a slight broadening of peaks owing to small particle size of crystallites [9-10]. The high intense peak for *fcc* materials is generally (111) reflection and is shown by the synthesised silver nanoparticles. The intensity of the peaks reflected the crystalline nature of the silver nanoparticles.

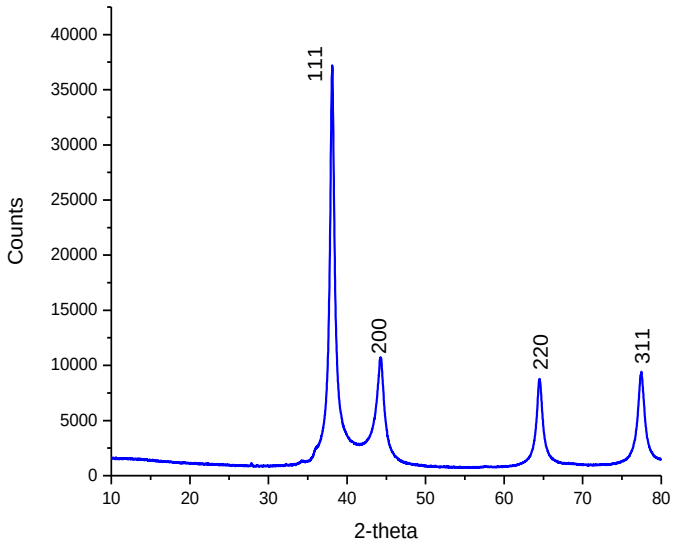

Fig. 4. Powder X-ray diffraction pattern of the synthesized silver nanoparticles.

Five peaks at 2θ values of 38.12, 44.24, 64.38 and 77.32 degrees corresponding to (111), (200), (220) and (311) planes of Silver were observed and found to match well with the standard powder diffraction card of Joint Committee on Powder Diffraction Standards (JCPDS), silver file No. 87–0720. The average 'a' value of the synthesised was found to be 4.079 Å.

IV. Conclusions

Silver nanoparticles were synthesized at room temperature using fenugreek extract. The present method of synthesis does not involve use of harmful chemicals and hence can safely be used for medicinal applications.

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AUTHORS

First Author – E. Daisy Rani Angelin, M.Sc. Chemistry, Department of Chemistry, Stella Maris College (Autonomous), Chennai- 600086. INDIA., e-mail: angelindaisy@gmail.com
Second Author – R. Bavya, M.Sc. Chemistry, Department of Chemistry, Stella Maris College (Autonomous), Chennai- 600086. INDIA., e-mail: bavyaravi@gmail.com

Third Author – Dr. Revathy Rajagopal, M.Sc, PhD Department of Chemistry, Stella Maris College (Autonomous), Chennai- 600086. INDIA.

Correspondence Author – Dr. Revathy Rajagopal, Department of Chemistry, Stella Maris College, Chennai, INDIA, Email: revathyrajagopalraju@gmail.com, Address: Department of Chemistry, Stella Maris College (Autonomous), 17, Cathedral Road, Chennai – 600086. INDIA, Phone: Landline: + 91- 44-28111987, Mobile: +91-9884271025