Effect of Medicinal Leaf Extract In Silver Nitrate - Size Reduction To Nano Scale

M. Irfana Amrin, R.Jothi Mani

ABSTRACT: Silver nanoparticles contribute a giant share to the field of modern nano biotechnology. They are attractive for medical purpose because of their unique features like relatively large surface to volume ratio and their ability to carry and adsorb drug/compounds. A great number of approaches were made to synthesize silver oxide nanoparticles with different shapes and sizes. Amongst them, plant extract mediated 'green' routes are popular to the researchers because of their easy availability and preparative protocol. Hence in the present work, Silver oxide (AgO) nanoparticles have been synthesized by using extracts of Alpinia galanga leaves as reducing agent. The synthesized material was characterized using X-ray diffraction (XRD),FTIR, Uv-Visible, Photoluminescence spectroscopy. The morphology wasfound from SEM micrographs and EDX analysis was also carried out.

Keywords: AgO nanoparticles; Alpinia galanga leaf; EDAX; FTIR;UV; SEM; XRD;

1. INTRODUCTION

"Nanotechnology is the application of science to control matter at the molecular level". Tremendous growth in nanotechnology has opened up novel fundamental and applied frontiers in materials science and engineering. Developments in the organization of nanoscale structures into predefined superstructures ensure that nanotechnology will play a critical role in many key technologies. It is gaining importance in areas such as mechanics, optics, biomedical sciences, chemical industry, electronics, space industries, drug-gene delivery, energy science, catalysis, optoelectronic devices, photo electrochemical applications, and nonlinear optical devices Nanoparticles are of great interest due to their extremely small size and large surface to volume ratio, which lead to both chemical and physical differences in their properties (*e.g.* mechanical properties, biological and sterical properties, catalytic activity, thermal and electrical conductivity, optical absorption and melting point) compared to bulk of the same chemical composition. There are many important applications for metal nanoparticles in medicine and pharmacy. Gold and silver nanoparticles are the most common ones used for biomedical applications and in emerging interdisciplinary field of nanobiotechnology. Nanoparticles have been produced physically and chemically for a long time, but recent developments show the critical role of microorganisms and biological systems in production of metal nanoparticles. The use of organisms in this area is rapidly developing due to their growing success and ease of formation of nanoparticles. For instance, production of silver nanoparticles by chemical reduction (*e.g.*, hydrazine hydrate, sodium borohydride, DMF, and ethylene glycol) may lead to absorption of harsh chemicals on the surfaces of nanoparticles raising the toxicity issue. Moreover, biosynthesis of metal nanoparticles is an environmentally friendly method (green chemistry) without use of harsh, toxic and expensive chemicals. [1- 2**]** *Alpinia galanga* (AG) is an important Ayurvedic medicinal plant belonging to the family Zingiberaceae. It is a perennial herb found commonly throughout the Western Ghats of India. The plant has been found to possess various therapeutic activities like anti-inflammatory, antiallergic, antifungal, antibacterial, and antidiabetic. It is used as a constituent in various Ayurvedic preparations like *Dasamoolarishtam, Rasnadi Choornam, Aswagandharishtam, Balarishtam,* and so forth. The rhizome is also used against rheumatism, ulcers, throat infections, stomach disorders, and skin diseases. The rhizome contains tannins and flavonoids such as kaempferol, galangin, and alpinin [3]. In addition to that, they are also found to contain acetoxy chavicol acetate, acetyl euginol acetate, *p*-coumaryl alcohol, methyl cinnamate, cineole, pinenes, and camphor to a certain extent [4]. In India it has many applications in traditional medicines such as for skin diseases, indigestion, colic, dysentery, enlarged spleen, respiratory diseases, mouth cancer and stomach cancer. It is used as a body deodorizer and halitosis remedy [5]. As there was no work reported before for synthesizing silver oxide nanoparticles using Alpinia galanga leaves it was carried out in the present work reported here.

2. EXPERIMENTAL DETAILS

2.1 Materials and synthesis:

Analytical grade $AgNO_3$ (silver nitrate, ≥99.9%) is purchased without any further purification. Fresh leaves of Alpinia galanga were collected from the garden, Tirunelveli. The leaves were washed under running tap water for several times and later with distilled water. They were grinded with the help of a mixer grinder and then the extract was taken from the grinded paste. It was then filtered and used for the synthesis process. A standard solution of 0.1 M silver nitrate was prepared and the leaves extract was added to the standard solution of silver nitrate until precipitate forms. The mixture was then stirred for about four hours. A colour change was observed from colourless to grayish black solution. Initial formation of silver nanoparticles was determined by its colour change (Fig 1). The solution obtained was filtered using whatman filter paper and washed twice with double distilled water and the precipitate were collected in a petri dish and dried in the hot air oven at 100°C for one day.

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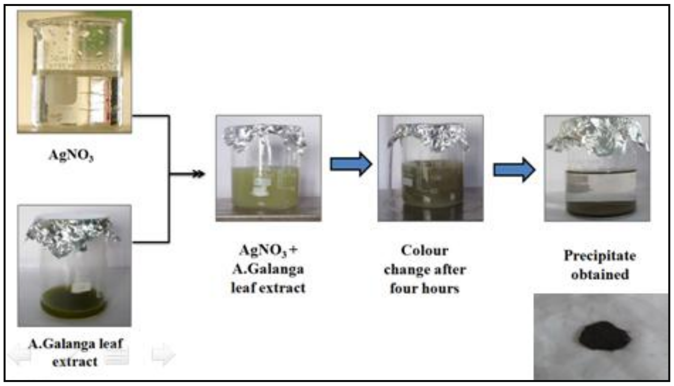


Figure 1: *Reaction process using A. galanga and the obtained AgO Nanoparticles*

2.2. Characterizations

Structural characterization of the nanoparticles were carried out at room temperature using Analytical XPERT-PRO with monochromatic beam of Cu Kα radiation (1.5406 A°) over 2θ range of 0°-80° The FTIR spectra of the synthesized samples were recorded using Thermo Scientific, Nicolet iS5 Fourier Transform Infrared Spectrometer and the Uv-Visible spectra of the synthesized nanoparticles were recorded in the range 200 nm - 900 nm covering the near UV, visible, near infrared region using Jasco UV650 UV-Vis Spectrophotometer. The photoluminescence spectrum at RT was recorded on a spectrofluorescencemeter. SEM analysis was carried out using JEOL, JSM6390 Scanning Electron Microscope and the EDAX analysis was performed using OXFORD INSTRUMENTS, INCApentaFETx3 Energy Dispersive X-Ray spectrometer.

3. RESULTS AND DISCUSSION

3.1. X-Ray Diffraction Analysis

The X - ray diffraction (Figure 2) shows the Braggs reflections at 2θ =29.7065, 32.3087, 38.2006, 46.2864, 54.9545, 57.5900 and 64.5489, which can be indexed to the (1 2 1), (2 0 2), (0 0 4), (1 3 2), (2 2 4), (4 0 2) and (2 4 2) planes of AgO respectively. These peaks were matched with the standard AgO (JCPDS No: 84-1108). The comparison confirms the presence of AgO phases in the present specimen and found to have tetragonal structure with lattice constant a= 6.7902A˚, c = 9.3659A˚. Figure 3 represents the Hall Williamson plot. The average crystallite size was found using scherrer formula and Hall Williamson plot [6] as 28.65 nm and 24.58 nm respectively.

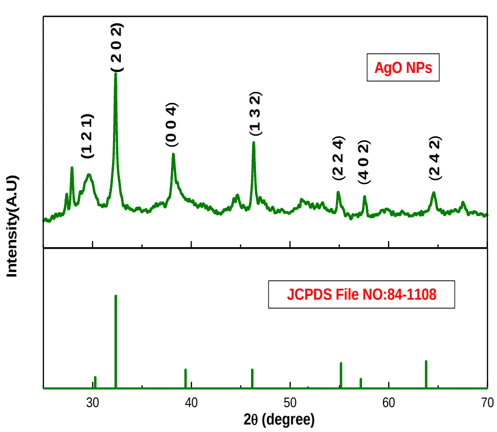


Figure 2. X-ray diffraction pattern

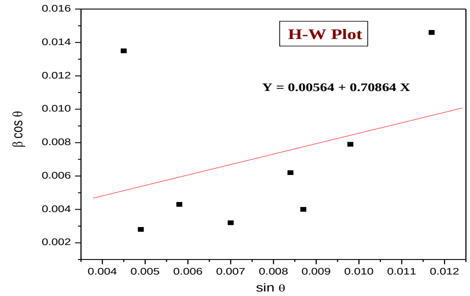


Figure 3. Hall Williamson plot of AgO Nanoparticles

3.2. FTIR Analysis

FTIR studies are important in the investigation of molecular structure and to identify the possible bio molecules present in the leaf extract that was responsible for the reduction of the Ag+ ions and the functional groups of the synthesized sample. Prominent peaks were observed around 1600 cm^{-1} , 700 cm^{-1} and 526 cm^{-1} corresponding to C=O stretching, C-H bending and AgO Vibration [7] respectively. In addition to this, some other minor peaks were also obtained. The spectrum of the leaf extract and the AgO Nanoparticles were shown in figure.4

3.3. UV and Photoluminescence analysis

To evaluate the optical properties, the as-synthesized silver oxide nanoparticles was examined by using a UV-Visible (UV-Vis) spectrophotometer at room-temperature. Figure 5 illustrates the typical UV-

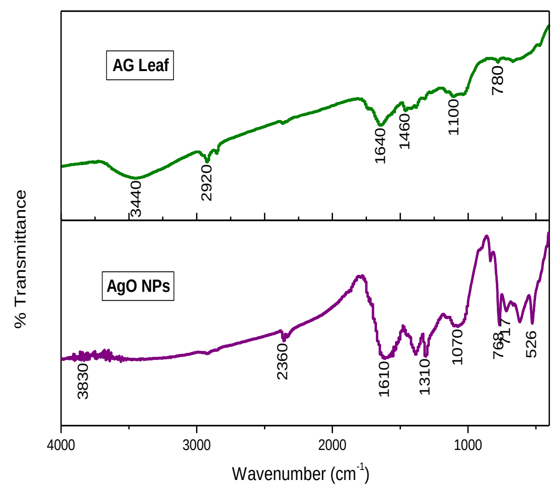


Figure 4. FTIR Spectra of AG leaves and AgO nanoparticles

Visible absorption and a well-defined absorption peak at about 300 nm is clearly visible which represents the characteristic Surface Plasmon Resonance (SPR) absorption band of the silver nanoparticles. The optical band gap (OBG) of the nanoparticles was observed by using the Tauc's equation, **$(\alpha h\nu) = A (h\nu - E_g)^n$**, where α is the absorption coefficient, A is a constant, *hν* is the energy of incident photons and exponent *n* whose value depends upon the type the transition which may have values 1/2, 2, 3/2 and 3 corresponding to the allowed direct, allowed indirect, forbidden direct and forbidden indirect transitions, respectively. The OBG was found to be 3.42 eV from tauc's plot shown in figure 5 (inner graph). The PL of the synthesized bio-inspired AgO NPs is studied via fluorescence emission spectroscopy to know the fluorescence property. The synthesized sample was excited at 300 nm. Based on the excitation maxima, emission scans were carried out in the range of 200- 900 nm. The emission of fluorescence was obtained for the synthesized sample (Fig 6). The peak at 380 nm (Eg = 3.3 eV) was nearly coincidence with the UV Spectra. The peaks at 520 nm and 790 nm were due to the presence of oxygen vacancy and surface imperfections respectively.

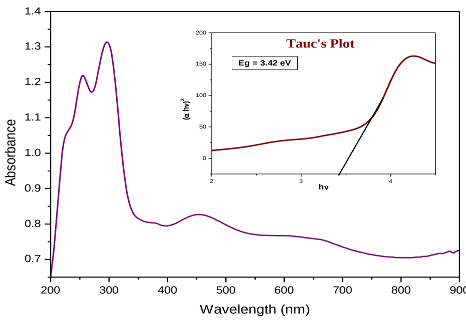


Figure 5. UV Absorbance Spectrum and Tauc's Plot

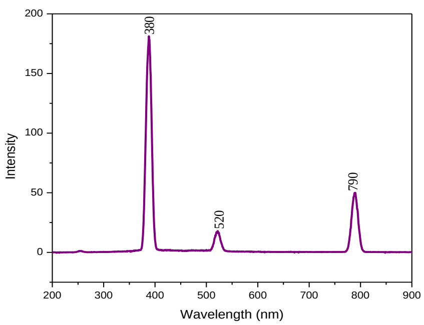
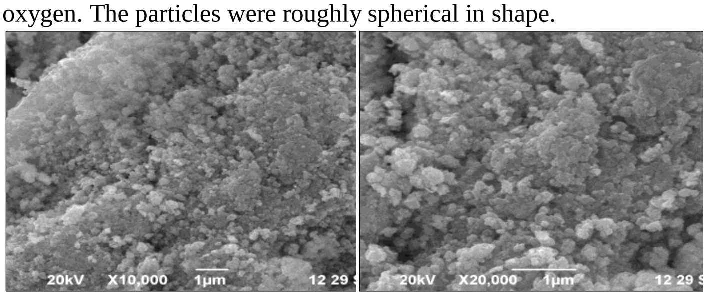


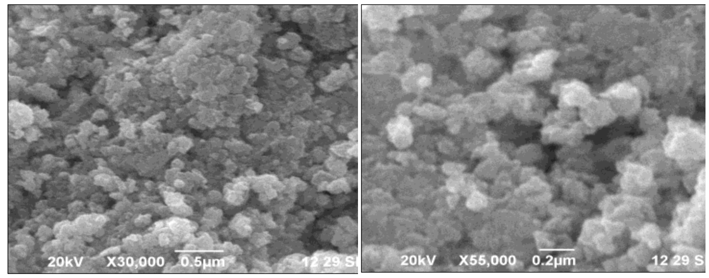
Figure 6. Photoluminescence Spectrum

3.4. SEM with EDX Analysis

Typical scanning electron microscopic analysis was employed to study the morphology of the nanoparticles and EDX to confirm the presence of elemental metal signals. Figure 7. represents the surface morphology of the silver oxide nanoparticles at different magnifications like (a) x 10,000 (b) x 20,000 (c) x 30,000 and (d) x 55,000. The SEM images reveal the high density silver oxide nanoparticles and confirmed the development of silver nanostructure. The particles seem to be aggregated however the boundaries between single crystallites are clearly observable. The EDX result shows higher counts at 3 keV due to silver nanoparticles (fig 8). Generally metallic silver nanocrystals show typical optical absorption peak approximately at 3 keV [8-9] due to surface plasmon resonance. It also revealed the presence of oxygen. The particles were roughly spherical in shape.



(a) (b)



(c) (d)

Figure 7. SEM micrographs of AGSO at different magnifications
(a) x 10,000 (b) x 20,000 (c) x 30,000 (d) x 55,000

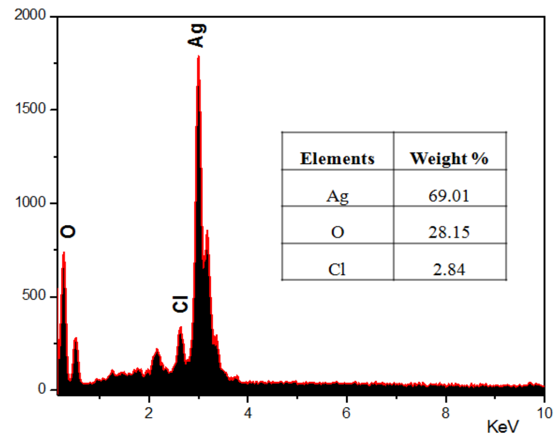


Figure 8. EDX Spectrum of Ago Nanopartcles

4. CONCLUSION

The present method is low cost at ambient condition and eco-friendly way to synthesize metal oxide nanoparticles. The size and structure of synthesized nanoparticles were determined from the XRD data. The FTIR spectroscopic analysis of the green reducing agent revealed the presence of the functional groups corresponding to the phytochemicals present in the plants that acted both as reducing and capping agent in the synthesis and also the synthesized samples showed the functional groups responsible for AgO Vibration. The bandgap was found to be 3.42 and 3.3 from UV and PL analysis respectively. The difference was due to the stokes shift. SEM analysis revealed the roughly spherical morphology of the nano crystallites. Elemetal compositions were identified by EDAX spectrum.

Acknowledgment

The authors are grateful to the management of Sadakathullah Appa College, Tirunelveli for the encouragement given to us to carry out the research work. Research supports given by Manonmaniam Sundaranar University at Tirunelveli, V.O.Chidambaram College at Thoothukudi, SFR College at Sivakasi and Karunya University at Coimbatore is gratefully acknowledged.

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