iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 3 **Issue:** VI **Month of publication:** June 2015

DOI:

International Journal for Research in Applied Science & Engineering Technology (IJRASET)

Synthesis and Characterization of Silver Nanoparticles Using Celastrus Paniculatus Leaf Extract

M. V. Ramana[1], V.V.Janaki Rama Rao[2], P.Anitha[3], T.Sujatha[4], S.Shantkriti[5], M.C.Rao[6]
[1,3] Department of Physics, [2] Department of Chemistry [4]Department of Microbiology,
SR&BGNR Govt. Arts & Science College, Khammam, Telangana, India.
[5] Department of Biotechnology, National College, Thiruchirapalli, Tamilnadu India
[6]Department of Physics, Andhra Loyola College, Vijayawada, Andhra Pradesh, India.

Abstract*— This paper reports a rapid and ecofriendly green method for the synthesis of silver nanoparticles from silver nitrate solution using Celastrus Paniculatus leaf extract. Effect of Celastrus Paniculatus leaf extract , silver nitrate concentration, reaction time and temperature on reaction rate were investigated. The synthesized silver nanoparticles(AgNPs) were characterized with X-Ray diffraction (XRD), Fourier Transform Infrared spectroscopy(FTIR), Scanning Elctron microscopy (SEM) and Energy Dispersive X-ray analysis (EDX) and UV-Vis spectrscopy. All these results indicate the formation of silver nanoparticles and the gave surface plasmon resonance SPR) at 437 nm reveals the reduction of silver ions (Ag+) to silver (Ag0) which indicates the formation of silver nanoparticles (AgNPs) . The nanoparticles synthesised in this route were spherical in shape and were around 29 to 57 nm in shape as observed by Scanning Electron Microscopy (SEM).
***Keywords*— Silver nanoparticles, Celastrus Paniculatus, leaf extract, Biosynthesis, XRD, EDX, FTIR and SEM**

I. INTRODUCTION

Nanotechnology is a rapidly expanding and has potential implications on society, industry, and medicine. The uses of nano-sized particles are even more remarkable. They are mostly prepared from noble metals like silver, gold, platinum and palladium out of which Silver nanoparticles are being most exploited [1]. Silver nanoparticles have various applications including medicine and electronics. Synthesis of inorganic nanoparticles by biological systems makes nanoparticles more biocompatible and environmentally benign [2]. The synthesis of nanoparticles using green methods has evolved into an important branch of nanotechnology, because these methods are considered to be safe and ecologically sound. The green synthesis techniques utilize relatively non-toxic solvents such as water, biological extracts, biological systems and microwave assisted synthesis. Because of their wide range of applications in electronics, medicine, materials sciences due to good conductivity and chemical stability, bio-labeling, opto-electronics, medical devices, antibacterial and biomaterials production, the Silver nanoparticles (AgNPs) have become the focus of intensive research. The use of plant extracts for the synthesis of silver nanoparticles has been extensively carried out by the researchers such as Ficus benghalensis, Rosa rugosa, Stevia rebaudiana, chenopodium album, Nicotiana toboccum,Trianthema de candra, polyathia longifolia, Cycas, Pinus desiflora, Diopyros kaki, Ginko biloba, Magnolia kobus, and Pllatanus orientalis, Catharanthus roseus, Pungamia pinnata, Hemiidesmus indicus, Syzygium cumini, Allium cepa, and pandadnus odorifer, Sesuvium portulacastrum , Acalypha indica , Pathenium hystrophorous, Capsicum annum, Piper longum, Arbutus unedo, and Ocium santum. A review of the synthesis of metal nanoparticles using biosynthesis routes using leaf extracts was carried by Ramana et al [3]. Recently biosynthesis of nanoparticles using plant extracts has become popular because of its simple and economic feasibility. Silver nanoparticles have been synthesized using biosynthesis routes, by this group recently, using Ocimum tenuiflorum L. Green and Purple [4], and Ocimum americanum L. [5] and Ocimum basilicum L.Var.thyrsiflorum [6] Leaf extracts. Ocimum gratissimum leaf extract is also found to be a good candidate to be used in nanostructure synthesis [7]. With the positive results that were obtained using different plant, root and leaf extracts in the synthesis of silver nanoparticles, and also on the basis of available scientific literature, this study was designed with a simple, rapid, cost-effective and environmental friendly synthesis method of silver nanoparticles at ambient conditions using *Celastrus Paniculatus* leaf extract.

II. EXPERIMENTAL

Silver Nitrate ($AgNO_3$) was obtained from Aldrich chemicals. Leaf extract of celastrus Paniculatus, with commercial and popular name Jyothismathi, was procured from the outlet of Vindhya herbals, MFPP&RC, Bhopal, India at Ujjain

Mahakaleswar temple, Ujjain. All glassware have been washed sterile distilled water and dried in an oven before use. The leaf extract solution was prepared by mixing 2 gms of leaf extract powder in 20 ml of sterile distilled water. The mixture was then boiled for 10 minutes until the colour of the aqueous solution darkens. Then the extract was cooled to room temperature and filtered with Whatman No.1 filter paper. Filterate was collected and stored at room temperature in order to be used for further experiments. This extract was used for the reduction of Silver Ions (Ag+) to Silver nanoparticles (Ag^0) . Accurate concentration of 1 mM $AgNO_3$ (Merck India Ltd) was prepared by dissolving 0.169 gram $AgNO_3$ in 1000 mL double distilled water and stored in Amber colored bottle to avoid auto oxidation of silver. 5 mL of Celastrus Paniculatus leaves extract (as supplied) was added by coninuously stirring to 100 ml of 10^{-3} M in aqueous solution of Silver Nitrate ($AgNO_3$) in 250mL flask at room temperature. The mixture was heated in a water bath at (30-80^0C) for 5 minutes. It was observed that the color or the Solution mixture of silver nitrate and Celastrus Paniculatus leaf extract changed at 40^0C and 8 min of reaction time. Increasing the temperature of water bath to 60^0C and 10 min of reaction time, the color of the mixture was changed to deep brown Color and at 15 min of reaction time at 60^0C the deep brown color was Changed to blackish gray. This type of change in colour is generally attributed to excitation of surface plasmon resonance. This indicates the reduction of Ag+ ions to Ag^0 nanoparticles. This shows that as the temperature of the reaction increases, the reaction was faster. The silver nanoparticles (AgNps) obtained by Celastrus Paniculatus leaf extract were centrifuged at 15,000 rpm for 10 min and subsequently redisposed in sterile distilled water to remove the uncoordinated biological matter. Synthesized Silver nanoparticles were initially characterized by taking absorption spectra in the range 300-700 nm using Shimadzu UV-1800 Spectrophotometer. Fourier-transform infra red spectrum was carried with Bruker FTIR model. The spectrum was recorded in mid-IR region of 400-4000cm^{-1} with 16 scan speed, using attenuated total reflectance (ATR) technique. Scanning electron microscopic (SEM) analysis was carried using Zeiss, EV-18 model scanning electron microscope. A thin film of the sample was prepared on a carbon coated copper grid by placing small amount of the sample on the grid. Then it was allowed to dry using mercury lamp for 5 min. Energy Dispersive X-ray analysis (EDX) was carried out on Zeiss, EV-18 model. The peaks obtained from EDX gives the element composition of the sample.

III. RESULTS AND DISCUSSION

The present study emphasizes the synthesis of Silver nanoparticles using Celastrus Paniculatus leaf extract, which act as reducing and capping agents in silver nanoparticles synthesis. Studies have indicated that biomolecules like protein, phenols, and flavonoids not only play a role in reducing the ions to the nano size, but also play an important role in the capping of the nanoparticles [8,9]. The reduction of Ag+ ions by combinations of biomolecules found in these extracts such as vitamins, enzymes, proteins, amino acids, polysaccharides and organic acids [9,10] which are environmentally benign, yet chemically complex.

A. UV –Visible Spectra Analysis

The nanoparticles were preliminarily characterized by UV-Visible Spectroscopy. As the leaf extracts were mixed with aqueous solution of the Silver nitrate solution, the change in colour indicates the excitation of the surface plasma vibrations indicating the formation of the Silver nanoparticles [11]. The UV -visible spectrum absorption is recorded at room temperature clearly indicates the surface plasma resonance with an absorption peak at 436 nm. This type of absorption has been reported by other workers in the case of silver nanoparticle formation [12].

B. FTIR- Spectroscopy

The FTIR spectrum of silver nanoparticles synthesized using Celastrus Paniculatus leaf extract was analysed and the bands are assigned after comparing FTIR spectra earlier reported in the case of silver nanoparticles, as follows:

TABLE I
FTIR BANDS ASSIGNMENT

wavenumber	Assignment
3298 cm^{-1}	O-H stretching of H-bonded alcohols and phenols
2929 cm^{-1}	O-H stretching of carboxylic acids
1638 cm^{-1}	N-H bending of primary amines
1549 cm^{-1}	N-H bending of primary amines

Volume 3 Issue VI, June 2015
ISSN: 2321-9653
International Journal for Research in Applied Science & Engineering Technology (IJRASET)

1448 cm^{-1}	C-C stretching of aromatic ring structure
1367 cm^{-1}1	C-N streching of aromatic amine group.
1219-1037 cm^{-1}	C-C streching of alcohols, carboxylic acids, ethers and esters

C. SEM Analysis

The scanning electron microscope images that are recorded show the presence of Silver nanoparticles. One such SEM image is presented in figure.1. The silver nanoparticles were spherical in shape. The size of these silver nanoparticles is ranging from 32nm to 57nm.

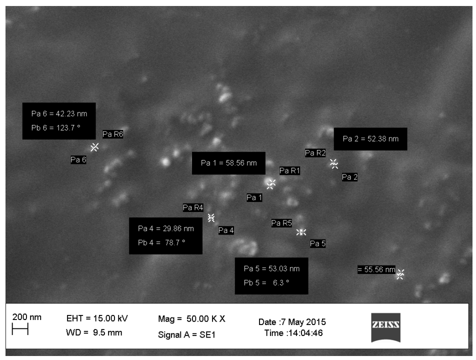

Fig .1 SEM image of silver nanoparticles formed using Celastrus Paniculatus leaf extract

D. EDX Analysis

The EDX spectra show the purity of the material and the complete chemical composition of synthesized silver nanoparticles. The EDX analysis of Silver nanoparticles produced by Celastrus Paniculatus leaf extract is presented in Fig.2 and it revealed a reasonable percentage of silver indicating the purity of the synthesized sample.

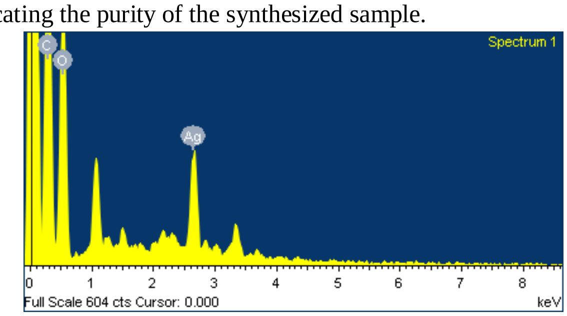

Fig .2 EDX spectrum of the samples under the study

E. XRD Analysis

The synthesized silver nanoparticles were analysed using X-Ray Diffraction technique. The diffracted intensities were recorded from 0^0 to 80^0 at 2 theta angles. The diffraction pattern almost corresponds to that of pure silver. No peaks of the XRD pattern of Ag_2O and other substances appeared. It can be stated that the obtained silver nanoparticles had a high purity. The presence of various crystalline biological macromolecules in the plant extract may be the reason for the observed peak broadening and noise. These were also related to the effect of nanosized particles in literature. These results indicate that the silver ions are reduced to Ag^0 by the addition of Celastrus Paniculatus leaf extract .

IV. CONCLUSIONS

The present study reveals that Celastrus Paniculatus leaf extract is yet another good source for the synthesis of Silver nanoparticles using green methods. The formation of silver nanoparticles was confirmed by the colour change . The silver nanoparticles synthesized using Celastrus Paniculatus leaf extract were characterized using XRD, UV-Vis, SEM, FTIR techniques. The silver nanoparticles formed were quite stable in the solution. The carbohydrates, flavanoids and poly phenol constituents present in leaf extract act as the surface active stabilizing molecules for the synthesis of Ag NPs. This method is another cost effective methods to biosynthesize nanoparticles from the natural resources.

V. ACKNOWLEDGMENT

The authors would like to thank Head, Department of Physics and the Director CFRD, Osmania University, Hyderabad for experimental facilities provided. One of the authors (MVR) would like to thank UGC, New Delhi for the financial assistance provided under project. No. 39-464/2010(SR) .

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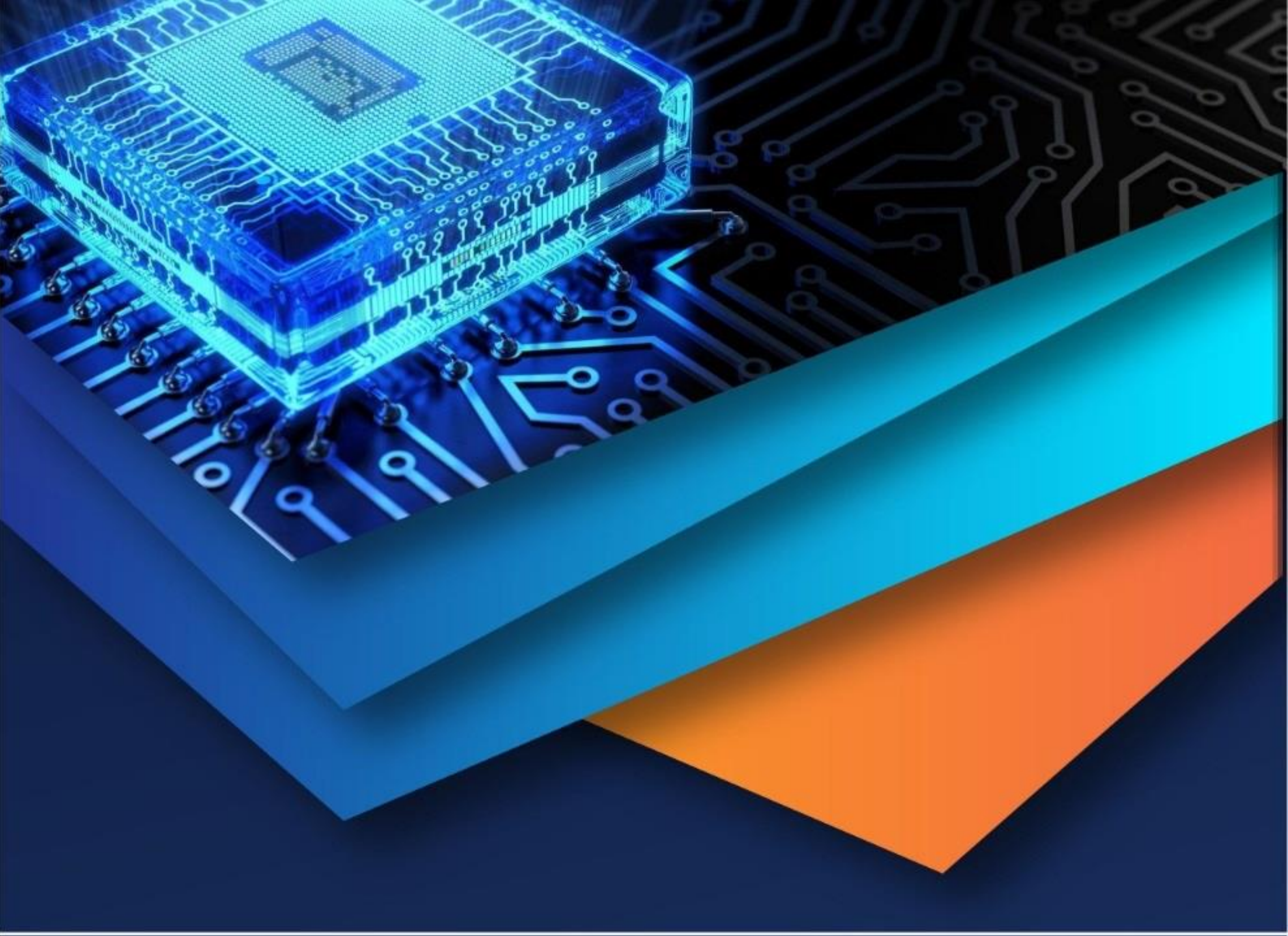

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