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Green synthesis of Silver Nanoparticles using *Datura metel* leaves extract

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Abstract

In the present paper, green synthesis of Silver Nanoparticles (Ag NPs) was performed from aqueous silver nitrate using the reducing agents of Datura metel L., leaves extract of partition aqueous fraction. The change of color from colorless to dark brown was visually identifying the formation of Ag NPs. The synthesized Ag NPs were characterized by UV-vis spectrophotometer, FTIR spectroscopy, and X-ray diffraction (XRD) analyses. From the UV-vis absorption of the wavelength region at 450nm was confirm the synthesis of Ag NPs. FTIR spectrum results to indicates the presence of phytochemical functional groups to capping the NPs. XRD analysis of Ag NPs, the four peaks were identified by face centered cubic structure of the nanoparticles. The mean sizes of nanoparticles were calculated by Debye-Schrrer equation.

Keywords- Datura metel L., Silver nanoparticles, Debye-Schrrer equation

I. INTRODUCTION

There is an increasing commercial demand for nanoparticles due to their wide applicability in various areas such as electronics [1], biology, chemistry [2], biotechnology energy and medicine [3]. Nanotechnology is mainly concerned with synthesis of various metal nanoparticles of variable sizes, shapes, chemical compositions and controlled dispersity and their potential use for human benefits. Although chemical and physical methods may successfully produce pure, well-defined nanoparticles, these methods are quite expensive and potentially dangerous to the environment. Use of biological organisms such as microorganisms [3], bacteria [4,5], fungi [6], and plant extract [7] or plant biomass could be an alternative to chemical and physical methods for the production of nanoparticles in an eco-friendly manner. Metallic nanoparticles are mostly prepared from Nobel metal ions such as Gold, Silver, Platinum and Lead by economic, eco-friendly simple route of green/biosynthesis of plant extract methods. Among the Nobel metals, Silver (Ag) is the metal of choice in the field of biological systems, living organisms and medicine. *Datura metel* L., (Karoo omatay – Tamil) belongs to Solanaceae family. The leaves of this plant, it helps in the treatment of swelling to the bite of vipers and poisonous insects. The whole plant, but especially the leaves and seed, have anaesthetic, hallucinogenic, antiasthmatic, antispasmodic, antitussive, bronchodilator, anodyne, hypnotic and mydriatic effects. It has a wide range of applications in India, including in the treatment of epilepsy, hysteria, insanity, heart diseases, and for fever with catarrh, diarrhea and skin diseases [8]. The major/minor phytochemicals such as steroids, saponins, tannins, alkaloids, flavonoids, and phenolic compounds [9] have been isolated various parts of this plant. A poultice of the crushed leaves is used to relieve pain. In the present work, green synthesis of Ag NPs was synthesized from the *Datura metel* leaves extract partition of aqueous fraction.

II. MATERIALS AND METHODS

2.1 Plant Materials

Healthy leaves of *Datura metel* L., were collected from the area of Keelapathai, Tirunelveli district, Tamilnadu, India. The freshly collected leaves of *D. metel* were thoroughly washed with running tap water followed by ultra–pure deionized water to remove the filth. The cleaned leaves were taken in a 250ml Erlenmeyer flask; 100ml of triply distilled water was added and boiled at 80°C for 10min. The leaf extract was filtrate through Whatman's filter paper and the obtained filtrate was stored at 4°C for further use in the partition of n-hexane (A1), chloroform (A2), ethyl acetate (A3) and triple distilled water (A4) by using separating funnel to required amount the solvent. The A4 fraction was used in the green synthesis of Ag NPs.

2.2 Green synthesis of Silver Nanoparticles

In the typical green synthesis of Ag NPs, 0.1ml of A4 fraction of *D. metel* leaves extract was added to 8ml of 1mM aqueous $AgNO_3$ solution and kept in a dark place at room temperature. After few minutes, the colorless reaction mixture was changed to dark brown color which indicates the formation of Ag NPs [10]. The synthesized Ag NPs were periodically characterized by UV-vis, FTIR spectroscopy and XRD technique.

2.3 Characterization of Silver Nanoparticles

The green synthesis of Ag NPs solution was recorded on a Perkin-Elmer (Lambda 25 Model) UV-vis spectrophotometer and the sample was measured in the wavelength region of 200-800nm. The performed green synthesized Ag NPs solution was centrifuged at 5000rpm speed for 15min at 40ºC to obtain the residue of nanoparticles. To remove untreated free biomass residue or compound that is not the capping ligand of the nanoparticles was re-dispersed in 10ml sterile distilled water to repeat the centrifuged. Thoroughly washed residual part of Ag NPs was dried in a hot air oven at 60ºC for 12h. After the purified and dried Ag NPs was analysis by X-ray diffraction (XRD) analysis using PANalytical X'PERT-PRO powder X-ray diffractometer operated at a voltage of 40 kV and a current of 30 mA with Cu Kα radiation in the 2θ range of 20-80 degree to record the spectrum. The crystallite domain size NPs was calculated from the width of the XRD peaks using the Debye Scherrer formula (1).

$$D= k \lambda / \beta \cos \theta \quad \text{-------- (1)}$$

where D is the average crystallite domain size perpendicular to the reflecting planes, λ is the X-ray wavelength, β is the full width at half maximum (FWHM), and θ is the diffraction angle. The phytochemical functional groups of the biomasses of the extract and NPs was recorded by JASCO FTIR spectrophotometer using KBr pellet technique in the range of 400-4000 cm^{-1} with the spectra resolution of 4 cm^{-1}.

III. RESULT AND DISCUSION

Green synthesis of Ag NPs was synthesized by *D. metel* leaves extract of aqueous fraction. Initially, the crude extract of this *D. metel* leaves extract was separated with n-hexane, chloroform, ethyl acetate and triple distilled water using the separating funnel to the required amount of solvent. The less reducing and capping phytocompounds of chlorophyll, sterols, terpenoids, and alkaloids was removed by n-hexane, chloroform, and ethyl acetate. The remaining aqueous fraction was used in the green synthesis of Ag NPs.

Green synthesis of Ag NPs was synthesized from 8ml of 1mM aqueous silver ions using the reducing and capping agents of the 0.1ml of *D. metel* leaves extract partition of the aqueous fraction (A4). After 2h the colorless reaction mixture changed to dark brown was visually identified the formation of Ag NPs as shown in Fig. 1. The change of dark brown color was confirm the corroborated the green synthesis of Ag NPs [11]. Formation and stability of Ag NPs was characterized using UV-vis spectrophotometer. Fig. 2 shows the characteristic surface Plasmon resonance band at 450nm was confirm the synthesis of Ag NPs respectively [12].

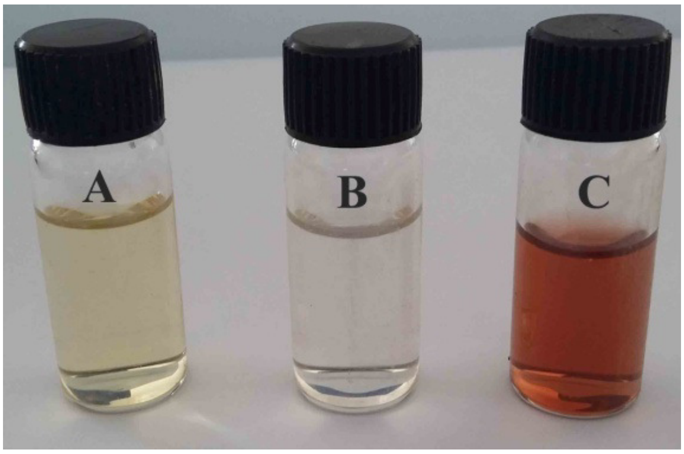

Fig .1 photograph image of the green synthesis of Ag NPs; A) *Datura metal* leaves extract separated A4 fraction; B) 1mM of Ag^{+} ions solution; C) Ag NPs.

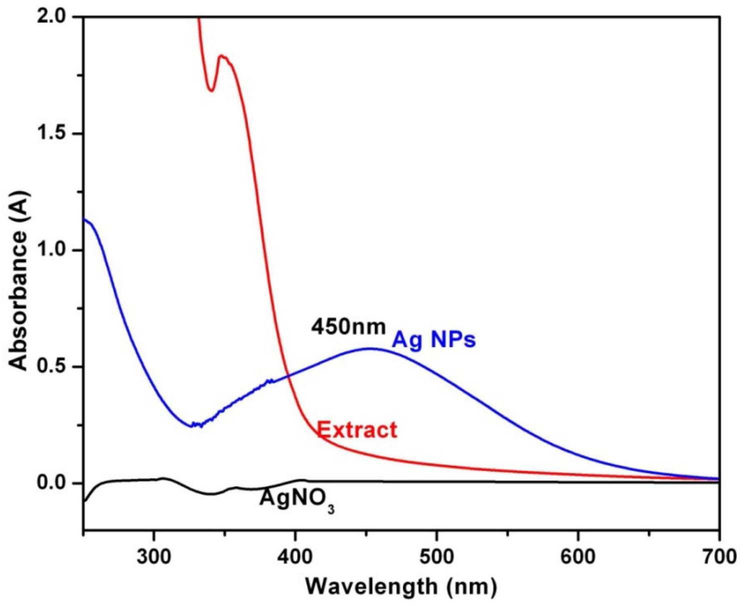

Fig. 2. UV-Vis absorption spectrum of Ag NPs synthesized by treating 1mM aqueous $AgNO_3$ solution with *Datura metal* leaf extract (A4 fraction) of after 4h.

The crystalline nature of the Ag NPs was confirmed by XRD analysis (Fig.3) of the four peaks 2θ value at 38.28, 44.42, 64.61, and 77.58 which correspond to lattice planes at (111), (200), (220), (311) have indexed as face centered cubic crystal structure of Ag NPs. The XRD pattern results are corroborated with the data base of JCPDS file no. 87-0720 and biosynthesized Ag NPs respectively [13]. The performed Ag NPs XRD values were calculated (Debye Scherrer equation) by the particles size ranges of the silver from 25-40nm respectively.

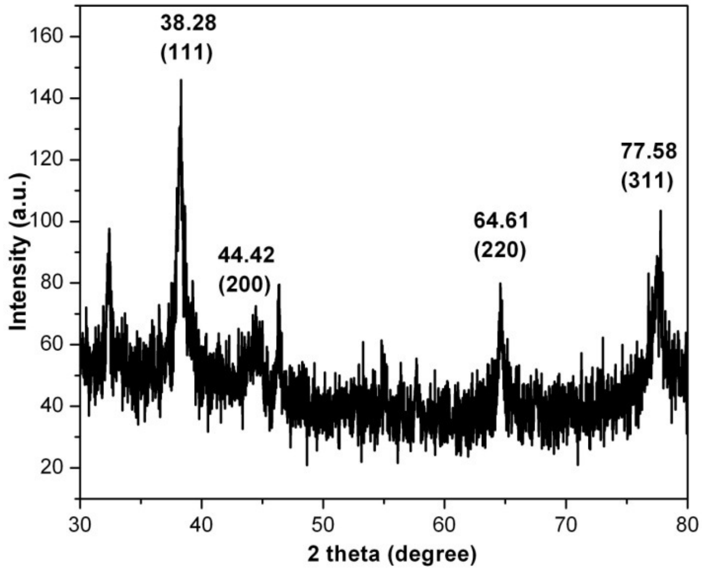

Fig. 3. XRD spectrum of Green synthesized of Ag NPs.

Further, the biogenic Ag NPs were characterized by FTIR spectra (Fig.4). The spectral results shown at 3450 and 2922 cm^{-1} values were assigned to –OH and –CH stretching respectively. The other peaks at 1638 cm^{-1} is due to C=O groups, 1382 cm^{-1} represented the amide group and 1105 cm^{-1} was assigned to C-N stretching vibration of the amine groups. The FTIR spectra results formerly indicated that the leaves extract phytocompounds such as flavonoids, polyphenolic compounds, carbohydrates, amino acids, and proteins might be participating in the process of nanoparticles synthesis [14,15].

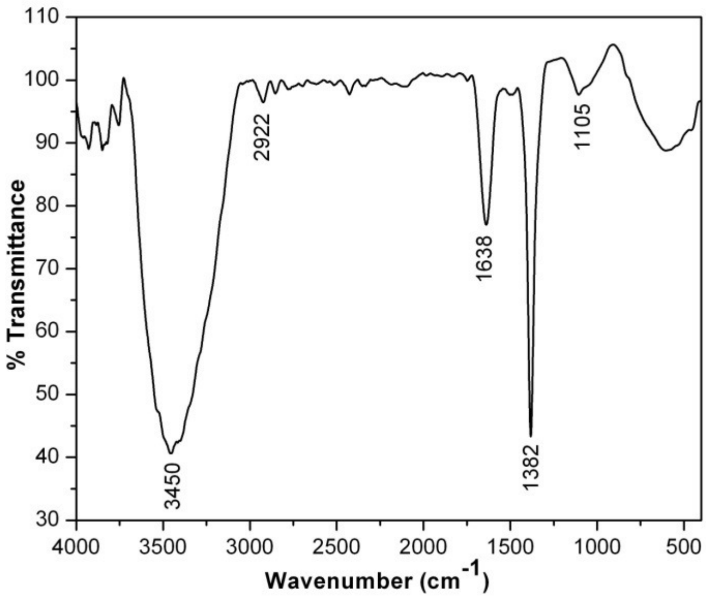

Fig. 4. FTIR spectrum of Ag NPs.

IV. CONCLUSION

In conclusion, the green synthesis of Ag NPs has been performed using the bio-reducing agent of *D. metal* leaves extract of the partition fraction A4. This A4 fraction contains the phytochemicals such as flavonoids, carbohydrates and polyphenolic compounds are present. These compounds are good reducing and stabilizing agents in the synthesized Ag NPs. Green synthesized procedure (using environmentally benign natural resources) with a lot of advantages such as eco-friendly, biocompatibility and cost-effective allowing large scale synthesis of Ag NPs and it's used in the antimicrobial, antioxidant and other pharmaceuticals activity.

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